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(Additional Counsel for Plaintiffs listed below signature line)

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

ALIPHCOM D/B/A JAWBONE and BODYMEDIA, INC. Plaintiffs, v. FITBIT, INC. Defendant.	Case No: 3:15-cv-2579 **COMPLAINT FOR PATENT INFRINGEMENT** JURY TRIAL DEMANDED

Plaintiffs AliphCom d/b/a Jawbone and BodyMedia, Inc. (collectively, "Plaintiffs" or "Jawbone"), by their undersigned attorneys, for their complaint against Fitbit, Inc. ("Fitbit"), hereby allege the following:

1. This is an action for patent infringement arising under the patent laws of the United States, Title 35 of the United States Code.[1] Jawbone seeks damages and injunctive relief for infringement of its patents by Fitbit's wearable fitness tracker devices.

2. AliphCom is a corporation organized and existing under the laws of California with its principal place of business located in San Francisco, California.

3. BodyMedia, Inc. is a corporation organized and existing under the laws of Delaware with its principal place of business located in Pittsburgh, Pennsylvania. BodyMedia is a wholly owned subsidiary of AliphCom.

4. Plaintiffs are informed and believe, and on that basis allege, that Defendant Fitbit is a corporation organized and existing under the laws of Delaware with its headquarters at 405 Howard Street, San Francisco, CA 94105. Fitbit transacts substantial business, either directly or through its agents, on an ongoing basis in this judicial district and elsewhere in the United States.

JURISDICTION AND VENUE

5. This Court has subject matter jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338(a).

6. This Court has personal jurisdiction over Defendant because Defendant is located in this District, has committed acts of infringement in violation of 35 U.S.C. § 271, and has placed infringing products into the stream of commerce, through an established distribution channel, with the knowledge and/or understanding that such products are used and sold in this District. These acts cause injury to Plaintiffs within the District. Defendant derives revenue from the sale of infringing products distributed within the District, expects or should reasonably expect

[1] AliphCom and BodyMedia intend to file a complaint requesting the International Trade Commission (ITC) to commence an investigation pursuant to Section 337 of the Tariff Act of 1930, 19 U.S.C. § 1337, of Fitbit's unlawful importation into the United States, sale for importation into the United States, and sale within the United States after importation of products that infringe AliphCom and BodyMedia's patents. The ITC complaint will include some or all of the patents and accused products asserted in this district court action.

transactions to have consequences within the District, and derives substantial revenue from interstate and international commerce.

7. Venue is proper in this Federal District pursuant to 28 U.S.C. §§ 1391(b)-(c) and 1400(b) in that Defendant has a regular and established place of business in this District, a substantial part of the events giving rise to the claim occurred in this District, and Defendant has committed acts of infringement in this district.

BACKGROUND

8. Jawbone is a world leader in consumer technology and wearable devices with hundreds of patents that have been granted or are pending related to Jawbone's ecosystem and wearable technology manufacturing processes. In the field of wearable technology, Jawbone's UP® system in connection with its UP Move, UP2 and UP3 trackers collect and provide personalized data about how consumers sleep, move and eat. The UP Platform also includes apps and services that integrate with UP devices to offer new, customized experiences.

9. In April 2013, AliphCom acquired BodyMedia for over $100 million and obtained the rights to BodyMedia's expansive patent portfolio in the field of wearable technology.

10. BodyMedia helped to pioneer the development of wearable body monitors that collect physiological data for use in improving health, wellness and fitness. Founded in 1999, BodyMedia patented widely in the field of wearable technology.

11. Together, BodyMedia and Jawbone have almost three decades worth of technology, science and intellectual property around wearable trackers that allow consumers to measure their activity and set wellness goals.

12. Jawbone has invested heavily in its wearable technology business. In just the last two years, Jawbone has spent well over a $100 million in research and development related to its wearable devices along with the technology and underlying systems that support them.

13. Jawbone employs over 400 people, spread across Jawbone's San Francisco, Sunnyvale, Pittsburgh, Seattle, and New York facilities as well as overseas. Jawbone's operations include BodyMedia employees and research operations.

14. Fitbit competes directly with Jawbone in the market for wearable fitness and activity trackers through its product line, most notably the Zip, One, Flex, Charge, Charge HR, Surge. These trackers – which make up virtually all of Fitbit's wearable technology line – infringe one or more of the Jawbone patents.

COUNT 1 – INFRINGEMENT OF U.S. PATENT NO. 8,446,275

15. On May 21, 2013, the United States Patent and Trademark Office issued United States Patent No. 8,446,275 ("the '275 patent") for an invention entitled "General Health And Wellness Management Method And Apparatus For A Wellness Application Using Data From A Data-Capable Band." AliphCom is the assignee and owner of the '275 patent and holds all rights, title and interests in the '275 patent, including the right to sue for and recover all past, present and future damages for infringement. A true and correct copy of the '275 patent is attached as Exhibit A.

16. Fitbit has infringed and continues to infringe one or more claims of the '275 patent by its making, manufacture, use, sale, importation, or offer for sale of its wearable fitness tracker devices, including but not limited to the following: Zip, One, Flex, Charge, Charge HR, Surge, and reasonably similar products.

17. Fitbit is liable for its infringement of the '275 patent pursuant to 35 U.S.C. § 271(a), (b), and (c).

18. Fitbit knowingly induces others to perform steps that infringe claims of the '275 patent. Fitbit's inducement of infringement includes, but is not limited to: (i) knowledge of the '275 patent; (ii) intent to induce direct infringement of the '275 patent; (iii) knowingly aiding and abetting infringement at least by providing and encouraging the use of the Fitbit App and/or Fitbit Dashboard, as well as by providing instruction manuals, online websites including tutorials and frequently asked questions, and other directions that instruct the purchaser or user of an accused device to use that device in a manner that infringes certain claims of the '275 patent; and (iv) actual or constructive knowledge that their actions induce infringement.

19. Fitbit is also liable for contributory infringement because it offers to sell or sells within the United States or imports into the United States wearable fitness tracker devices that

constitute a component of a patented combination and a material part of the invention claimed by the ’275 patent, knowing the same to be especially made or especially adapted for use in an infringement of such patent, which wearable fitness tracker devices are not a staple article or commodity of commerce suitable for substantial noninfringing use.

20. Fitbit’s acts of infringement have damaged Plaintiffs, and Plaintiffs are entitled to recover from Fitbit the damages they have sustained as a result of Fitbit’s wrongful acts in an amount subject to proof at trial. Fitbit’s infringement of Plaintiffs’ rights under the ’275 patent will continue to damage Plaintiffs, causing irreparable harm for which there is no adequate remedy at law, unless enjoined by this Court.

COUNT 2 – INFRINGEMENT OF U.S. PATENT NO. 8,073,707

21. On December 6, 2011, the United States Patent and Trademark Office issued United States Patent No. 8,073,707 (“the ’707 patent”) for an invention entitled “System For Detecting, Monitoring, And Reporting An Individual’s Physiological Or Contextual Status.” BodyMedia is the assignee and owner of the ’707 patent and holds all rights, title and interests in the ‘707 patent, including the right to sue for and recover all past, present and future damages for infringement. A true and correct copy of the ’707 patent is attached as Exhibit B.

22. Fitbit has infringed and continues to infringe one or more claims of the ’707 patent by its making, manufacture, use, sale, importation, or offer for sale of its wearable fitness tracker devices, including but not limited to the following: Charge HR, Surge, Aria, and reasonably similar products.

23. Fitbit is liable for its infringement of the ’707 patent pursuant to 35 U.S.C. § 271(a), (b), and (c).

24. Fitbit knowingly induces others to perform steps that infringe claims of the ’707 patent. Fitbit’s inducement of infringement includes, but is not limited to: (i) knowledge of the ’707 patent; (ii) intent to induce direct infringement of the ’707 patent; (iii) knowingly aiding and abetting infringement at least by providing and encouraging the use of the Fitbit App and/or Fitbit Dashboard, as well as by providing instruction manuals, online websites including tutorials and frequently asked questions, and other directions that instruct the purchaser or user of an accused

device to use that device in a manner that infringes certain claims of the '707 patent; and (iv) actual or constructive knowledge that their actions induce infringement.

25. Fitbit is also liable for contributory infringement because it offers to sell or sells within the United States or imports into the United States fitness tracker devices that constitute a component of a patented combination and a material part of the invention claimed by the '707 patent, knowing the same to be especially made or especially adapted for use in an infringement of such patent, which fitness tracker devices are not a staple article or commodity of commerce suitable for substantial noninfringing use.

26. Fitbit's acts of infringement have damaged Plaintiffs, and Plaintiffs are entitled to recover from Fitbit the damages they have sustained as a result of Fitbit's wrongful acts in an amount subject to proof at trial. Fitbit's infringement of Plaintiffs' rights under the '707 patent will continue to damage Plaintiffs, causing irreparable harm for which there is no adequate remedy at law, unless enjoined by this Court.

COUNT 3 – INFRINGEMENT OF U.S. PATENT NO. 8,398,546

27. On March 19, 2013, the United States Patent and Trademark Office issued United States Patent No. 8,398,546 ("the '546 patent") for an invention entitled "System For Monitoring And Managing Body Weight And Other Physiological Conditions Including Iterative And Personalized Planning, Intervention And Reporting Capability." BodyMedia is the assignee and owner of the '546 patent and holds all rights, title and interests in the '546 patent, including the right to sue for and recover all past, present and future damages for infringement. A true and correct copy of the '546 patent is attached as Exhibit C.

28. Fitbit has infringed and continues to infringe one or more claims of the '546 patent by its making, manufacture, use, sale, importation, or offer for sale of its wearable fitness tracker devices, including but not limited to the following: One, Charge, Charge HR, Surge, and reasonably similar products.

29. Fitbit is liable for its infringement of the '546 patent pursuant to 35 U.S.C. § 271(a), (b), and (c).

30. Fitbit knowingly induces others to perform steps that infringe claims of the '546 patent. Fitbit's inducement of infringement includes, but is not limited to: (i) knowledge of the '546 patent; (ii) intent to induce direct infringement of the '546 patent; (iii) knowingly aiding and abetting infringement at least by providing and encouraging the use of the Fitbit App and/or Fitbit Dashboard, as well as by providing instruction manuals, online websites including tutorials and frequently asked questions, and other directions that instruct the purchaser or user of an accused device to use that device in a manner that infringes certain claims of the '546 patent; and (iv) actual or constructive knowledge that their actions induce infringement.

31. Fitbit is also liable for contributory infringement because it offers to sell or sells within the United States or imports into the United States wearable fitness tracker devices that constitute a component of a patented combination and a material part of the invention claimed by the '546 patent, knowing the same to be especially made or especially adapted for use in an infringement of such patent, which wearable fitness tracker devices are not a staple article or commodity of commerce suitable for substantial noninfringing use.

32. Fitbit's acts of infringement have damaged Plaintiffs, and Plaintiffs are entitled to recover from Fitbit the damages they have sustained as a result of Fitbit's wrongful acts in an amount subject to proof at trial. Fitbit's infringement of Plaintiffs' rights under the '546 patent will continue to damage Plaintiffs, causing irreparable harm for which there is no adequate remedy at law, unless enjoined by this Court.

JURY DEMAND

33. Pursuant to Rule 38(b) of the Federal Rules of Civil Procedure, Plaintiffs respectfully requests a trial by jury on all issues.

PRAYER FOR RELIEF

WHEREFORE, Plaintiffs request entry of judgment in their favor and against Fitbit as follows:

a. Declaring that Defendant has infringed the '275,'707 and '546 patents;

b. Awarding compensatory damages arising out of Defendant's infringement of the '275,'707 and '546 patents to Plaintiffs together with prejudgment and post-judgment interest, in an amount according to proof;

c. Permanently enjoining Defendant and its respective officers, agents, employees, and those acting in privity with them from the make, manufacture, use, sale, importation, or offer for sale of products that infringe, including by contributory infringement or induced infringement, the '275,'707 and '546 patents;

d. Awarding attorney's fees pursuant to 35 U.S.C. § 285 or as otherwise permitted by law; and

e. Awarding such other costs and further relief as the Court may deem just and proper.

Dated: June 10, 2015

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Attorneys for Plaintiffs AliphCom d/b/a Jawbone and BodyMedia, Inc.

Exhibit A

US008446275B2

(12) **United States Patent**
Utter, II

(10) **Patent No.: US 8,446,275 B2**
(45) **Date of Patent: May 21, 2013**

(54) **GENERAL HEALTH AND WELLNESS MANAGEMENT METHOD AND APPARATUS FOR A WELLNESS APPLICATION USING DATA FROM A DATA-CAPABLE BAND**

(75) Inventor: **Max Everett Utter, II**, San Francisco, CA (US)

(73) Assignee: **AliphCom**, San Francisco, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/454,040**

(22) Filed: **Apr. 23, 2012**

(65) **Prior Publication Data**

US 2012/0313776 A1 Dec. 13, 2012

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/433,204, filed on Mar. 28, 2012, which is a continuation-in-part of application No. 13/181,495, filed on Jul. 12, 2011, which is a continuation-in-part of application No. 13/180,000, filed on Jul. 11, 2011, said application No. 13/433,204 is a continuation-in-part of application No. 13/158,416, filed on Jun. 11, 2011, which is a continuation-in-part of application No. 13/158,372, filed on Jun. 10, 2011, said application No. 13/181,495 is a continuation-in-part of application No.

(Continued)

(51) **Int. Cl.**
G08B 1/08 (2006.01)

(52) **U.S. Cl.**
USPC **340/539.12**; 340/573.1; 600/300; 600/301; 482/9

(58) **Field of Classification Search**
USPC 340/539.12, 573.1, 691.6, 693.5, 340/3.1, 3.31; 600/509, 300, 301; 482/8, 482/9, 900; 128/905, 920
See application file for complete search history.

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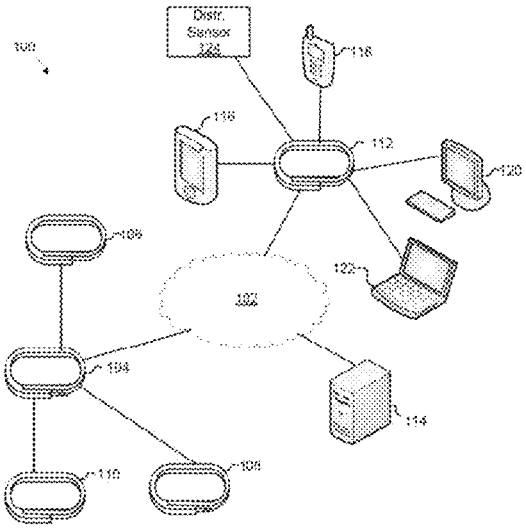
(Continued)

Primary Examiner — Toan N Pham
(74) *Attorney, Agent, or Firm* — Kokka & Backus, PC

(57) **ABSTRACT**

General health and wellness management techniques and devices are configured for use with a data-capable personal worn or carried device. In one embodiment, a method receiving data representing a profile upon which a target score is established based on one or more health-related activities, and acquiring data representing one or more subsets of acquired parameters based on, for example, one or more sensors disposed in a wearable computing device. The method can include determining data representing values for the one or more subsets of the acquired parameters based on reference values for the parameters set forth in the profile and calculating at a first processor a score based on data representing the values. The score represents an attained portion of the one or more health-related activities. In some cases, the method includes causing presentation of a representation of the score relative to the target score.

19 Claims, 32 Drawing Sheets



Related U.S. Application Data

13/180,320, filed on Jul. 11, 2011, said application No. 13/433,204 is a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, said application No. 13/181,495 is a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, said application No. 13/181,495 is a continuation-in-part of application No. 13/158,372, said application No. 13/433,204 is a continuation-in-part of application No. 13/180,320, said application No. 13/433,204 is a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, said application No. 13/433,204 is a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, said application No. 13/433,204 is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/361,919, filed on Jan. 30, 2012, which is a continuation of application No. 13/181,495, said application No. 13/433,204 is a continuation-in-part of application No. 13/180,000, said application No. 13/433,204 is a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, said application No. 13/181,495 is a continuation-in-part of application No. 13/180,320, said application No. 13/433,204 is a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, said application No. 13/361,919 is a continuation of application No. 13/181,511, filed on Jul. 12, 2011, said application No. 13/433,204 is a continuation-in-part of application No. 13/180,000, said application No. 13/433,204 is a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, said application No. 13/181,511 is a continuation-in-part of application No. 13/180,320, said application No. 13/433,204 is a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/181,511, which is a continuation-in-part of application No. 13/180,000, which is a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, said application No. 13/181,511 is a continuation-in-part of application No. 13/180,320, said application No. 13/433,204 is a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/433,208, filed on Mar. 28, 2012, which is a continuation-in-part of application No. 13/181,495, which is a continuation-in-part of application No. 13/180,000, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/180,320, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/180,320, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/180,320, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/180,320, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/180,320, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/180,320, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/180,320, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/433,213, filed on Mar. 28, 2012, which is a continuation-in-part of application No. 13/181,495, which is a continuation-in-part of application No. 13/180,000, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a 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which is a continuation-in-part of application No. 13/158,372, and a continuation of application No. 13/181,511, and a continuation-in-part of application No. 13/180,000, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/180,320, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/181,511, and a continuation-in-part of application No. 13/180,000, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/180,320, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/361,919, which is a continuation of application No. 13/181,495, and a continuation-in-part of application No. 13/180,000, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/180,320, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation of application No. 13/181,511, and a continuation-in-part of application No. 13/180,000, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/180,320, which is a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/181,511, and a continuation-in-part of application No. 13/180,000, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372, and a continuation-in-part of application No. 13/180,320, and a continuation-in-part of application No. 13/158,416, which is a continuation-in-part of application No. 13/158,372.

(60) Provisional application No. 61/495,995, filed on Jun. 11, 2011, provisional application No. 61/495,994, filed on Jun. 11, 2011, provisional application No. 61/495,997, filed on Jun. 11, 2011, provisional application No. 61/495,996, filed on Jun. 11, 2011.

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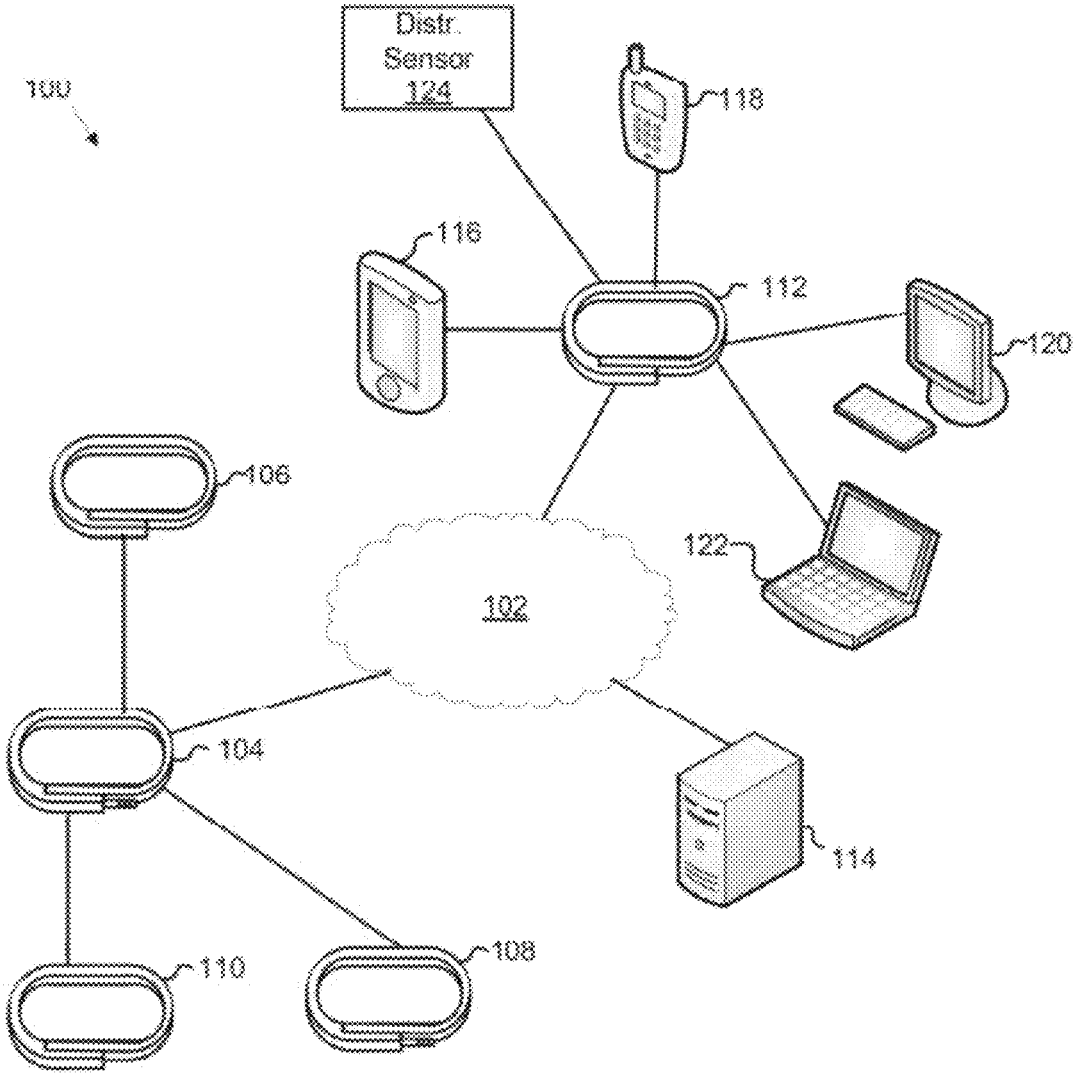
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Sensor
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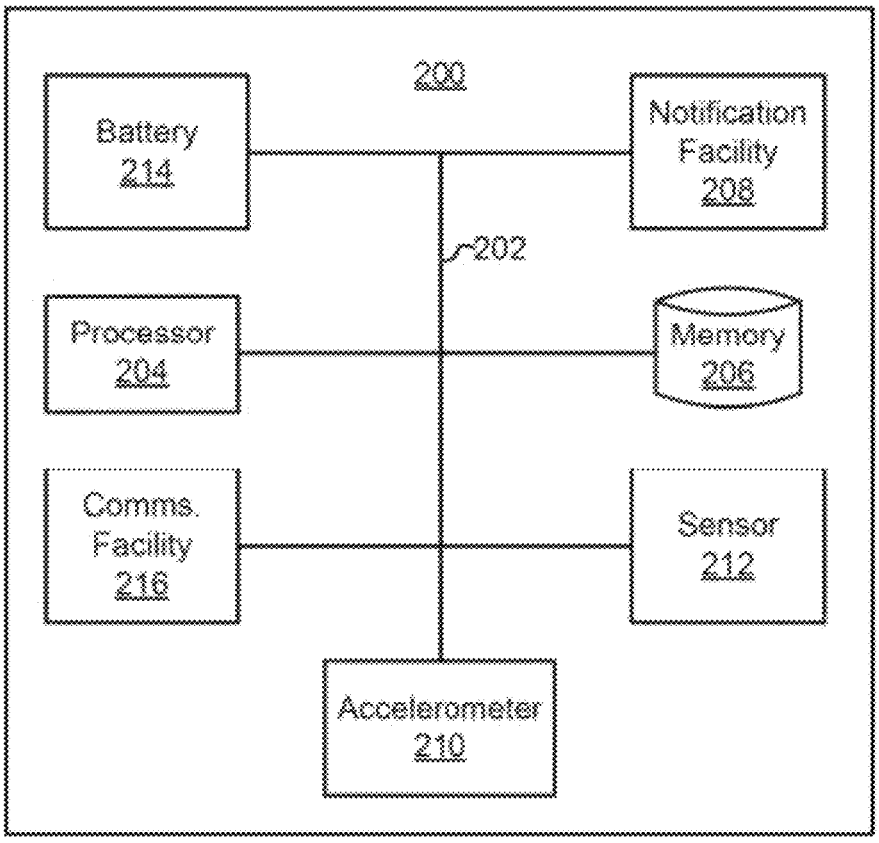
FIG. 1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Battery
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Notification
Facility
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202
Processor
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Memory
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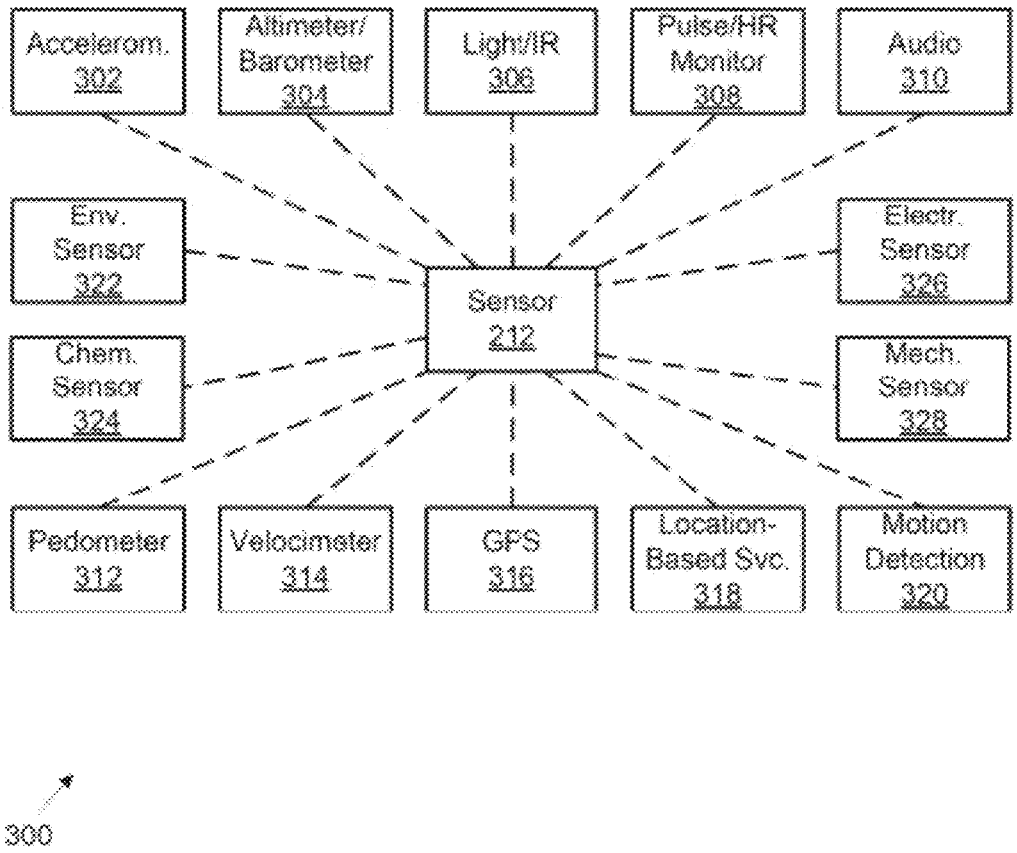
Comms.
Facility
216
Sensor
212
Accelerometer
210

FIG. 2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Pulse/HR Monitor 308
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Sensor 212
Electr. Sensor 326
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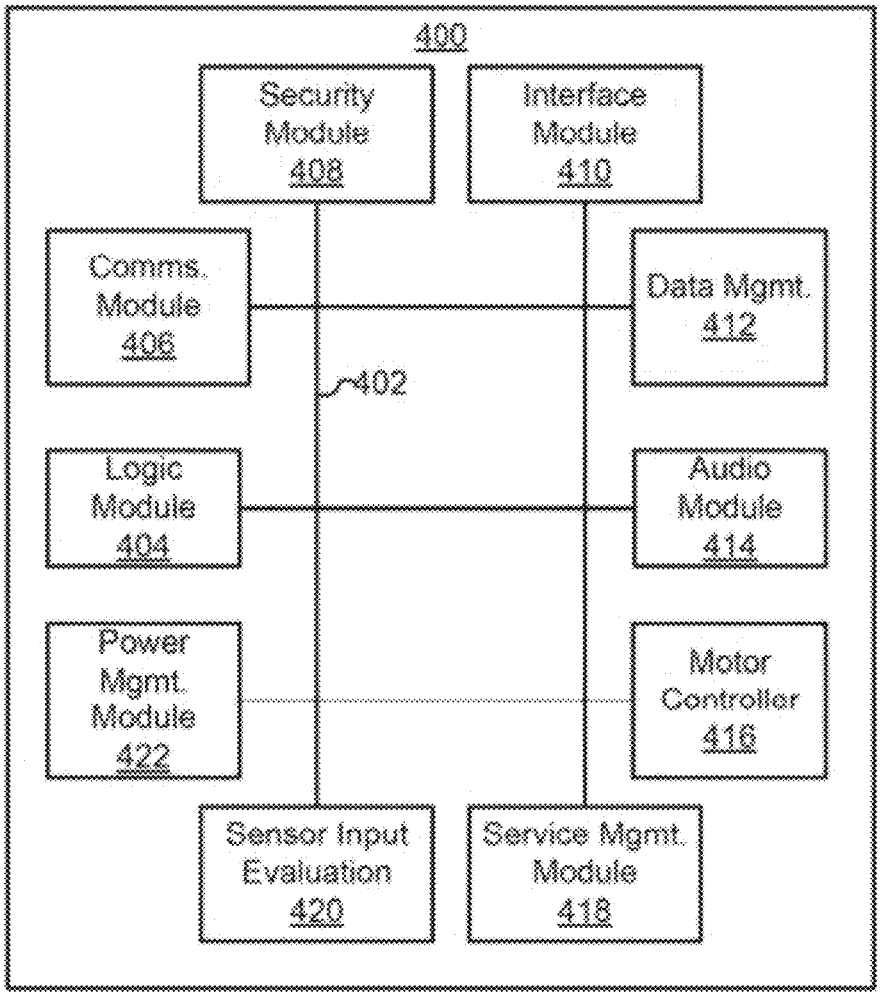
Mech. Sensor 328
Pedometer 312
Velocimeter 314
GPS 316
Location-Based Svc. 318
Motion Detection 320
300

FIG. 3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Interface Module 410
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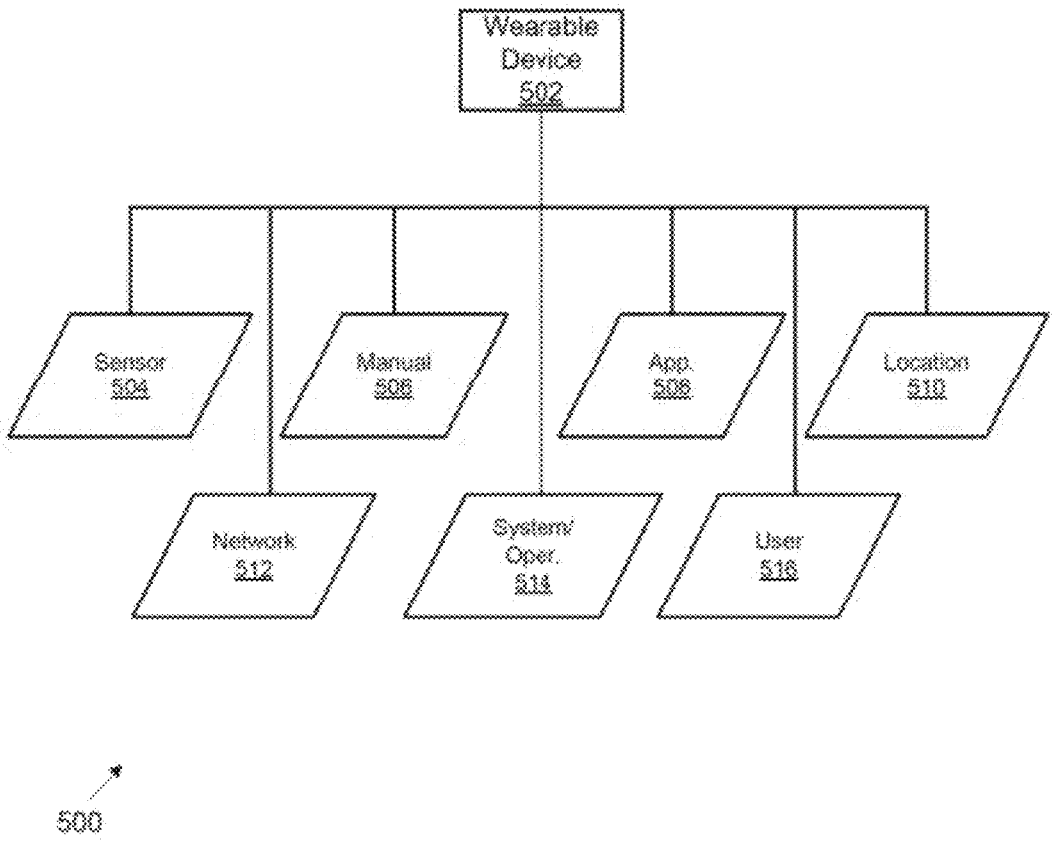
Service Mgmt. Module 418

FIG. 4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App. 508
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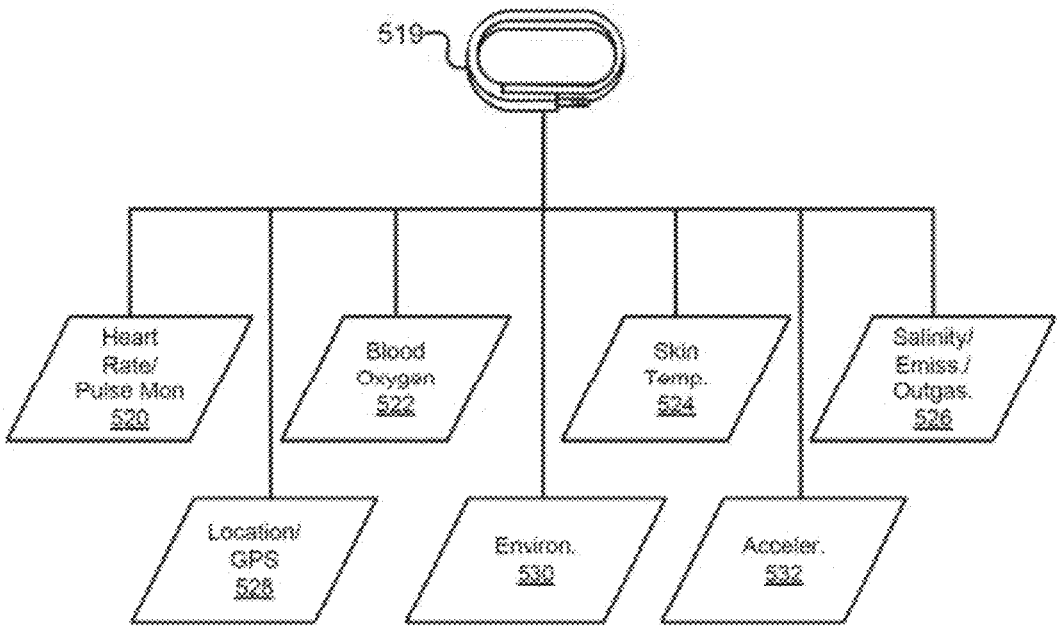
FIG. 5A


519
Heart Rate/ Pulse Mon 520
Blood Oxygen 522
Skin Temp. 524
Salinity/ Emiss./ Outgas. 526
Location/ GPS 528
Environ. 530
Acceler. 532

518

FIG. 5B

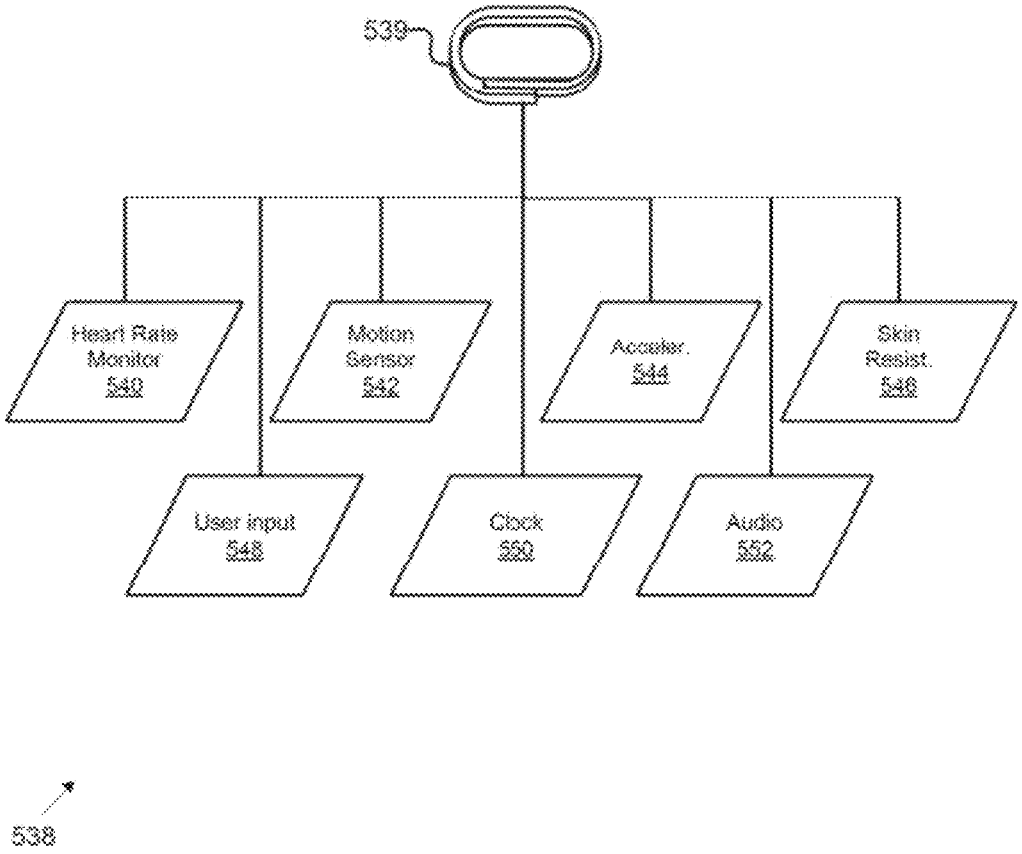

539
Heart Rate Monitor 540
Motion Sensor 542
Acceler. 544
Skin Resist. 546
User input 548
Clock 550
Audio 552
538

FIG. 5C

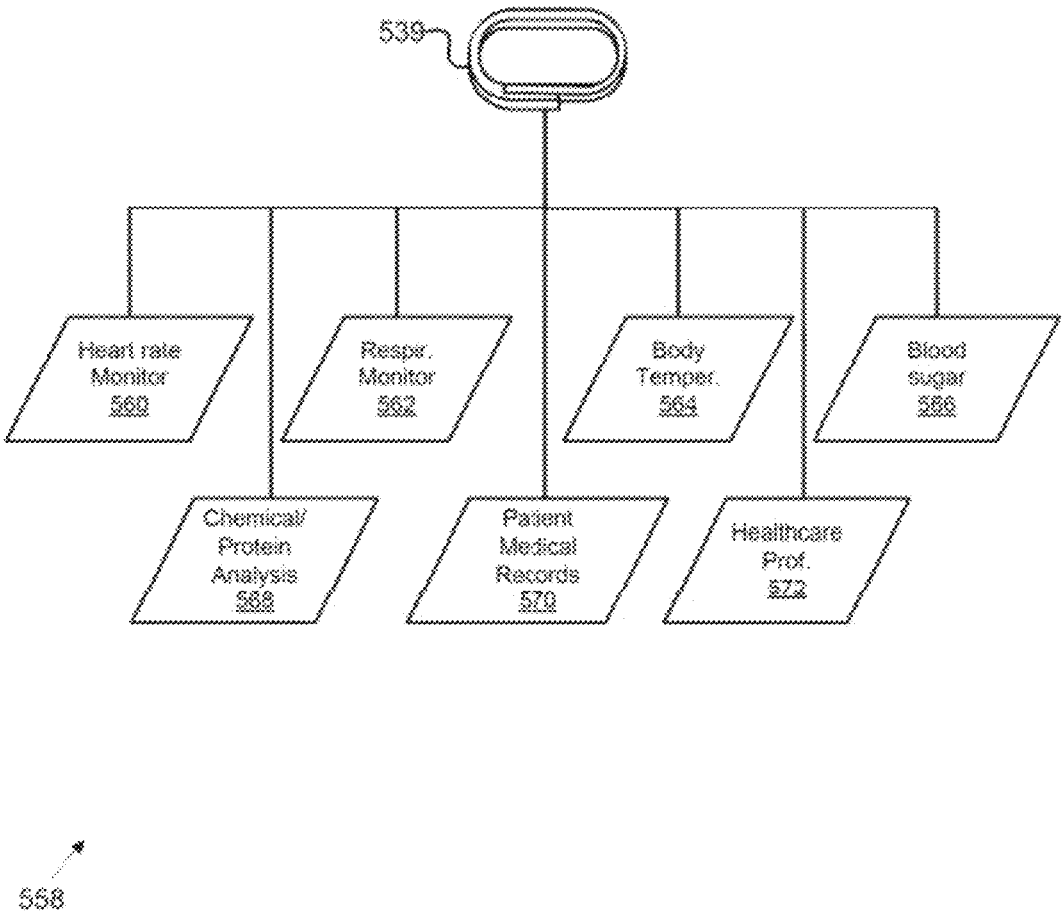

538
Heart rate Monitor 560
Respir. Monitor 562
Body Temper. 564
Blood sugar 566
Chemical/ Protein Analysis 568
Patient Medical Records 570
Healthcare Prof. 572
568

FIG. 5D

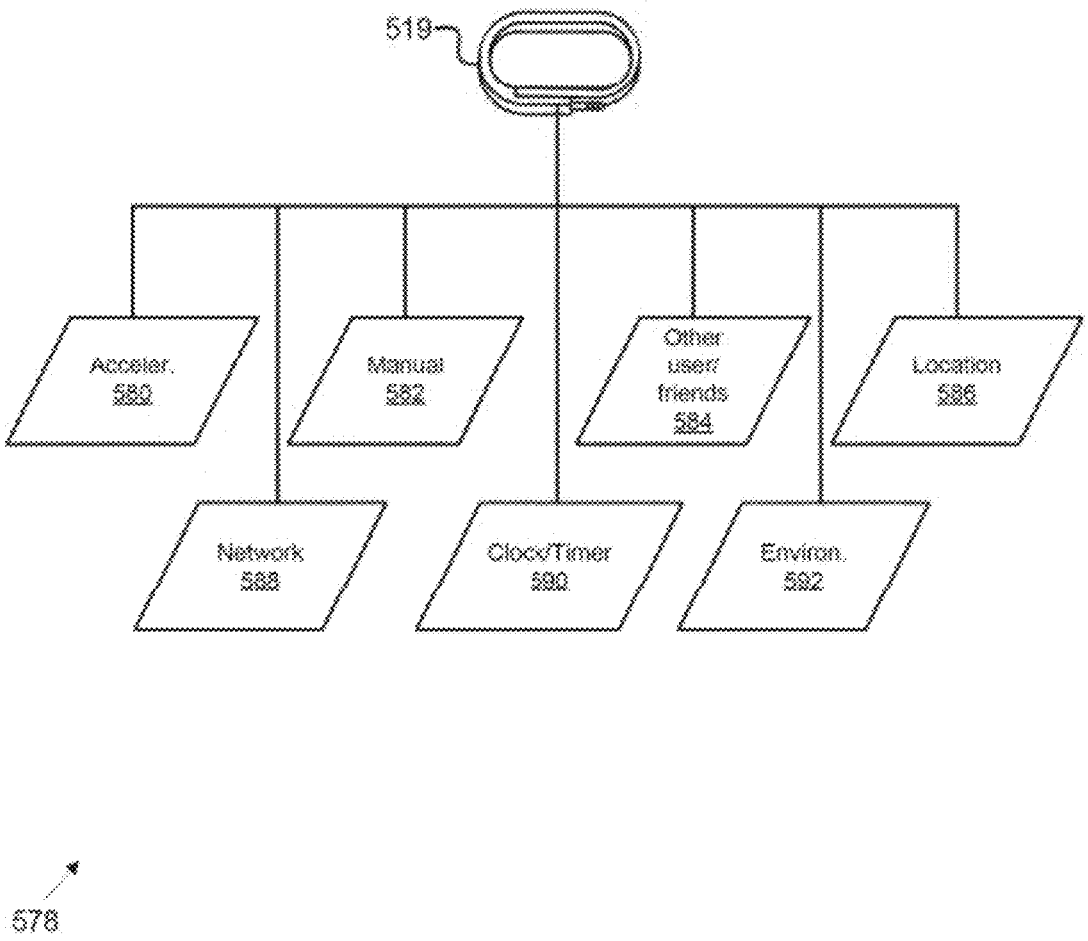

519
Acceler.
580
Manual
582
Other
user/
friends
584
Location
586
Network
588
Clock/Timer
590
Environ.
592
578

FIG. 5E

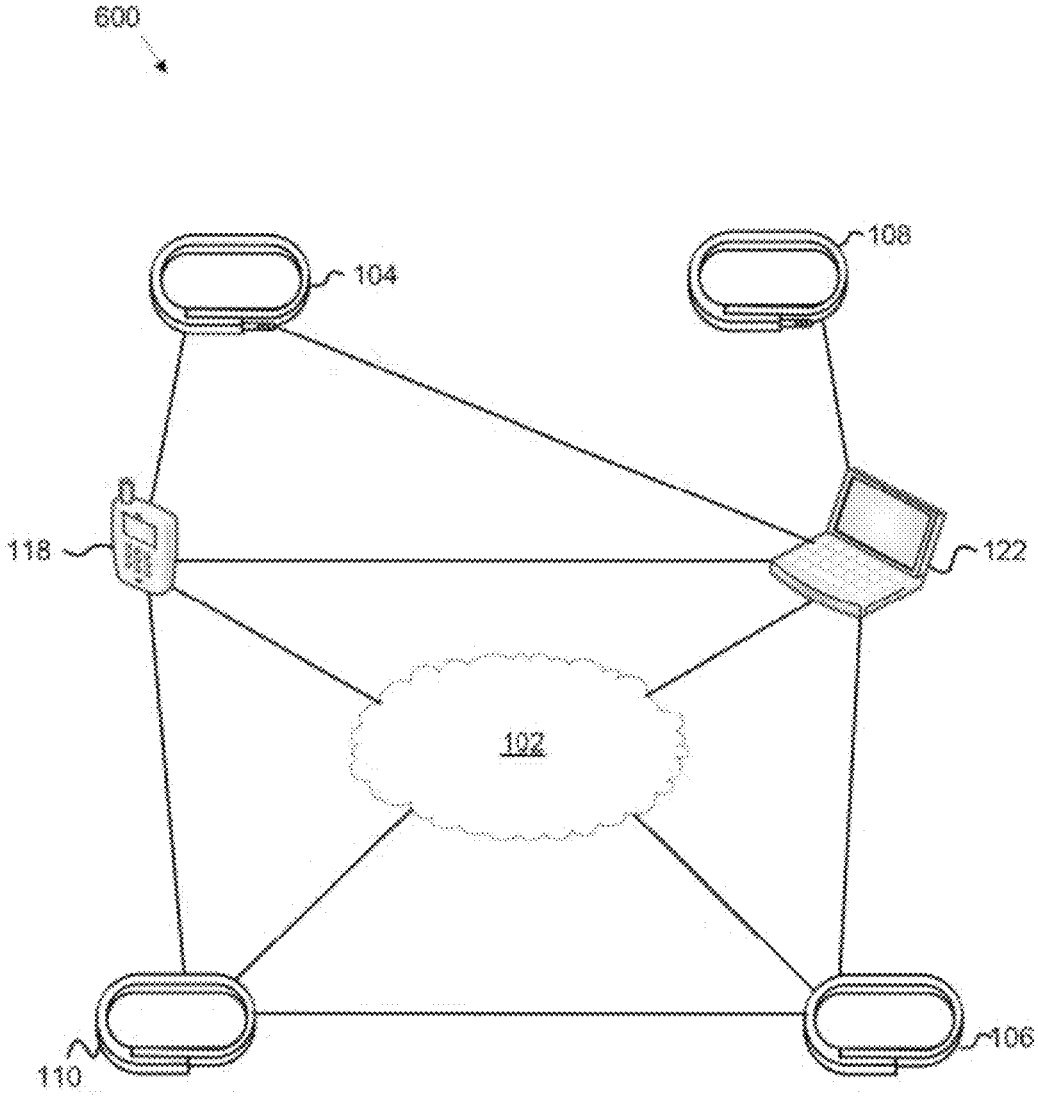


FIG. 6

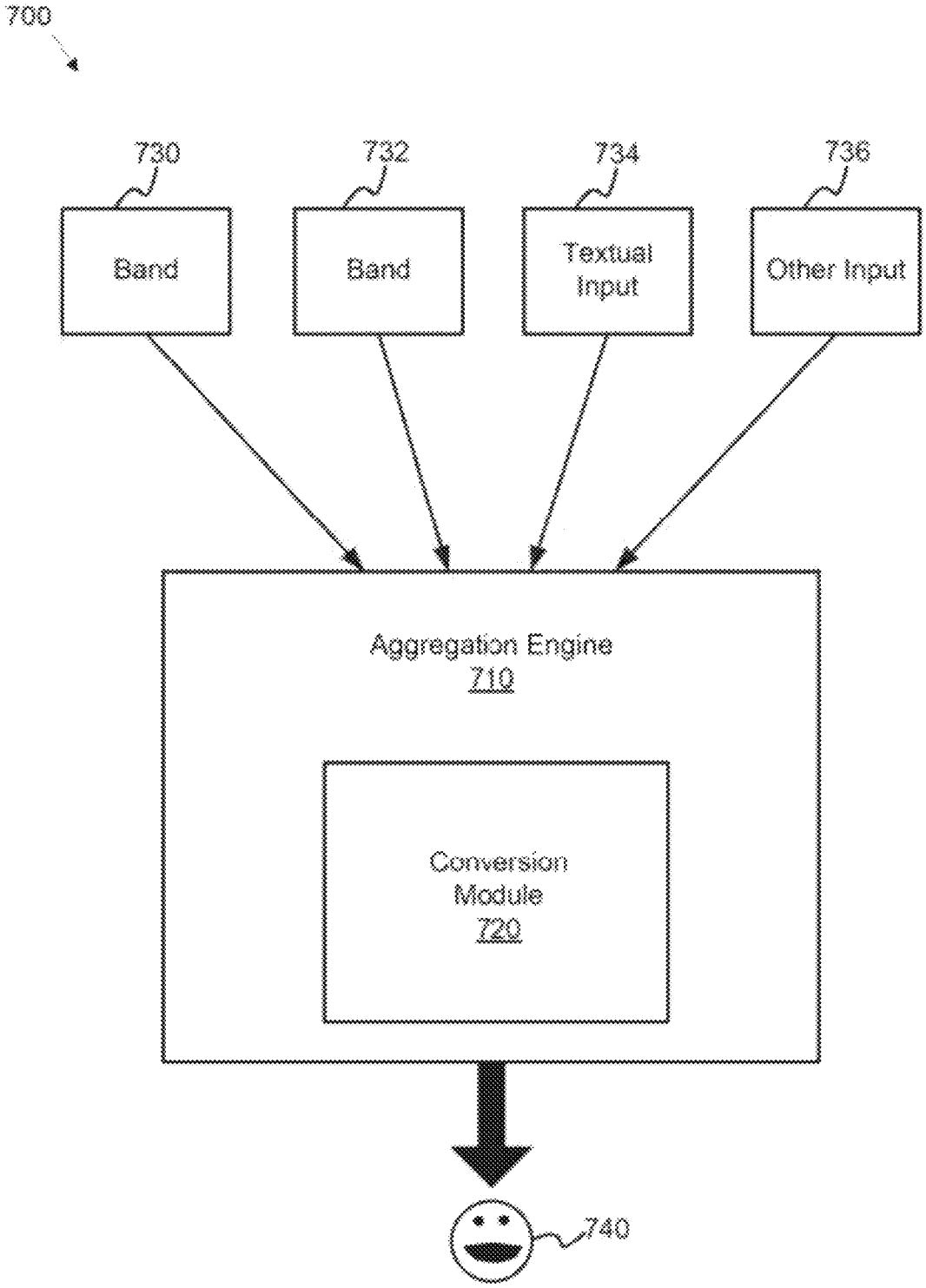

700
730
Band
732
Band
734
Textual Input
736
Other Input
Aggregation Engine
710
Conversion Module
720
740

FIG. 7

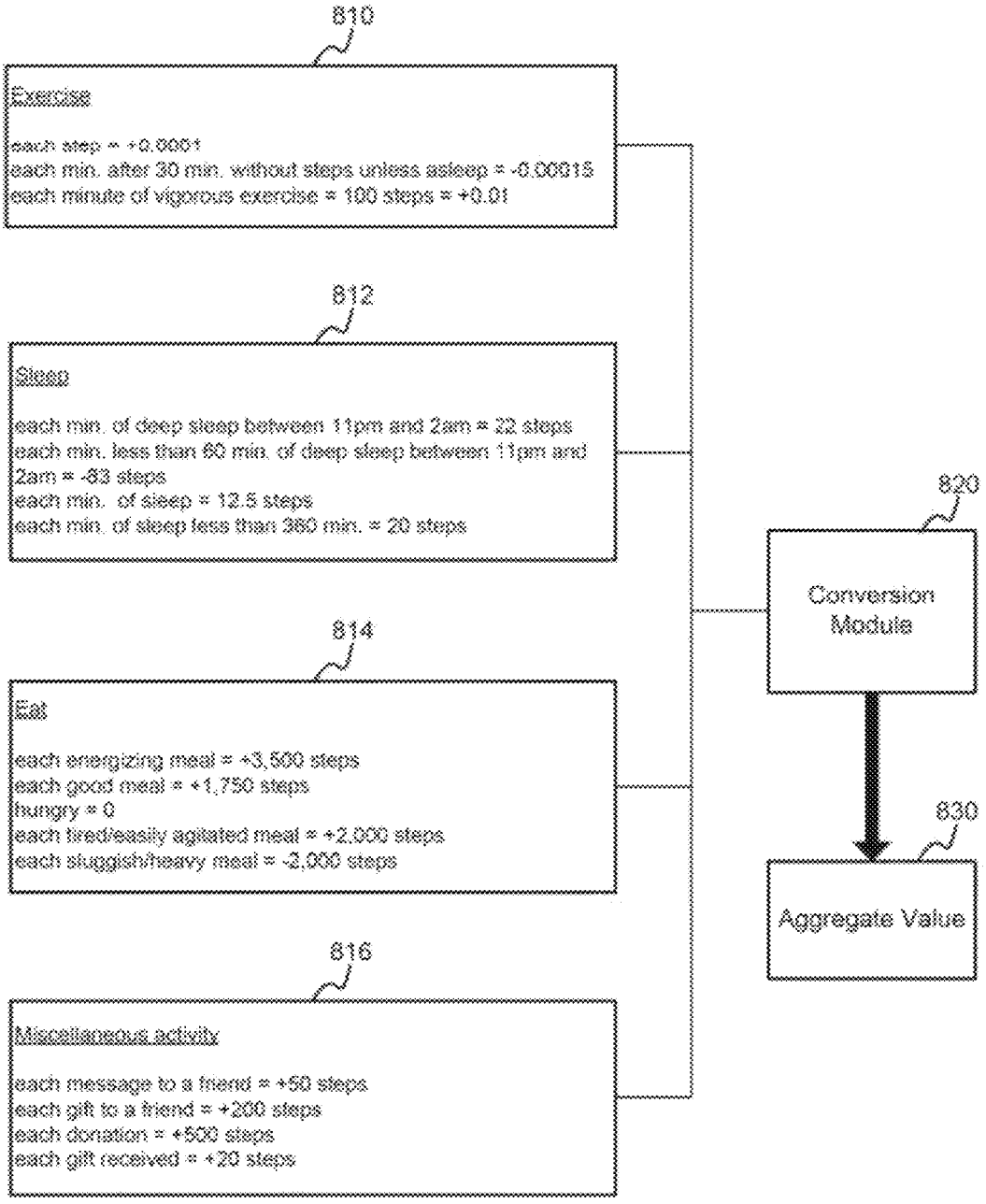

810
Exercise
each step = +0.0001
each min. after 30 min. without steps unless asleep = -0.00015
each minute of vigorous exercise = 100 steps = +0.01
812
Sleep
each min. of deep sleep between 11pm and 2am = 22 steps
each min. less than 60 min. of deep sleep between 11pm and 2am = -83 steps
each min. of sleep = 12.5 steps
each min. of sleep less than 360 min. = 20 steps
814
Eat
each energizing meal = +3,500 steps
each good meal = +1,750 steps
hungry = 0
each tired/easily agitated meal = +2,000 steps
each sluggish/heavy meal = -2,000 steps
816
Miscellaneous activity
each message to a friend = +50 steps
each gift to a friend = +200 steps
each donation = +500 steps
each gift received = +20 steps
820
Conversion Module
830
Aggregate Value

FIG. 8

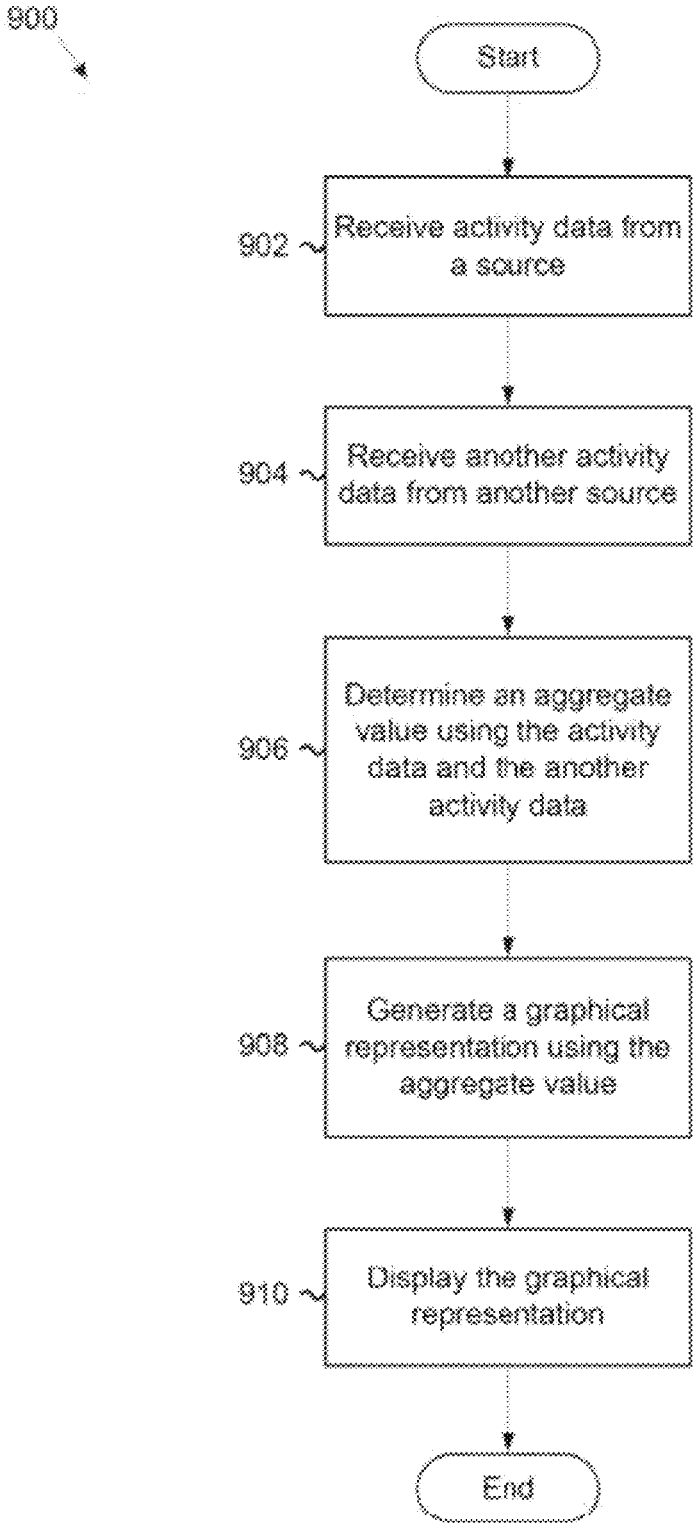

900
Start
902
Receive activity data from a source
904
Receive another activity data from another source
906
Determine an aggregate value using the activity data and the another activity data
908
Generate a graphical representation using the aggregate value
910
Display the graphical representation
End

FIG. 9

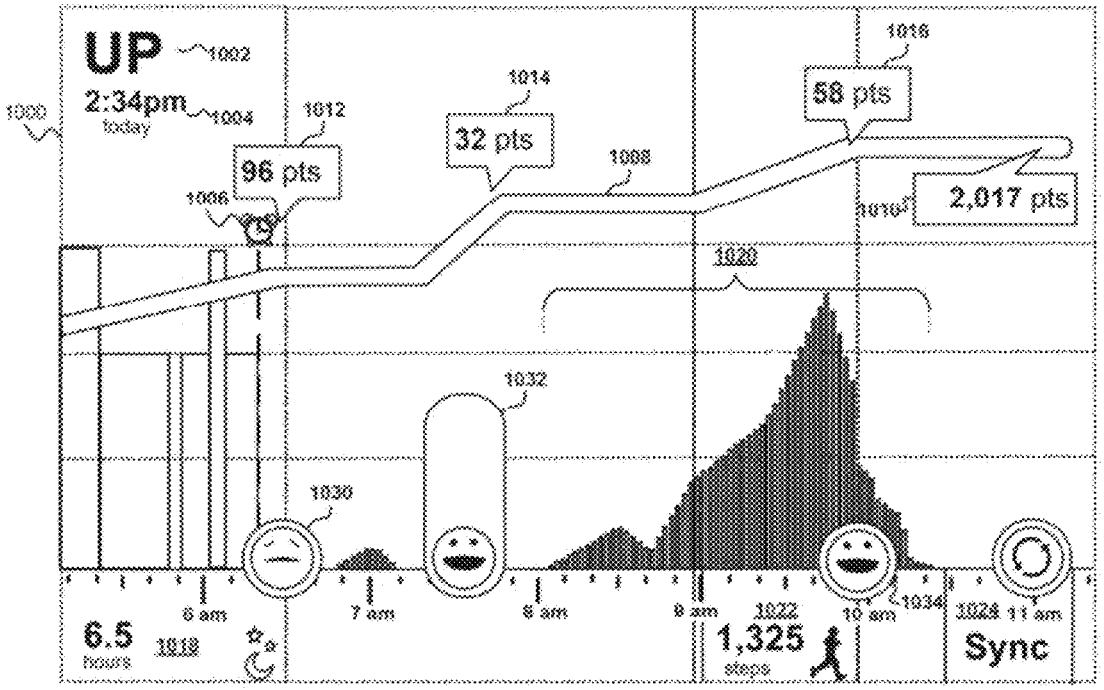

UP
1002
2:34pm
today
1004
1000
1012
96 pts
1006
1014
32 pts
1008
1016
58 pts
2,017 pts
1020
1032
1030
6 am
7 am
8 am
9 am
10 am
11 am
1022
1034
1028
6.5
hours
1018
1,325
steps
Sync

FIG. 10

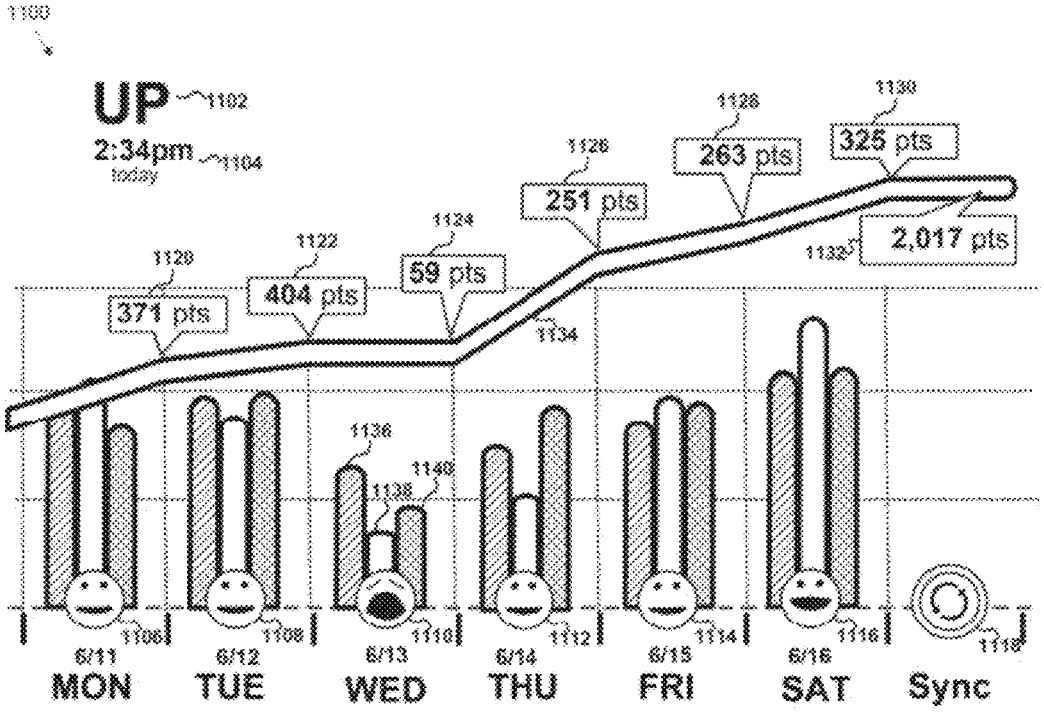

1100
UP
1102
2:34pm
today
1104
371 pts
1120
404 pts
1122
59 pts
1124
251 pts
1126
263 pts
1128
325 pts
1130
2,017 pts
1132
1134
1136
1138
1140
6/11
MON
6/12
TUE
6/13
WED
6/14
THU
6/15
FRI
6/16
SAT
Sync

FIG. 11

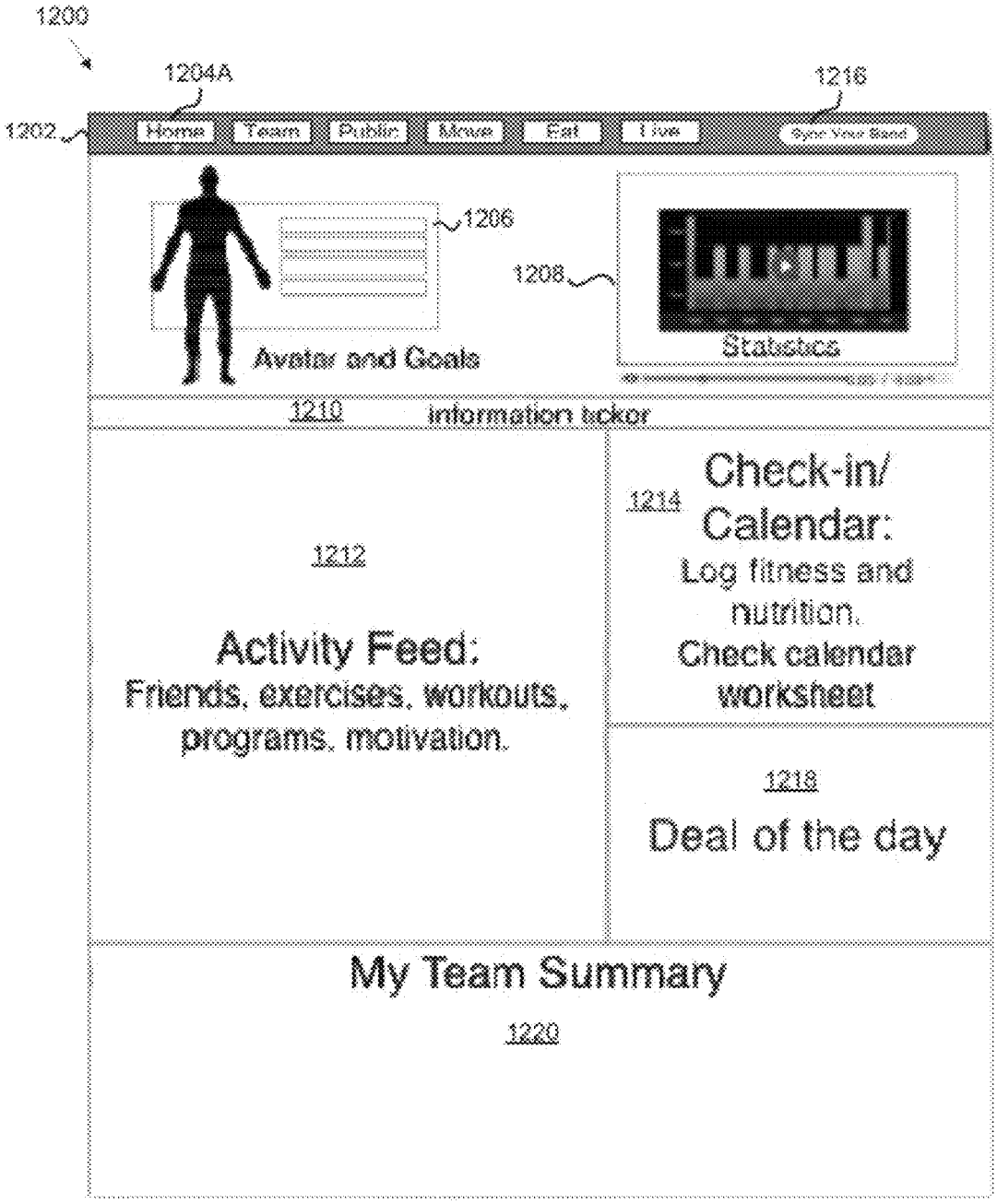

1200
1204A
1216
1202
Home
Team
Public
Move
Eat
Live
Sync Your Band
1206
1208
Avatar and Goals
Statistics
1210
Information ticker
1212
Activity Feed:
Friends, exercises, workouts, programs, motivation.
1214
Check-in/ Calendar:
Log fitness and nutrition.
Check calendar worksheet
1218
Deal of the day
My Team Summary
1220

FIG. 12A

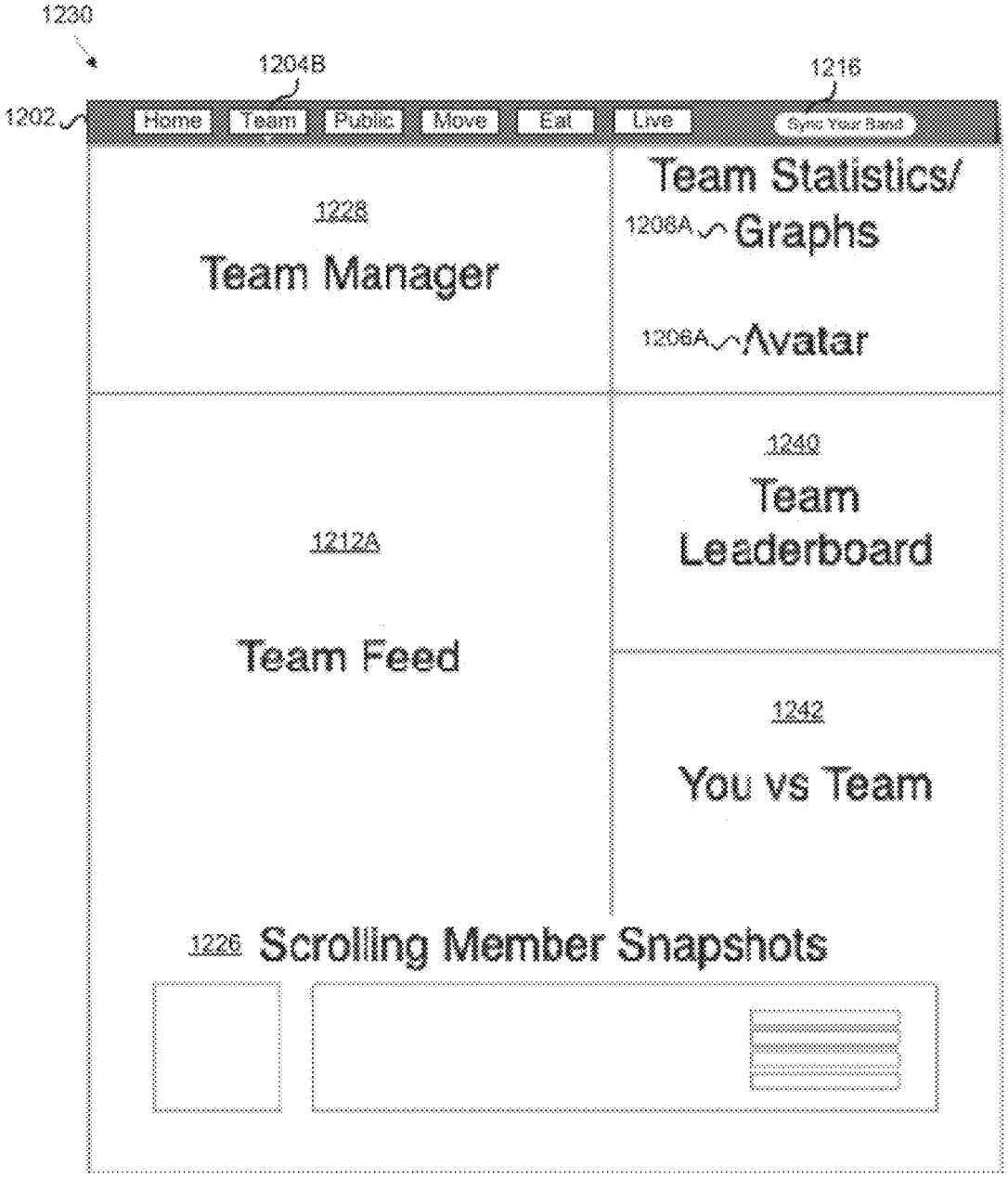

1230
1204B
1216
1202
Home
Team
Public
Move
Eat
Live
Sync Your Band
1228
Team Manager
Team Statistics/
1206A
Graphs
1206A
Avatar
1240
Team
Leaderboard
1212A
Team Feed
1242
You vs Team
1226
Scrolling Member Snapshots

FIG. 12B

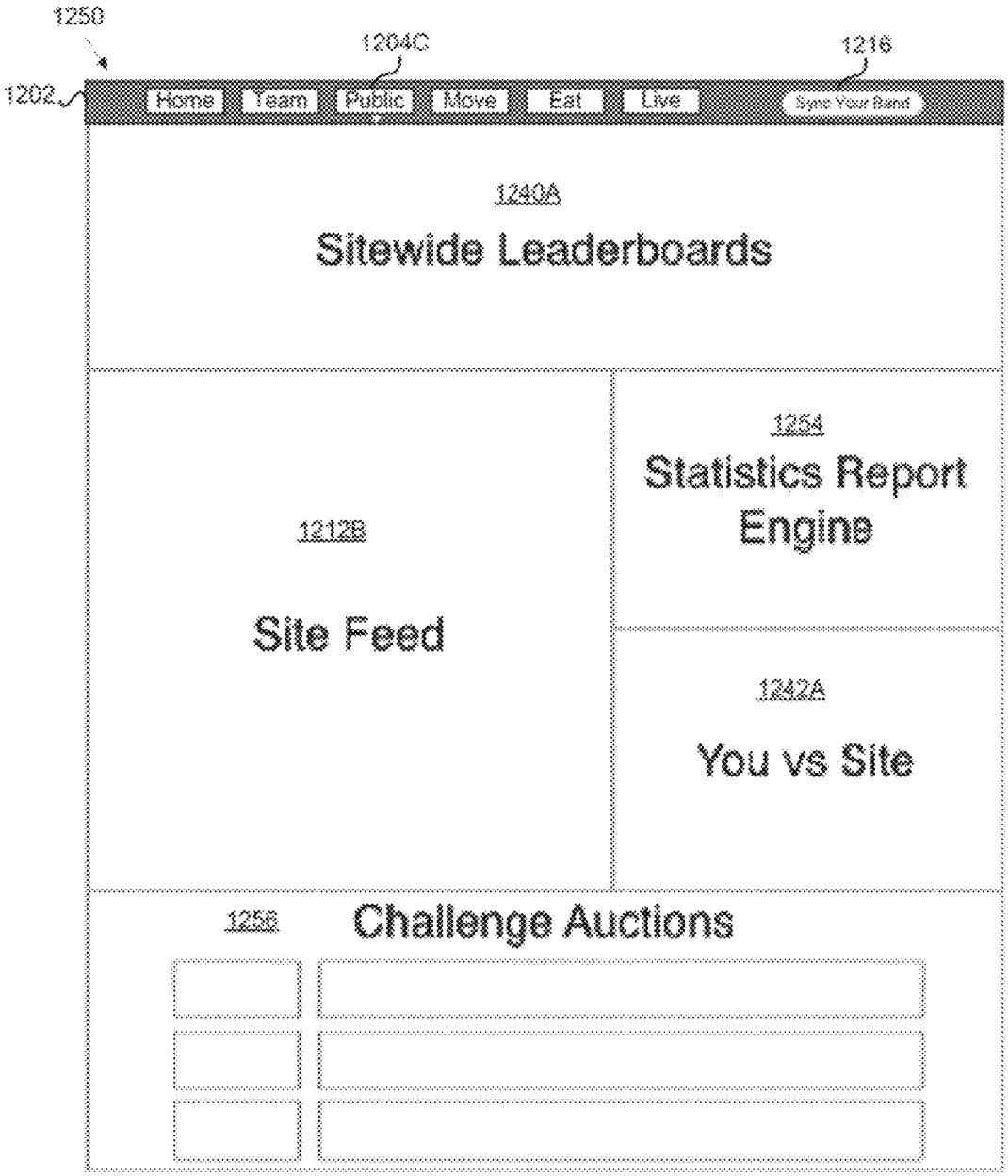

1250
1204C
1216
1202
Home
Team
Public
Move
Eat
Live
Sync Your Band
1240A
Sitewide Leaderboards
1254
Statistics Report Engine
1212B
Site Feed
1242A
You vs Site
1256
Challenge Auctions

FIG. 12C

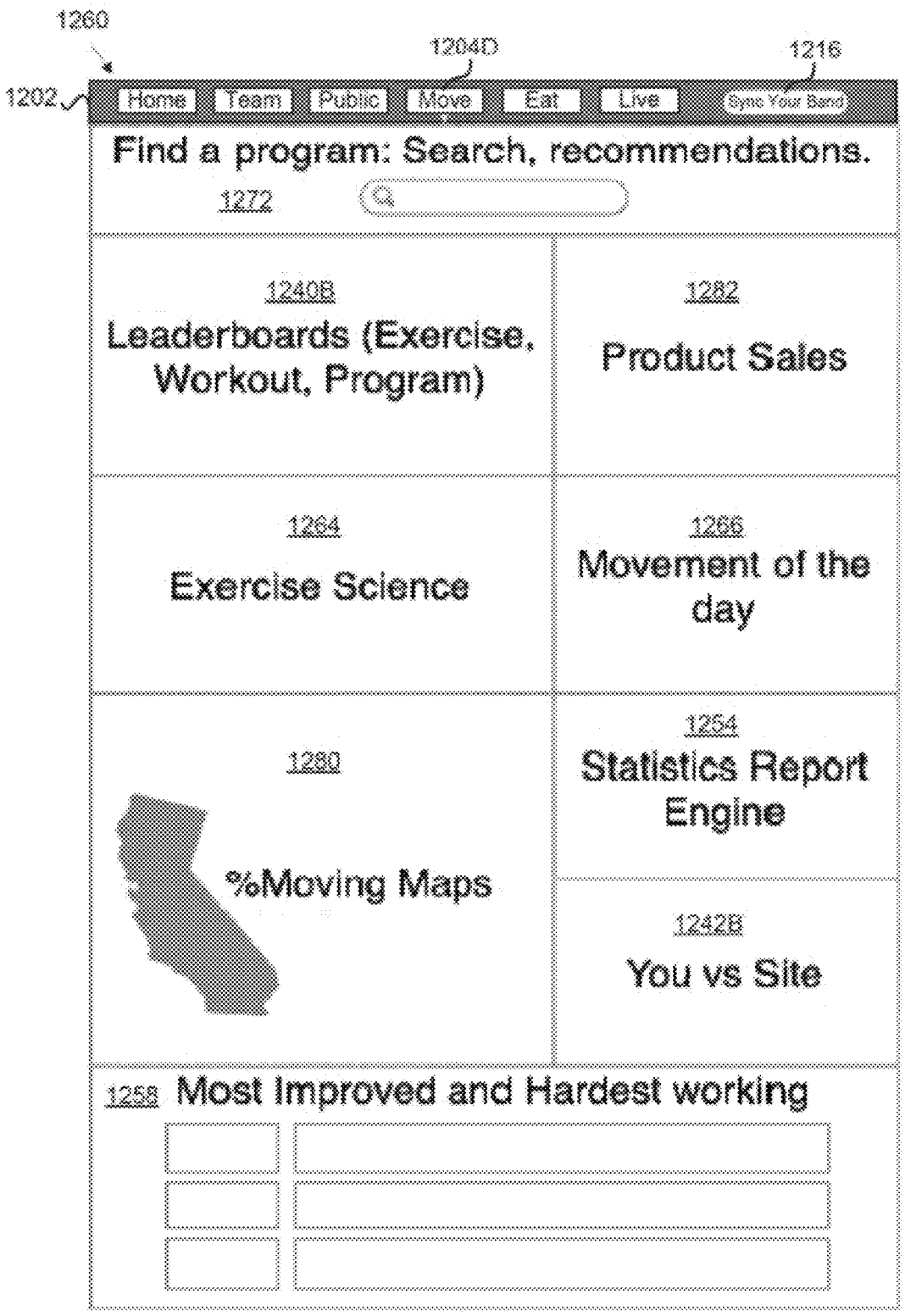

1260
1204D
1216
1202
Home
Team
Public
Move
Eat
Live
Sync Your Band
Find a program: Search, recommendations.
1272
1240B
Leaderboards (Exercise, Workout, Program)
1282
Product Sales
1264
Exercise Science
1266
Movement of the day
1280
%Moving Maps
1254
Statistics Report Engine
1242B
You vs Site
1258 Most Improved and Hardest working

FIG. 12D

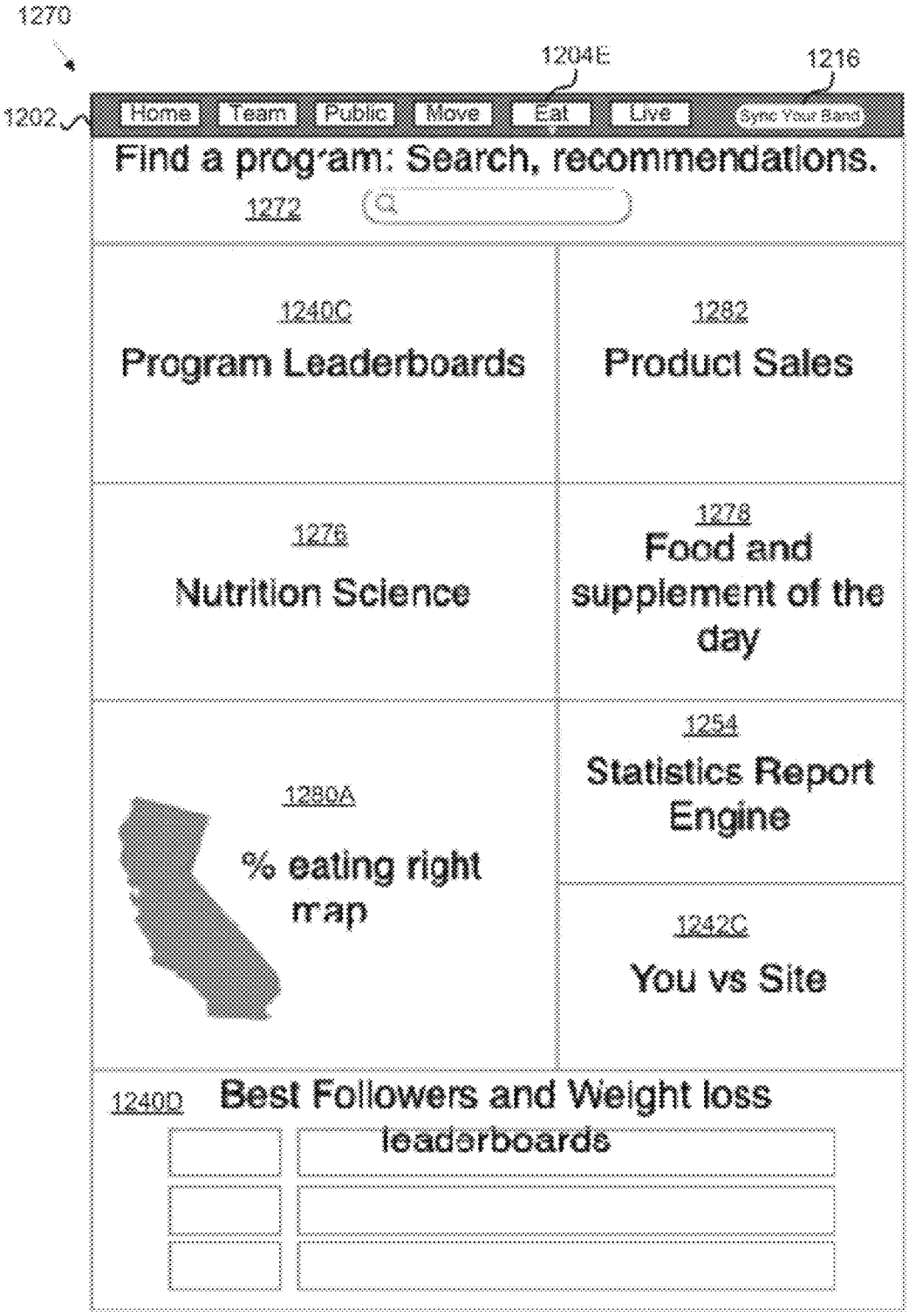

1270
1204E
1216
1202
Home
Team
Public
Move
Eat
Live
Sync Your Band
Find a program: Search, recommendations.
1272
1240C
Program Leaderboards
1282
Product Sales
1278
Nutrition Science
1278
Food and supplement of the day
1280A
% eating right map
1284
Statistics Report Engine
1242C
You vs Site
1240D
Best Followers and Weight loss leaderboards

FIG. 12E

1280
1202
1204F
1216
Home
Team
Public
Move
Eat
Live
Sync Your Band
Find a program: Search, recommendations.
1272
1240E
Sleep/Health leaderboards
1282
Product Sales
1286
Health Research
1280B
%living healthy map
1212C
Q&A Feed
Product Research
1290

FIG. 12F

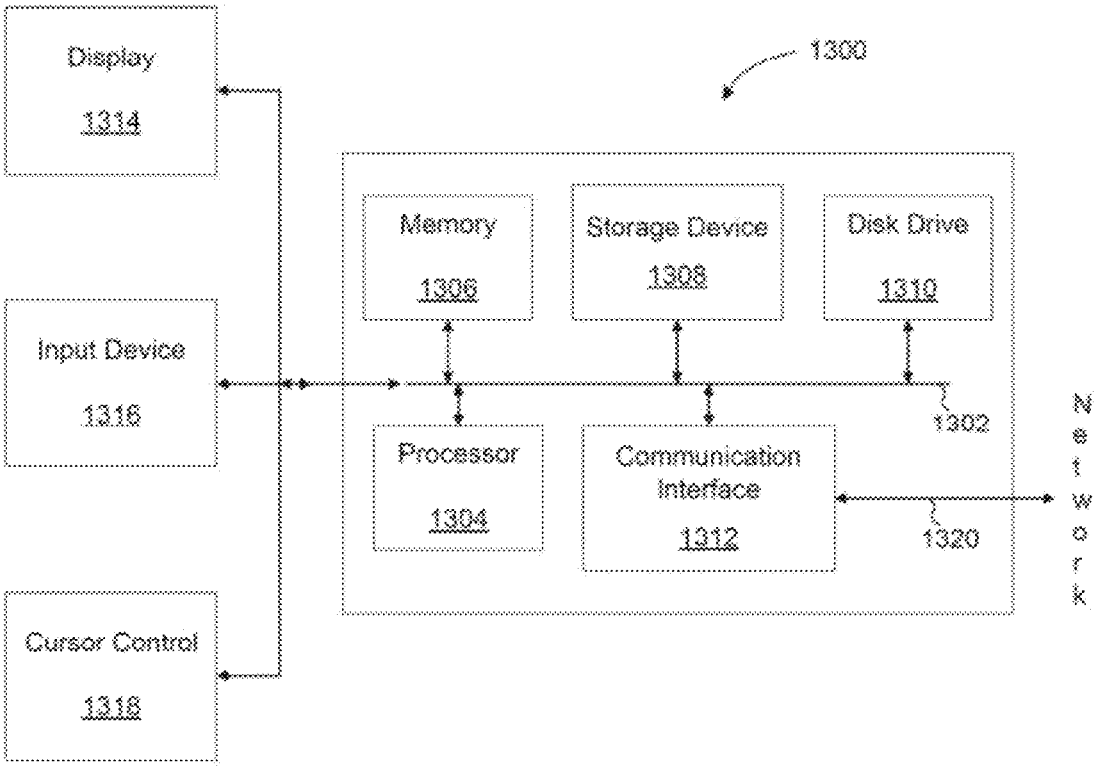

Display
1314
1300
Memory
1306
Storage Device
1308
Disk Drive
1310
Input Device
1316
1302
Processor
1304
Communication Interface
1312
1320
Network
Cursor Control
1318

FIG. 13

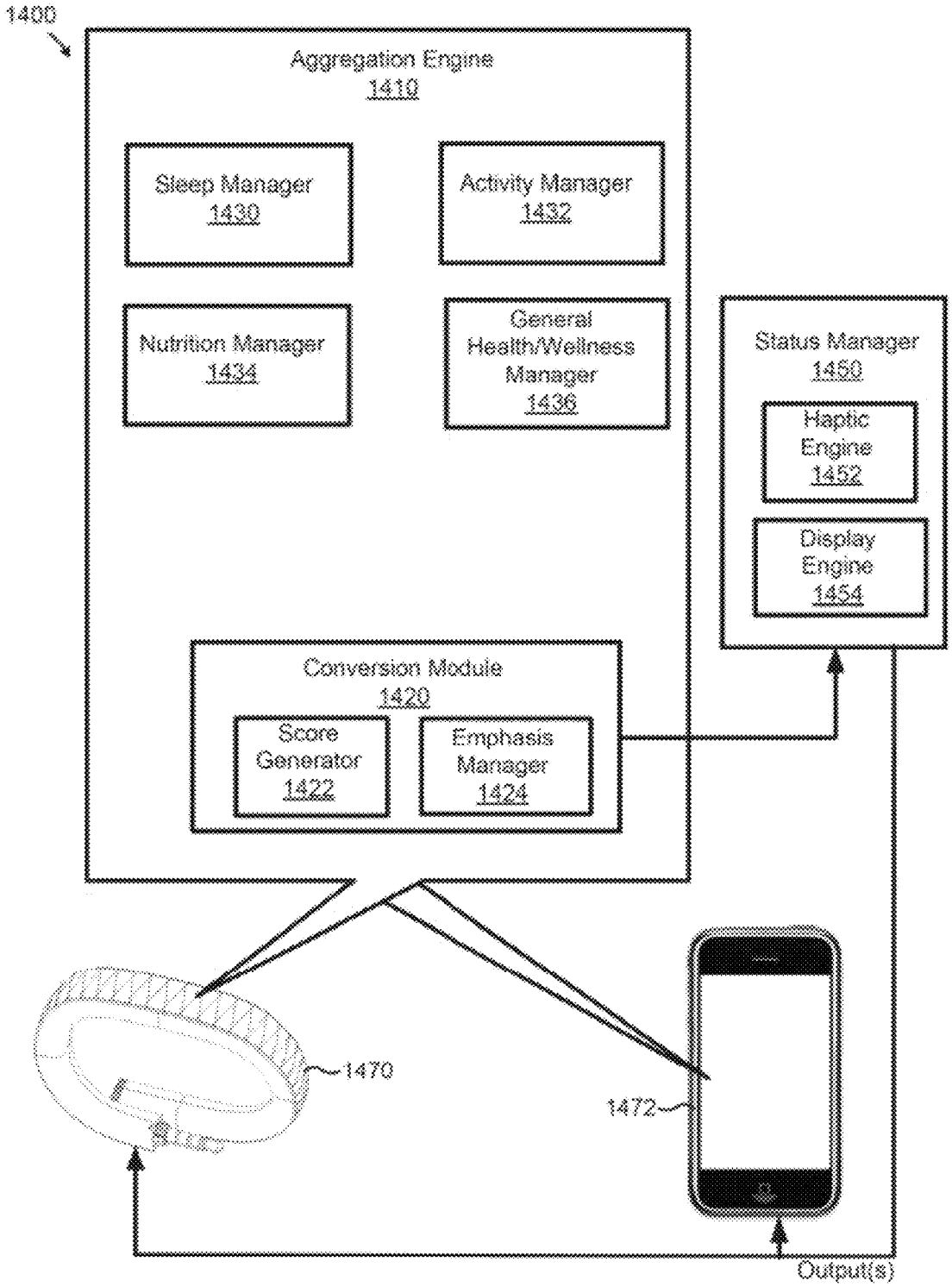

1400
Aggregation Engine
1410
Sleep Manager
1430
Activity Manager
1432
Nutrition Manager
1434
General Health/Wellness Manager
1436
Status Manager
1450
Haptic Engine
1452
Display Engine
1454
Conversion Module
1420
Score Generator
1422
Emphasis Manager
1424
1470
1472
Output(s)

FIG. 14

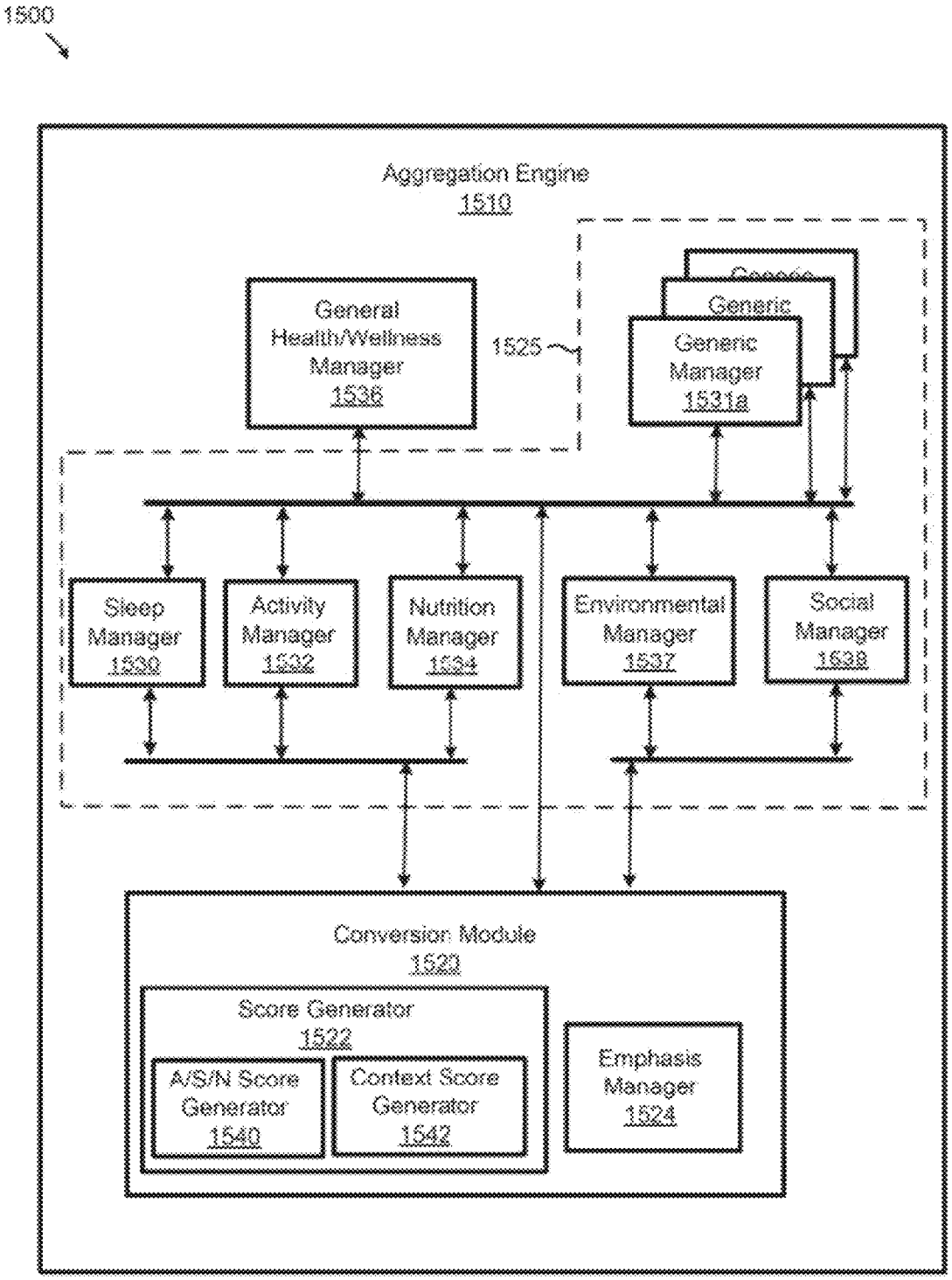

1500
Aggregation Engine
1510
General Health/Wellness Manager
1536
1525
Generic
Generic Manager
1531a
Sleep Manager
1530
Activity Manager
1532
Nutrition Manager
1534
Environmental Manager
1537
Social Manager
1538
Conversion Module
1520
Score Generator
1522
A/S/N Score Generator
1540
Context Score Generator
1542
Emphasis Manager
1524

FIG. 15A

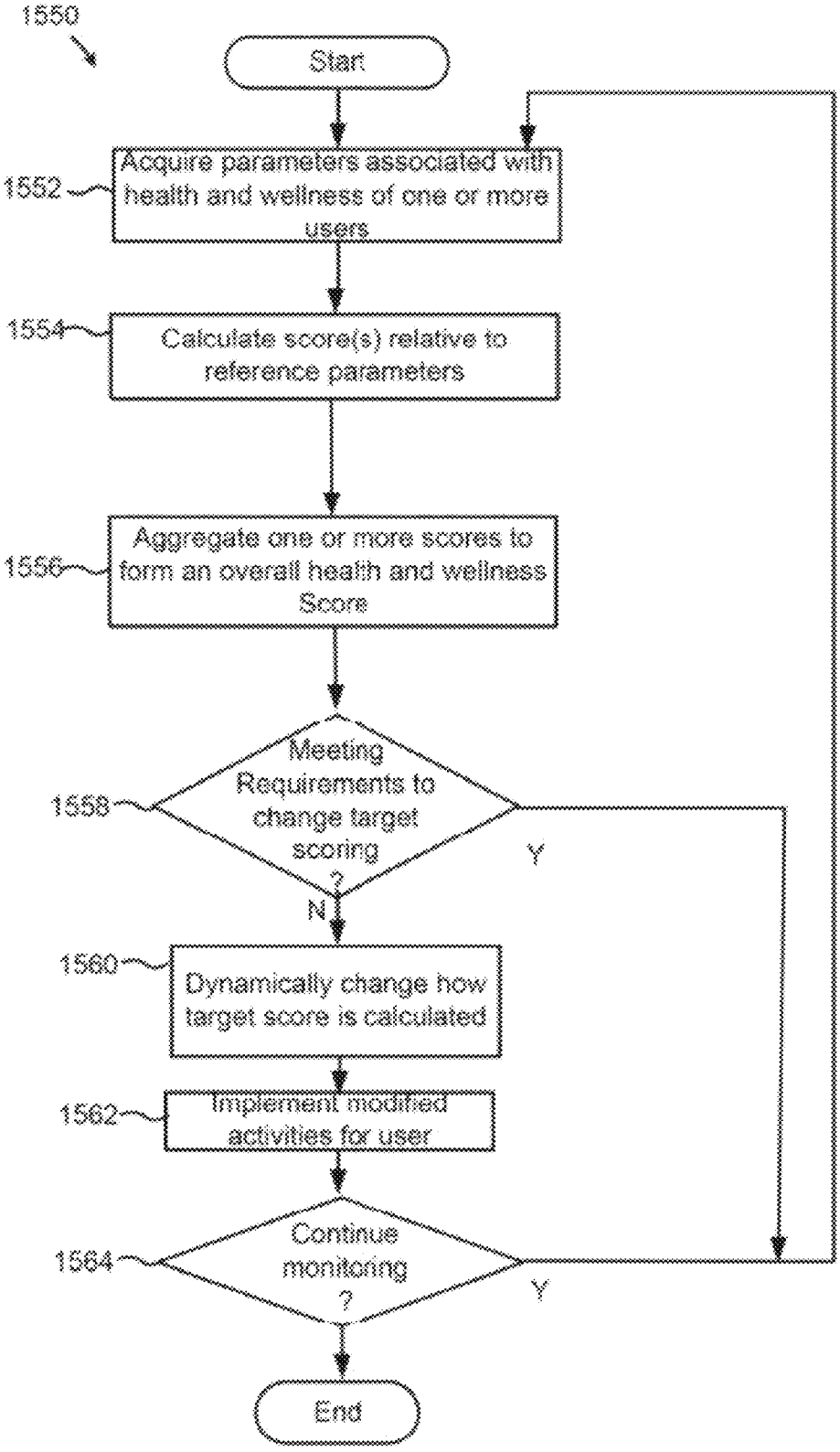

1550
Start
1552
Acquire parameters associated with health and wellness of one or more users
1554
Calculate score(s) relative to reference parameters
1556
Aggregate one or more scores to form an overall health and wellness Score
1558
Meeting Requirements to change target scoring ?
Y
N
1560
Dynamically change how target score is calculated
1562
Implement modified activities for user
1564
Continue monitoring ?
Y
End

FIG. 15B

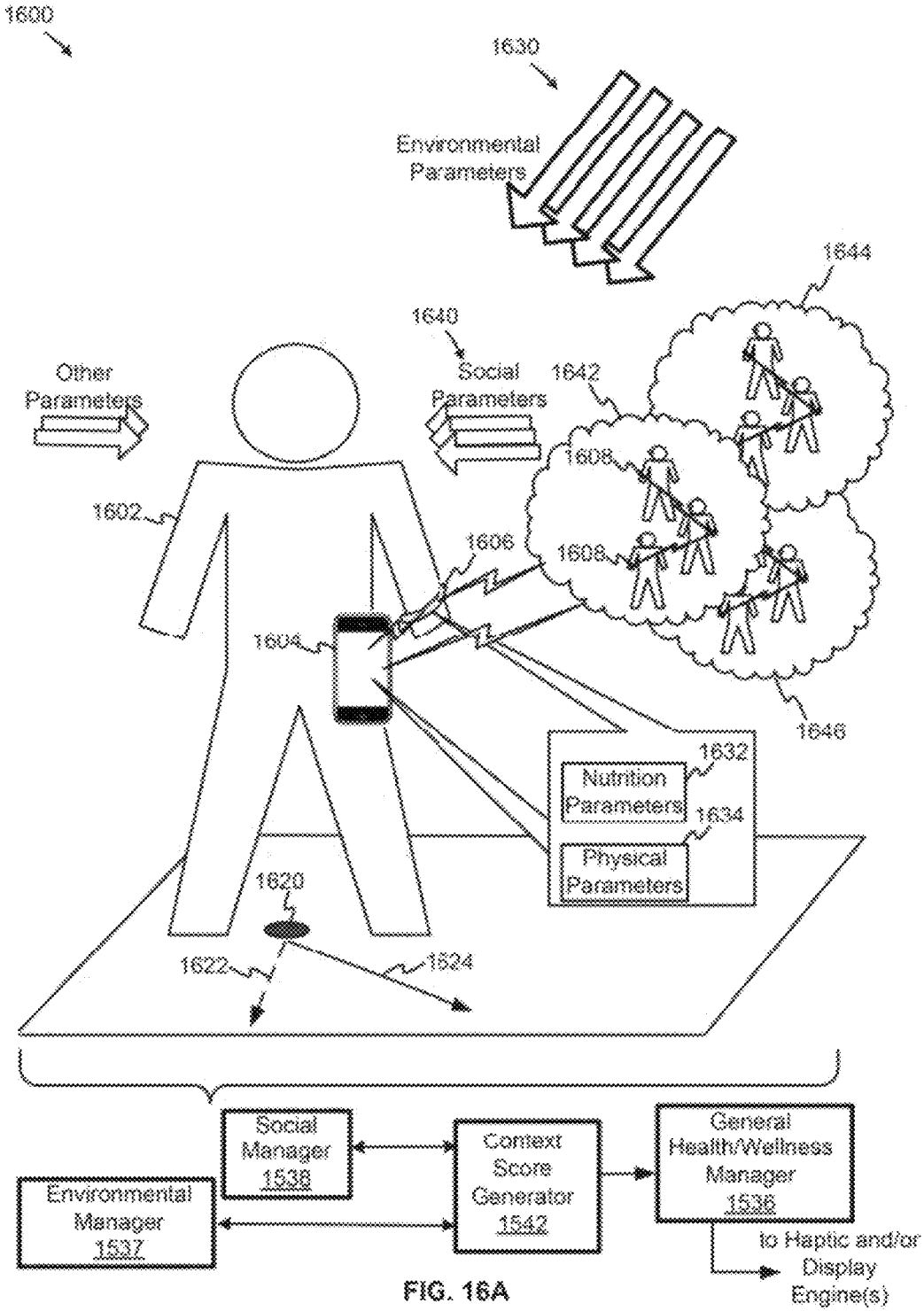

1600
1630
Environmental Parameters
1644
1640
Social Parameters
1642
Other Parameters
1608
1602
1606
1608
1604
1646
1632
Nutrition Parameters
1634
Physical Parameters
1620
1622
1624
Social Manager 1538
Context Score Generator 1542
General Health/Wellness Manager 1536
Environmental Manager 1537
to Haptic and/or Display Engine(s)

FIG. 16A

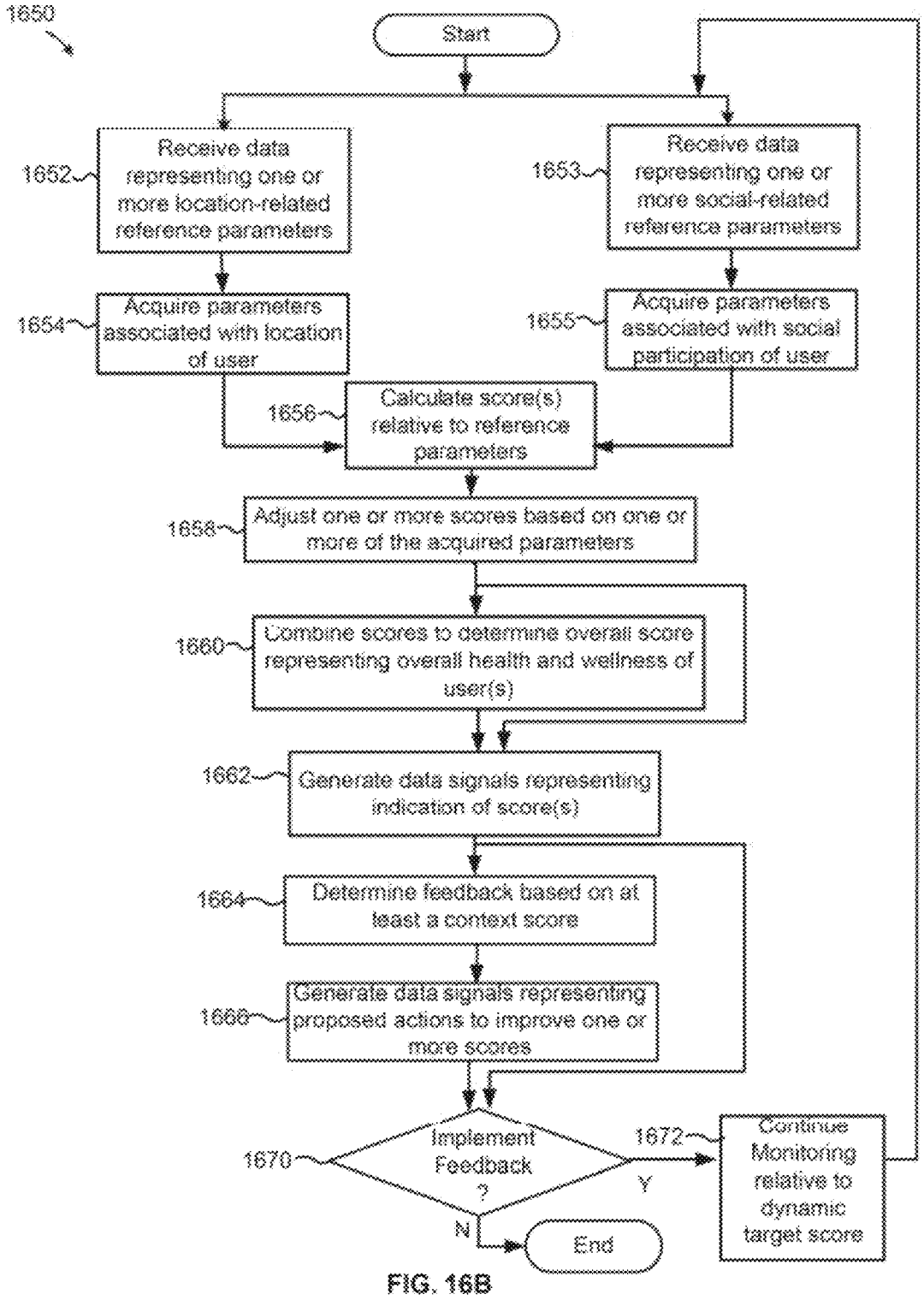

1650
Start
1652
Receive data representing one or more location-related reference parameters
1653
Receive data representing one or more social-related reference parameters
1654
Acquire parameters associated with location of user
1655
Acquire parameters associated with social participation of user
1656
Calculate score(s) relative to reference parameters
1658
Adjust one or more scores based on one or more of the acquired parameters
1660
Combine scores to determine overall score representing overall health and wellness of user(s)
1662
Generate data signals representing indication of score(s)
1664
Determine feedback based on at least a context score
1666
Generate data signals representing proposed actions to improve one or more scores
1670
Implement Feedback ?
Y
N
1672
Continue Monitoring relative to dynamic target score
End

FIG. 16B

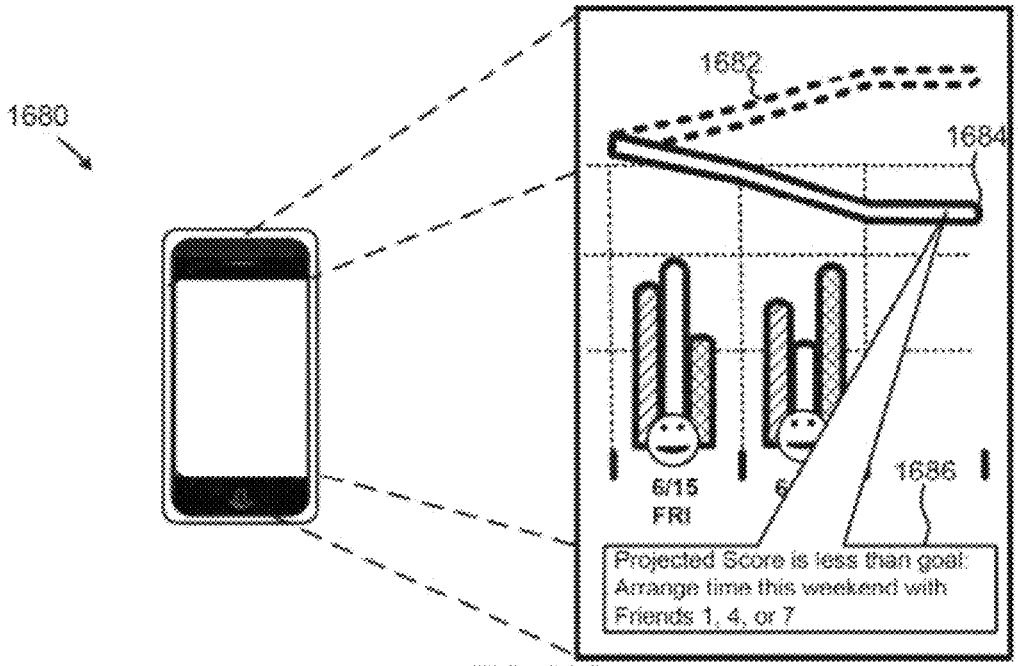


FIG. 16C

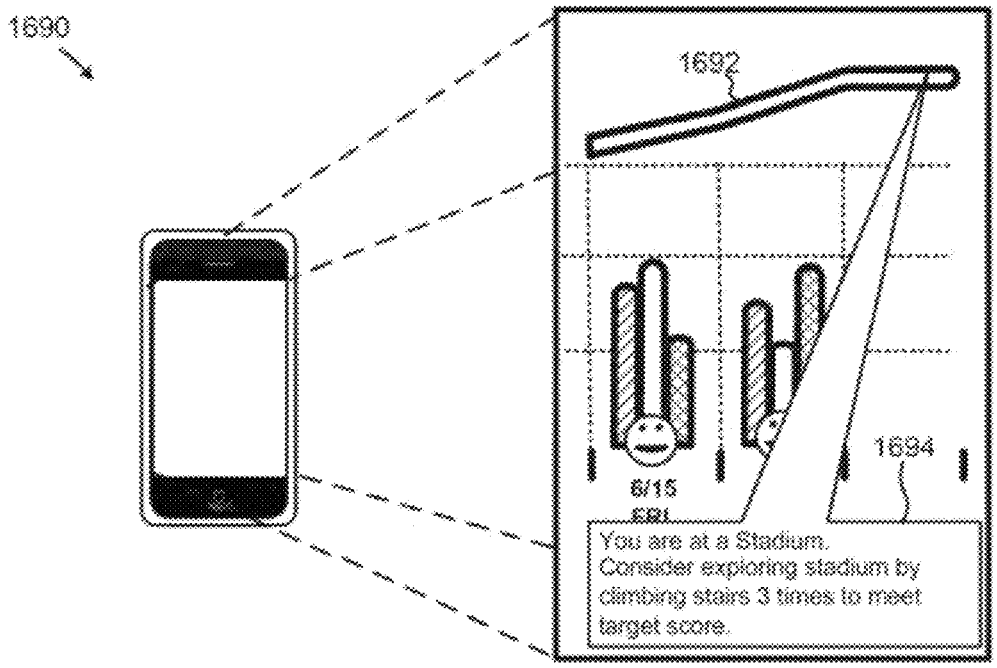


FIG. 16D

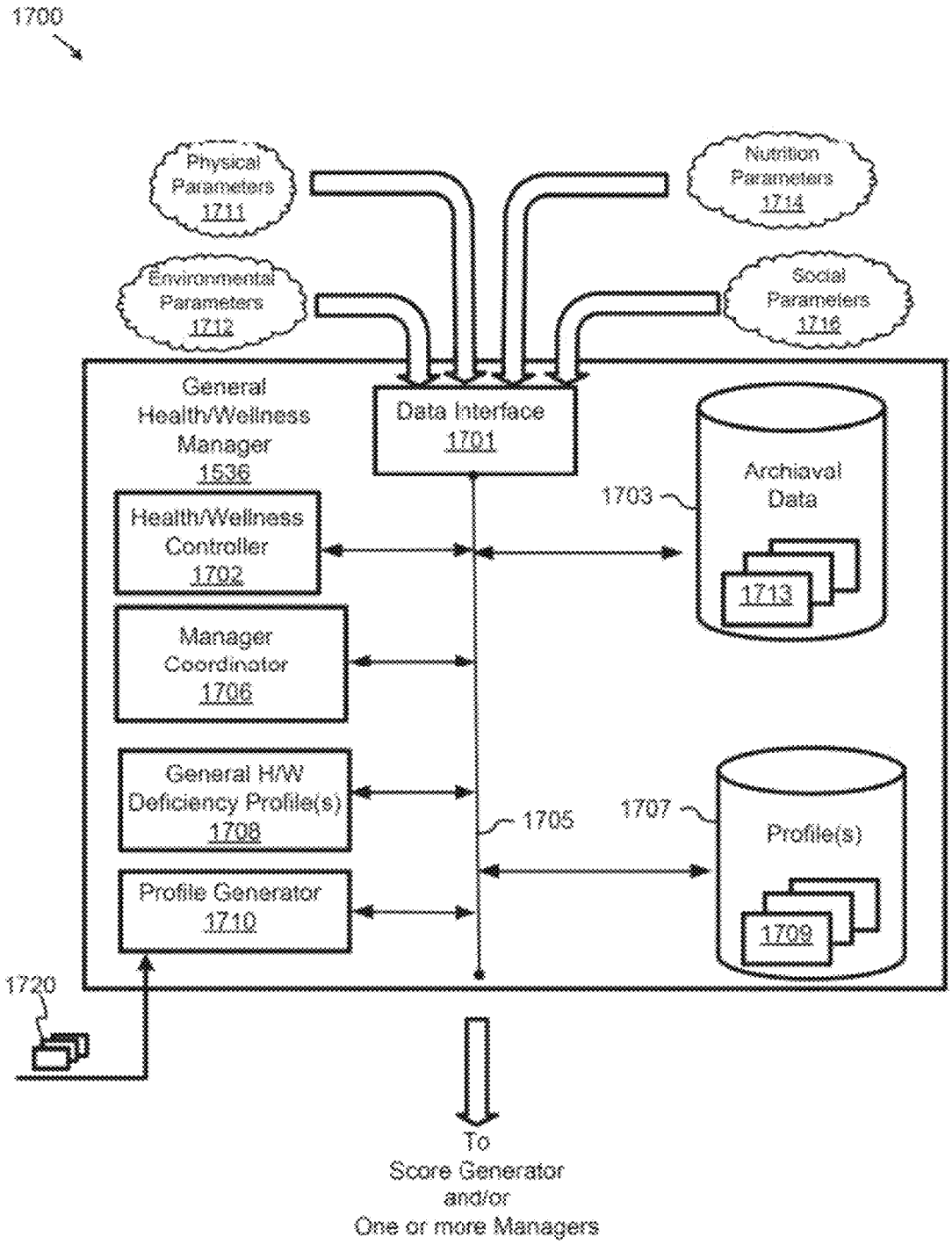

1700
Physical Parameters 1711
Nutrition Parameters 1714
Environmental Parameters 1712
Social Parameters 1716
General Health/Wellness Manager 1536
Data Interface 1701
Archiaval Data
1703
1713
Health/Wellness Controller 1702
Manager Coordinator 1706
General H/W Deficiency Profile(s) 1708
1705
1707
Profile(s)
1709
Profile Generator 1710
1720
To Score Generator and/or One or more Managers

FIG. 17A

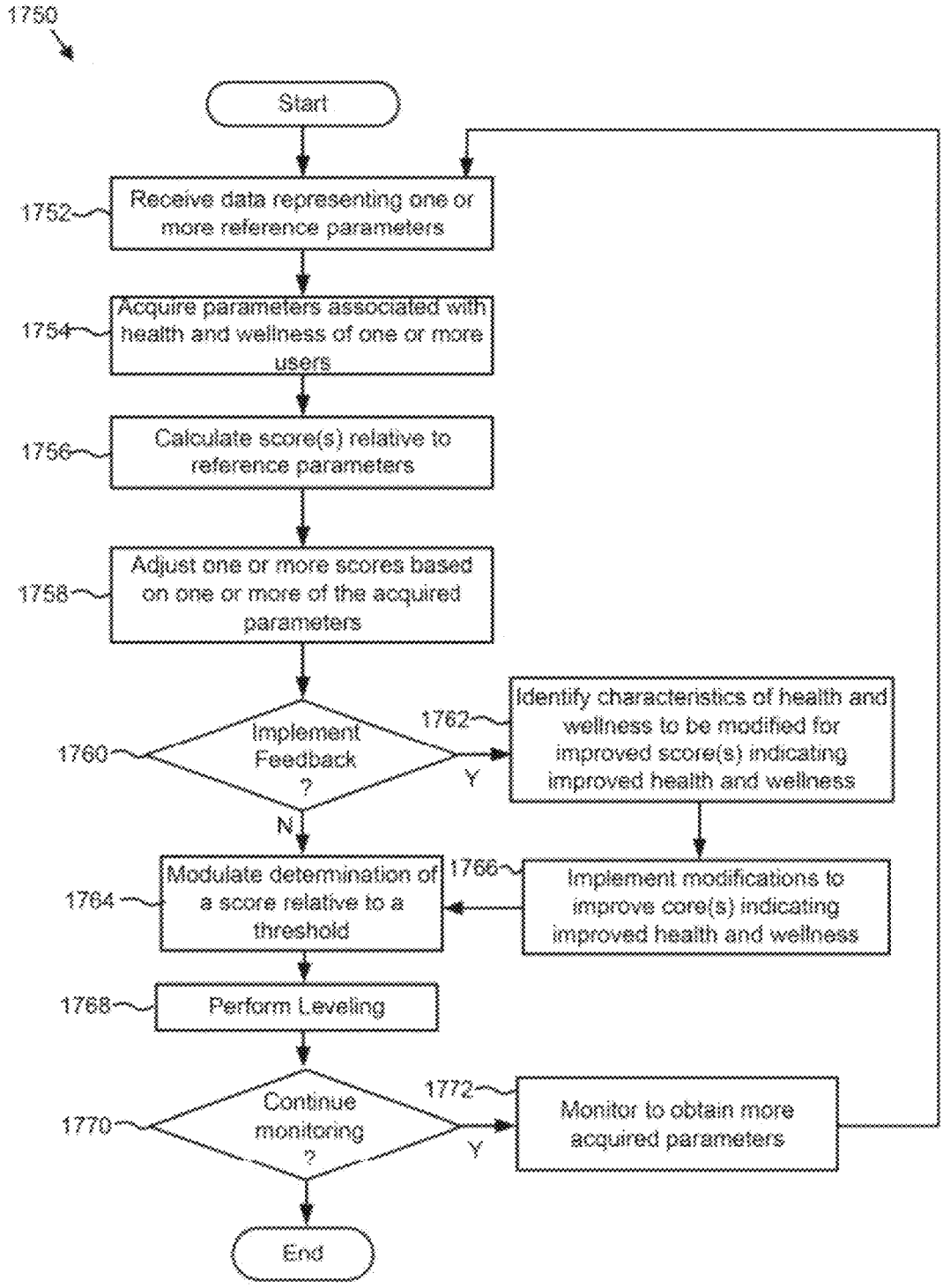

1750
Start
1752
Receive data representing one or more reference parameters
1754
Acquire parameters associated with health and wellness of one or more users
1756
Calculate score(s) relative to reference parameters
1758
Adjust one or more scores based on one or more of the acquired parameters
1760
Implement Feedback ?
Y
N
1762
Identify characteristics of health and wellness to be modified for improved score(s) indicating improved health and wellness
1764
Modulate determination of a score relative to a threshold
1766
Implement modifications to improve core(s) indicating improved health and wellness
1768
Perform Leveling
1770
Continue monitoring ?
Y
1772
Monitor to obtain more acquired parameters
End

FIG. 17B

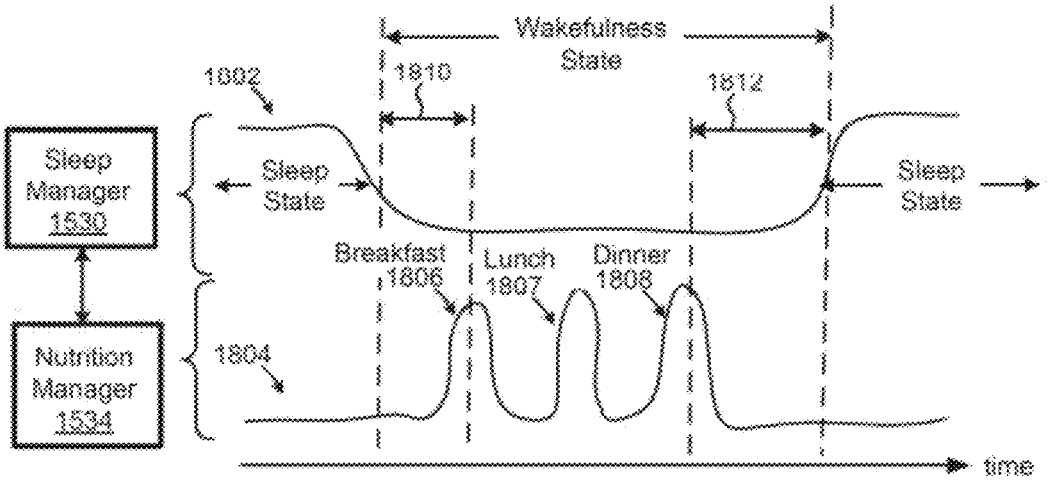


FIG. 18A

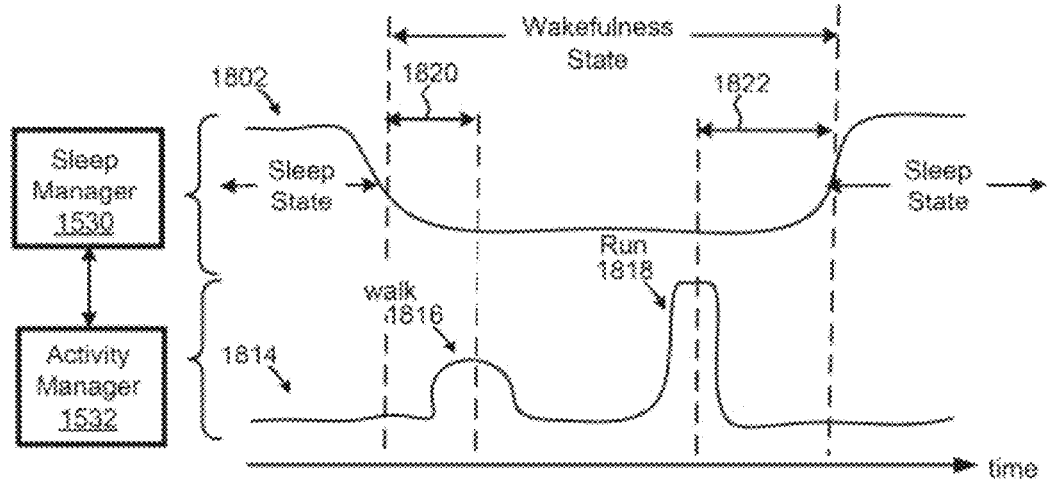


FIG. 18B

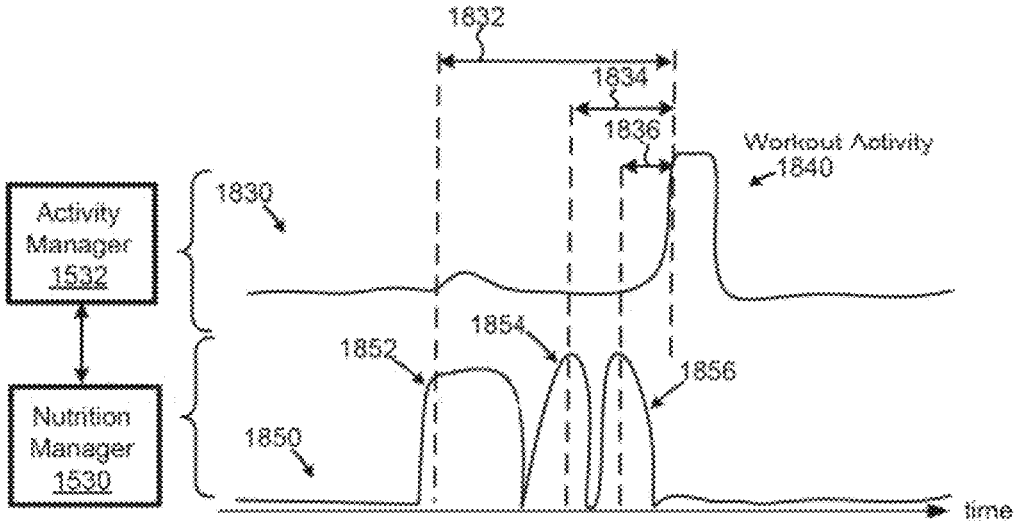


FIG. 18C

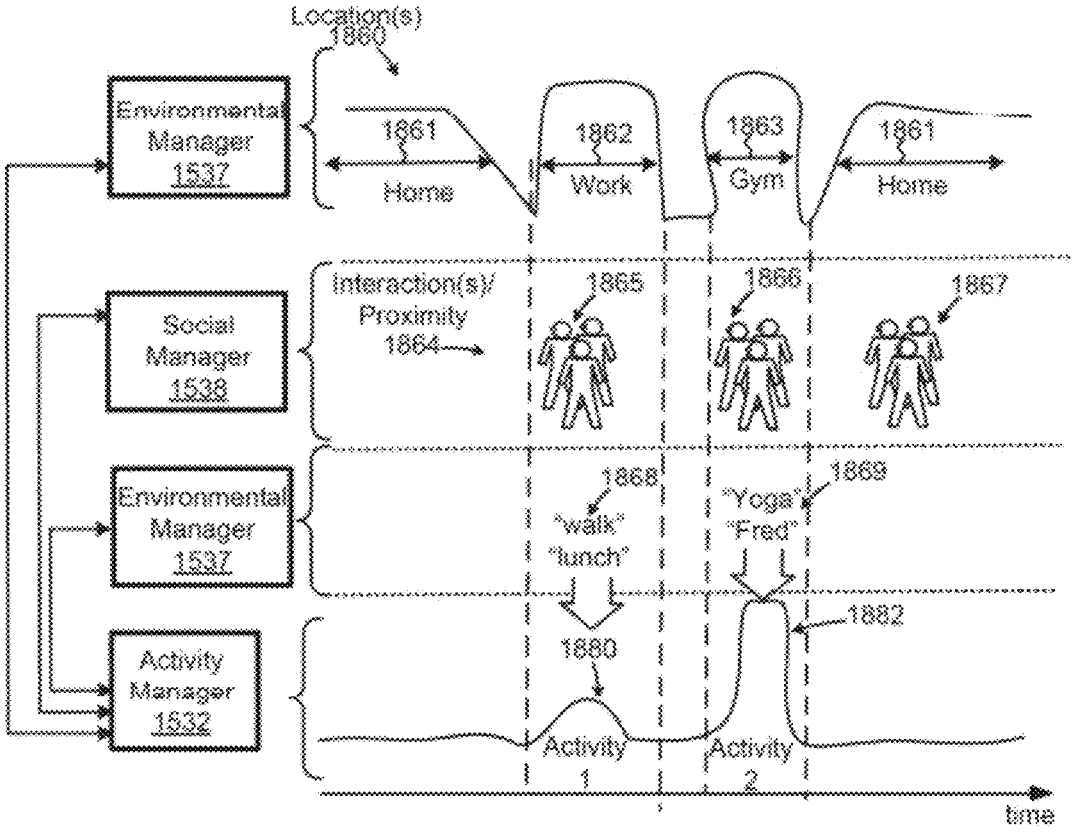


FIG. 18D

GENERAL HEALTH AND WELLNESS MANAGEMENT METHOD AND APPARATUS FOR A WELLNESS APPLICATION USING DATA FROM A DATA-CAPABLE BAND

CROSS-REFERENCE TO RELATED APPLICATIONS

THIS application is a continuation-in-part of U.S. non-provisional patent application 13/433,204, filed Mar. 28, 2012, which is a continuation-in-part of U.S. non-provisional patent application Ser. No. of 13/181,495, filed Jul. 12, 2011, which is a continuation-in-part of prior U.S. patent application Ser. No. 13/180,000, filed Jul. 11, 2011, which claims the benefit of U.S. Provisional Patent Application No. 61/495,995, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,994, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,997, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,996, filed Jun. 11, 2011, and U.S. patent application Ser. No. 13/180,000 is a continuation-in-part of prior U.S. patent application Ser. No. 13/158,416, filed Jun. 11, 2011, which is a continuation-in-part of prior U.S. patent application Ser. No. 13/158,372, filed Jun. 10, 2011, and U.S. patent application Ser. No. 13/181,495 claims the benefit of U.S. Provisional Patent Application No. 61/495,995, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,994, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,997, filed Jun. 11, 2011, and U.S. Provisional Patent Application No. 61/495,996, filed Jun. 11, 2011; U.S. patent application Ser. No. 13/181,495 is also a continuation-in-part of prior U.S. patent application Ser. No. 13/180,320, filed Jul. 11, 2011, which claims the benefit of U.S. Provisional Patent Application No. 61/495,995, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,994, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,997, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,996, filed Jun. 11, 2011, and U.S. patent application Ser. No. 13/180,320 is a continuation-in-part of prior U.S. patent application Ser. No. 13/158,416, filed Jun. 11, 2011, which is a continuation-in-part of prior U.S. patent application Ser. No. 13/158,372, filed Jun. 10, 2011, which claims the benefit of U.S. Provisional Patent Application No. 61/495,995, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,994, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,997, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,996, filed Jun. 11, 2011; U.S. patent application Ser. No. 13/181,495 is also a continuation-in-part of prior U.S. patent application Ser. No. 13/158,416, filed Jun. 11, 2011, which is a continuation-in-part of prior U.S. patent application Ser. No. 13/158,372, filed Jun. 10, 2011; U.S. patent application Ser. No. 13/181,495 is also a continuation-in-part of prior U.S. patent application Ser. No. 13/158,372, filed Jun. 10, 2011; U.S. non-provisional patent application Ser. No. 13/433,204 claims the benefit of U.S. Provisional Patent Application No. 61/495,995, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,994, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,997, filed Jun. 11, 2011, and U.S. Provisional Patent Application No. 61/495,996, filed Jun. 11, 2011, and is a continuation-in-part of prior U.S. patent application Ser. No. 13/180,320, filed Jul. 11, 2011, which claims the benefit of U.S. Provisional Patent Application No. 61/495,995, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,994, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,997, filed Jun. 11, 2011, U.S. Provisional Patent Application No. 61/495,996, filed Jun. 11, 2011, and is a continuation-in-part

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FIELD

The present invention relates generally to electrical and electronic hardware, computer software, wired and wireless network communications, and computing devices. More specifically, general health and wellness management techniques and devices for use with a data-capable personal worn or carried device are described.

BACKGROUND

With the advent of greater computing capabilities in smaller personal and/or portable form factors and an increasing number of applications (i.e., computer and Internet software or programs) for different uses, consumers (i.e., users) have access to large amounts of personal data. Information and data are often readily available, but poorly captured using conventional data capture devices. Conventional devices typically lack capabilities that can capture, analyze, communicate, or use data in a contextually-meaningful, comprehensive, and efficient manner. Further, conventional solutions are often limited to specific individual purposes or uses, demanding that users invest in multiple devices in order to perform different activities (e.g., a sports watch for tracking time and distance, a GPS receiver for monitoring a hike or run, a cyclometer for gathering cycling data, and others). Although a wide range of data and information is available, conventional devices and applications fail to provide effective solutions that comprehensively capture data for a given user across numerous disparate activities.

Some conventional solutions combine a small number of discrete functions. Functionality for data capture, processing, storage, or communication in conventional devices such as a watch or timer with a heart rate monitor or global positioning system ("GPS") receiver are available conventionally, but are expensive to manufacture and purchase. Other conventional solutions for combining personal data capture facilities often present numerous design and manufacturing problems such as size restrictions, specialized materials requirements, lowered tolerances for defects such as pits or holes in coverings for water-resistant or waterproof devices, unreliability, higher failure rates, increased manufacturing time, and expense. Subsequently, conventional devices such as fitness watches, heart rate monitors, GPS-enabled fitness monitors, health monitors (e.g., diabetic blood sugar testing units), digital voice recorders, pedometers, altimeters, and other conventional personal data capture devices are generally manufactured for conditions that occur in a single or small groupings of activities. Problematically, though, conventional devices do not provide effective solutions to users in terms of providing a comprehensive view of one's overall health or wellness as a result of a combined analysis of data gathered. This is a limiting aspect of the commercial attraction of the various types of conventional devices listed above.

Generally, if the number of activities performed by conventional personal data capture devices increases, there is a corresponding rise in design and manufacturing requirements that results in significant consumer expense, which eventually becomes prohibitive to both investment and commercialization. Further, conventional manufacturing techniques are often limited and ineffective at meeting increased requirements to protect sensitive hardware, circuitry, and other components that are susceptible to damage, but which are required to perform various personal data capture activities. As a conventional example, sensitive electronic components such as printed circuit board assemblies ("PCBA"), sensors, and computer memory (hereafter "memory") can be significantly damaged or destroyed during manufacturing processes where overmoldings or layering of protective material occurs using techniques such as injection molding, cold molding, and others. Damaged or destroyed items subsequently raises the cost of goods sold and can deter not only investment and commercialization, but also innovation in data capture and analysis technologies, which are highly compelling fields of opportunity.

Thus, what is needed is a solution for data capture devices without the limitations of conventional techniques.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments or examples ("examples") of the invention are disclosed in the following detailed description and the accompanying drawings:

FIG. **1** illustrates an exemplary data-capable band system;

FIG. **2** illustrates a block diagram of an exemplary data-capable band;

FIG. **3** illustrates sensors for use with an exemplary data-capable band;

FIG. **4** illustrates an application architecture for an exemplary data-capable band;

FIG. **5**A illustrates representative data types for use with an exemplary data-capable band;

FIG. **5**B illustrates representative data types for use with an exemplary data-capable band in fitness-related activities;

FIG. **5**C illustrates representative data types for use with an exemplary data-capable band in sleep management activities;

FIG. **5**D illustrates representative data types for use with an exemplary data-capable band in medical-related activities;

FIG. **5**E illustrates representative data types for use with an exemplary data-capable band in social media/networking-related activities;

FIG. **6** illustrates an exemplary communications device system implemented with multiple exemplary data-capable bands;

FIG. **7** illustrates an exemplary wellness tracking system for use with or within a distributed wellness application;

FIG. **8** illustrates representative calculations executed by an exemplary conversion module to determine an aggregate value for producing a graphical representation of a user's wellness;

FIG. **9** illustrates an exemplary process for generating and displaying a graphical representation of a user's wellness based upon the user's activities;

FIG. **10** illustrates an exemplary graphical representation of a user's wellness over a time period;

FIG. **11** illustrates another exemplary graphical representation of a user's wellness over a time period;

FIGS. **12**A-**12**F illustrate exemplary wireframes of exemplary webpages associated with a wellness marketplace portal;

FIG. **13** illustrates an exemplary computer system suitable for implementation of a wellness application and use with a data-capable band;

FIG. **14** depicts an example of an aggregation engine, according to some examples;

FIG. **15**A depicts an example of an aggregation engine including a general health and wellness manager configured to operate with and/or control one or more managers, according to some examples;

FIG. **15**B depicts an example of a flow to modify a target score to enhance a general health and wellness of a user, according to some examples;

FIG. **16**A depicts examples of a social manager and an environmental manager configured to generate a context score, according to some examples;

FIG. **16**B is an example of a flow diagram to determine recommendations based on a context score to manage health and wellness, according to some examples;

FIGS. **16**C and **16**D depict examples of displays including feedback based on environmental or social parameters, according to some examples;

FIG. **17**A depicts an example of a general health and wellness manager, according to some examples;

FIG. **17**B is an example flow diagram for a technique of managing overall health and wellness using, for example, wearable devices that include sensors, according to some examples; and

FIGS. **18**A to **18**D depict interrelationships between different aspects of health and wellness and different managers cooperating to optimize the same, according to various examples.

DETAILED DESCRIPTION

Various embodiments or examples may be implemented in numerous ways, including as a system, a process, an apparatus, a user interface, or a series of program instructions on a computer readable medium such as a computer readable storage medium or a computer network where the program instructions are sent over optical, electronic, or wireless communication links. In general, operations of disclosed processes may be performed in an arbitrary order, unless otherwise provided in the claims.

A detailed description of one or more examples is provided below along with accompanying figures. The detailed description is provided in connection with such examples, but is not limited to any particular example. The scope is limited only by the claims and numerous alternatives, modifications, and equivalents are encompassed. Numerous specific details are set forth in the following description in order to provide a thorough understanding. These details are provided for the purpose of example and the described techniques may be practiced according to the claims without some or all of these specific details. For clarity, technical material that is known in the technical fields related to the examples has not been described in detail to avoid unnecessarily obscuring the description.

FIG. **1** illustrates an exemplary data-capable band system. Here, system **100** includes network **102**, bands **104-112**, server **114**, mobile computing device **116**, mobile communications device **118**, computer **120**, laptop **122**, and distributed sensor **124**. Bands **104-112** may be implemented as data-capable device that may be worn as a strap or band around an arm, leg, ankle, or other bodily appendage or feature. In other examples, bands **104-112** may be attached directly or indirectly to other items, organic or inorganic, animate, or static. In still other examples, bands **104-112** may be used differently.

As described above, bands **104-112** may be implemented as wearable personal data or data capture devices (e.g., data-capable devices) that are worn by a user around a wrist, ankle, arm, ear, or other appendage, or attached to the body or affixed to clothing. One or more facilities, sensing elements, or sensors, both active and passive, may be implemented as part of bands **104-112** in order to capture various types of data from different sources. Temperature, environmental, temporal, motion, electronic, electrical, chemical, or other types of sensors (including those described below in connection with FIG. **3**) may be used in order to gather varying amounts of data, which may be configurable by a user, locally (e.g., using user interface facilities such as buttons, switches, motion-activated/detected command structures (e.g., accelerometer-gathered data from user-initiated motion of bands **104-112**), and others) or remotely (e.g., entering rules or parameters in a website or graphical user interface ("GUI") that may be used to modify control systems or signals in firmware, circuitry, hardware, and software implemented (i.e., installed) on bands **104-112**). Bands **104-112** may also be implemented as data-capable devices that are configured for data communication using various types of communications infrastructure and media, as described in greater detail below. Bands **104-112** may also be wearable, personal, non-intrusive, lightweight devices that are configured to gather large amounts of personally relevant data that can be used to improve user health, fitness levels, medical conditions, athletic performance, sleeping physiology, and physiological conditions, or used as a sensory-based user interface ("UI") to signal social-related notifications specifying the state of the user through vibration, heat, lights or other sensory based notifications. For example, a social-related notification signal indicating a user is on-line can be transmitted to a recipient, who in turn, receives the notification as, for instance, a vibration.

Using data gathered by bands **104-112**, applications may be used to perform various analyses and evaluations that can generate information as to a person's physical (e.g., healthy, sick, weakened, or other states, or activity level), emotional, or mental state (e.g., an elevated body temperature or heart rate may indicate stress, a lowered heart rate and skin temperature, or reduced movement (e.g., excessive sleeping), may indicate physiological depression caused by exertion or other factors, chemical data gathered from evaluating outgassing from the skin's surface may be analyzed to determine whether a person's diet is balanced or if various nutrients are lacking, salinity detectors may be evaluated to determine if high, lower, or proper blood sugar levels are present for diabetes management, and others). Generally, bands **104-112** may be configured to gather from sensors locally and remotely.

As an example, band **104** may capture (i.e., record, store, communicate (i.e., send or receive), process, or the like) data from various sources (i.e., sensors that are organic (i.e., installed, integrated, or otherwise implemented with band **104**) or distributed (e.g., microphones on mobile computing device **116**, mobile communications device **118**, computer **120**, laptop **122**, distributed sensor **124**, global positioning system ("GPS") satellites, or others, without limitation)) and exchange data with one or more of bands **106-112**, server **114**, mobile computing device **116**, mobile communications device **118**, computer **120**, laptop **122**, and distributed sensor **124**. As shown here, a local sensor may be one that is incorporated, integrated, or otherwise implemented with bands **104-112**. A remote or distributed sensor (e.g., mobile computing device **116**, mobile communications device **118**, computer **120**, laptop **122**, or, generally, distributed sensor **124**) may be sensors that can be accessed, controlled, or otherwise used by bands **104-112**. For example, band **112** may be configured to control devices that are also controlled by a given user (e.g., mobile computing device **116**, mobile communications device **118**, computer **120**, laptop **122**, and distributed sensor **124**). For example, a microphone in mobile communications device **118** may be used to detect, for example, ambient audio data that is used to help identify a person's location, or an ear clip (e.g., a headset as described below) affixed to an ear may be used to record pulse or blood oxygen saturation levels. Additionally, a sensor implemented with a screen on mobile computing device **116** may be used to read a user's temperature or obtain a biometric signature while a user is interacting with data. A further example may include using data that is observed on computer **120** or laptop **122** that provides information as to a user's online behavior and the type of content that she is viewing, which may be used by bands **104-112**. Regardless of the type or location of sensor used, data may be transferred to bands **104-112** by using, for example, an analog audio jack, digital adapter (e.g., USB, mini-USB), or other, without limitation, plug, or other type of connector that may be used to physically couple bands **104-112** to another device or system for transferring data and, in some examples, to provide power to recharge a battery (not shown). Alternatively, a wireless data communication interface or facility (e.g., a wireless radio that is configured to communicate data from bands **104-112** using one or more data communication protocols (e.g., IEEE 802.11a/b/g/n (WiFi), WiMax, ANT™, ZigBee®, Bluetooth®, Near Field Communications ("NFC"), and others)) may be used to receive or transfer data. Further, bands **104-112** may be configured to analyze, evaluate, modify, or otherwise use data gathered, either directly or indirectly.

In some examples, bands **104-112** may be configured to share data with each other or with an intermediary facility, such as a database, website, web service, or the like, which may be implemented by server **114**. In some embodiments, server **114** can be operated by a third party providing, for example, social media-related services. Bands **104-112** and other related devices may exchange data with each other directly, or bands **104-112** may exchange data via a third party server, such as a third party like Facebook®, to provide social-media related services. Examples of other third party servers include those implemented by social networking services, including, but not limited to, services such as Yahoo! IM™, GTalk™, MSN Messenger™, Twitter® and other private or public social networks. The exchanged data may include personal physiological data and data derived from sensory-based user interfaces ("UI"). Server **114**, in some examples, may be implemented using one or more processor-based computing devices or networks, including computing clouds, storage area networks ("SAN"), or the like. As shown, bands **104-112** may be used as a personal data or area network (e.g., "PDN" or "PAN") in which data relevant to a given user or band (e.g., one or more of bands **104-112**) may be shared. As shown here, bands **104** and **112** may be configured to exchange data with each other over network **102** or indirectly using server **114**. Users of bands **104** and **112** may direct a web browser hosted on a computer (e.g., computer **120**, laptop **122**, or the like) in order to access, view, modify, or perform other operations with data captured by bands **104** and **112**. For example, two runners using bands **104** and **112** may be geographically remote (e.g., users are not geographically in close proximity locally such that bands being used by each user are in direct data communication), but wish to share data regarding their race times (pre, post, or in-race), personal records (i.e., "PR"), target split times, results, performance characteristics (e.g., target heart rate, target VO2 max, and others), and other information. If both runners (i.e., bands **104** and **112**) are engaged in a race on the same day, data can be gathered for comparative analysis and other uses. Further, data can be shared in substantially real-time (taking into account any latencies incurred by data transfer rates, network topologies, or other data network factors) as well as uploaded after a given activity or event has been performed. In other words, data can be captured by the user as it is worn and configured to transfer data using, for example, a wireless network connection (e.g., a wireless network interface card, wireless local area network ("LAN") card, cell phone, or the like). Data may also be shared in a temporally asynchronous manner in which a wired data connection (e.g., an analog audio plug (and associated software or firmware) configured to transfer digitally encoded data to encoded audio data that may be transferred between bands **104-112** and a plug configured to receive, encode/decode, and process data exchanged) may be used to transfer data from one or more bands **104-112** to various destinations (e.g., another of bands **104-112**, server **114**, mobile computing device **116**, mobile communications device **118**, computer **120**, laptop **122**, and distributed sensor **124**). Bands **104-112** may be implemented with various types of wired and/or wireless communication facilities and are not intended to be limited to any specific technology. For example, data may be transferred from bands **104-112** using an analog audio plug (e.g., TRRS, TRS, or others). In other examples, wireless communication facilities using various types of data communication protocols (e.g., WiFi, Bluetooth®, ZigBee®, ANT™, and others) may be implemented as part of bands **104-112**, which may include circuitry, firmware, hardware, radios, antennas, processors, microprocessors, memories, or other electrical, electronic,

mechanical, or physical elements configured to enable data communication capabilities of various types and characteristics.

As data-capable devices, bands **104-112** may be configured to collect data from a wide range of sources, including onboard (not shown) and distributed sensors (e.g., server **114**, mobile computing device **116**, mobile communications device **118**, computer **120**, laptop **122**, and distributed sensor **124**) or other bands. Some or all data captured may be personal, sensitive, or confidential and various techniques for providing secure storage and access may be implemented. For example, various types of security protocols and algorithms may be used to encode data stored or accessed by bands **104-112**. Examples of security protocols and algorithms include authentication, encryption, encoding, private and public key infrastructure, passwords, checksums, hash codes and hash functions (e.g., SHA, SHA-1, MD-5, and the like), or others may be used to prevent undesired access to data captured by bands **104-112**. In other examples, data security for bands **104-112** may be implemented differently.

Bands **104-112** may be used as personal wearable, data capture devices that, when worn, are configured to identify a specific, individual user. By evaluating captured data such as motion data from an accelerometer, biometric data such as heart rate, skin galvanic response, and other biometric data, and using long-term analysis techniques (e.g., software packages or modules of any type, without limitation), a user may have a unique pattern of behavior or motion and/or biometric responses that can be used as a signature for identification. For example, bands **104-112** may gather data regarding an individual person's gait or other unique biometric, physiological or behavioral characteristics. Using, for example, distributed sensor **124**, a biometric signature (e.g., fingerprint, retinal or iris vascular pattern, or others) may be gathered and transmitted to bands **104-112** that, when combined with other data, determines that a given user has been properly identified and, as such, authenticated. When bands **104-112** are worn, a user may be identified and authenticated to enable a variety of other functions such as accessing or modifying data, enabling wired or wireless data transmission facilities (i.e., allowing the transfer of data from bands **104-112**), modifying functionality or functions of bands **104-112**, authenticating financial transactions using stored data and information (e.g., credit card, PIN, card security numbers, and the like), running applications that allow for various operations to be performed (e.g., controlling physical security and access by transmitting a security code to a reader that, when authenticated, unlocks a door by turning off current to an electromagnetic lock, and others), and others. Different functions and operations beyond those described may be performed using bands **104-112**, which can act as secure, personal, wearable, data-capable devices. The number, type, function, configuration, specifications, structure, or other features of system **100** and the above-described elements may be varied and are not limited to the examples provided.

FIG. **2** illustrates a block diagram of an exemplary data-capable band. Here, band **200** includes bus **202**, processor **204**, memory **206**, notification facility **208**, accelerometer **210**, sensor **212**, battery **214**, and communications facility **216**. In some examples, the quantity, type, function, structure, and configuration of band **200** and the elements (e.g., bus **202**, processor **204**, memory **206**, notification facility **208**, accelerometer **210**, sensor **212**, battery **214**, and communications facility **216**) shown may be varied and are not limited to the examples provided. As shown, processor **204** may be implemented as logic to provide control functions and signals to memory **206**, notification facility **208**, accelerometer **210**, sensor **212**, battery **214**, and communications facility **216**. Processor **204** may be implemented using any type of processor or microprocessor suitable for packaging within bands **104-112** (FIG. **1**). Various types of microprocessors may be used to provide data processing capabilities for band **200** and are not limited to any specific type or capability. For example, a MSP430F5528-type microprocessor manufactured by Texas Instruments of Dallas, Tex. may be configured for data communication using audio tones and enabling the use of an audio plug-and-jack system (e.g., TRRS, TRS, or others) for transferring data captured by band **200**. Further, different processors may be desired if other functionality (e.g., the type and number of sensors (e.g., sensor **212**)) are varied. Data processed by processor **204** may be stored using, for example, memory **206**.

In some examples, memory **206** may be implemented using various types of data storage technologies and standards, including, without limitation, read-only memory ("ROM"), random access memory ("RAM"), dynamic random access memory ("DRAM"), static random access memory ("SRAM"), static/dynamic random access memory ("SDRAM"), magnetic random access memory ("MRAM"), solid state, two and three-dimensional memories, Flash®, and others. Memory **206** may also be implemented using one or more partitions that are configured for multiple types of data storage technologies to allow for non-modifiable (i.e., by a user) software to be installed (e.g., firmware installed on ROM) while also providing for storage of captured data and applications using, for example, RAM. Once captured and/or stored in memory **206**, data may be subjected to various operations performed by other elements of band **200**.

Notification facility **208**, in some examples, may be implemented to provide vibratory energy, audio or visual signals, communicated through band **200**. As used herein, "facility" refers to any, some, or all of the features and structures that are used to implement a given set of functions. In some examples, the vibratory energy may be implemented using a motor or other mechanical structure. In some examples, the audio signal may be a tone or other audio cue, or it may be implemented using different sounds for different purposes. The audio signals may be emitted directly using notification facility **208**, or indirectly by transmission via communications facility **216** to other audio-capable devices (e.g., headphones (not shown), a headset (as described below with regard to FIG. **12**), mobile computing device **116**, mobile communications device **118**, computer **120**, laptop **122**, distributed sensor **124**, etc.). In some examples, the visual signal may be implemented using any available display technology, such as lights, light-emitting diodes (LEDs), interferometric modulator display (IMOD), electrophoretic ink (E Ink), organic light-emitting diode (OLED), or other display technologies. As an example, an application stored on memory **206** may be configured to monitor a clock signal from processor **204** in order to provide timekeeping functions to band **200**. For example, if an alarm is set for a desired time, notification facility **208** may be used to provide a vibration or an audio tone, or a series of vibrations or audio tones, when the desired time occurs. As another example, notification facility **208** may be coupled to a framework (not shown) or other structure that is used to translate or communicate vibratory energy throughout the physical structure of band **200**. In other examples, notification facility **208** may be implemented differently.

Power may be stored in battery **214**, which may be implemented as a battery, battery module, power management module, or the like. Power may also be gathered from local power sources such as solar panels, thermo-electric genera-

tors, and kinetic energy generators, among others that are alternatives power sources to external power for a battery. These additional sources can either power the system directly or can charge a battery, which, in turn, is used to power the system (e.g., of a band). In other words, battery **214** may include a rechargeable, expendable, replaceable, or other type of battery, but also circuitry, hardware, or software that may be used in connection with in lieu of processor **204** in order to provide power management, charge/recharging, sleep, or other functions. Further, battery **214** may be implemented using various types of battery technologies, including Lithium Ion ("LI"), Nickel Metal Hydride ("NiMH"), or others, without limitation. Power drawn as electrical current may be distributed from battery via bus **202**, the latter of which may be implemented as deposited or formed circuitry or using other forms of circuits or cabling, including flexible circuitry. Electrical current distributed from battery **204** and managed by processor **204** may be used by one or more of memory **206**, notification facility **208**, accelerometer **210**, sensor **212**, or communications facility **216**.

As shown, various sensors may be used as input sources for data captured by band **200**. For example, accelerometer **210** may be used to gather data measured across one, two, or three axes of motion. In addition to accelerometer **210**, other sensors (i.e., sensor **212**) may be implemented to provide temperature, environmental, physical, chemical, electrical, or other types of sensed inputs. As presented here, sensor **212** may include one or multiple sensors and is not intended to be limiting as to the quantity or type of sensor implemented. Data captured by band **200** using accelerometer **210** and sensor **212** or data requested from another source (i.e., outside of band **200**) may also be exchanged, transferred, or otherwise communicated using communications facility **216**. For example, communications facility **216** may include a wireless radio, control circuit or logic, antenna, transceiver, receiver, transmitter, resistors, diodes, transistors, or other elements that are used to transmit and receive data from band **200**. In some examples, communications facility **216** may be implemented to provide a "wired" data communication capability such as an analog or digital attachment, plug, jack, or the like to allow for data to be transferred. In other examples, communications facility **216** may be implemented to provide a wireless data communication capability to transmit digitally encoded data across one or more frequencies using various types of data communication protocols, without limitation. In still other examples, band **200** and the above-described elements may be varied in function, structure, configuration, or implementation and are not limited to those shown and described.

FIG. **3** illustrates sensors for use with an exemplary data-capable band. Sensor **212** may be implemented using various types of sensors, some of which are shown. Like-numbered and named elements may describe the same or substantially similar element as those shown in other descriptions. Here, sensor **212** (FIG. **2**) may be implemented as accelerometer **302**, altimeter/barometer **304**, light/infrared ("IR") sensor **306**, pulse/heart rate ("HR") monitor **308**, audio sensor (e.g., microphone, transducer, or others) **310**, pedometer **312**, velocimeter **314**, GPS receiver **316**, location-based service sensor (e.g., sensor for determining location within a cellular or micro-cellular network, which may or may not use GPS or other satellite constellations for fixing a position) **318**, motion detection sensor **320**, environmental sensor **322**, chemical sensor **324**, electrical sensor **326**, or mechanical sensor **328**.

As shown, accelerometer **302** may be used to capture data associated with motion detection along 1, 2, or 3-axes of measurement, without limitation to any specific type of specification of sensor. Accelerometer **302** may also be implemented to measure various types of user motion and may be configured based on the type of sensor, firmware, software, hardware, or circuitry used. As another example, altimeter/barometer **304** may be used to measure environment pressure, atmospheric or otherwise, and is not limited to any specification or type of pressure-reading device. In some examples, altimeter/barometer **304** may be an altimeter, a barometer, or a combination thereof. For example, altimeter/barometer **304** may be implemented as an altimeter for measuring above ground level ("AGL") pressure in band **200**, which has been configured for use by naval or military aviators. As another example, altimeter/barometer **304** may be implemented as a barometer for reading atmospheric pressure for marine-based applications. In other examples, altimeter/barometer **304** may be implemented differently.

Other types of sensors that may be used to measure light or photonic conditions include light/IR sensor **306**, motion detection sensor **320**, and environmental sensor **322**, the latter of which may include any type of sensor for capturing data associated with environmental conditions beyond light. Further, motion detection sensor **320** may be configured to detect motion using a variety of techniques and technologies, including, but not limited to comparative or differential light analysis (e.g., comparing foreground and background lighting), sound monitoring, or others. Audio sensor **310** may be implemented using any type of device configured to record or capture sound.

In some examples, pedometer **312** may be implemented using devices to measure various types of data associated with pedestrian-oriented activities such as running or walking. Footstrikes, stride length, stride length or interval, time, and other data may be measured. Velocimeter **314** may be implemented, in some examples, to measure velocity (e.g., speed and directional vectors) without limitation to any particular activity. Further, additional sensors that may be used as sensor **212** include those configured to identify or obtain location-based data. For example, GPS receiver **316** may be used to obtain coordinates of the geographic location of band **200** using, for example, various types of signals transmitted by civilian and/or military satellite constellations in low, medium, or high earth orbit (e.g., "LEO," "MEO," or "GEO"). In other examples, differential GPS algorithms may also be implemented with GPS receiver **316**, which may be used to generate more precise or accurate coordinates. Still further, location-based services sensor **318** may be implemented to obtain location-based data including, but not limited to location, nearby services or items of interest, and the like. As an example, location-based services sensor **318** may be configured to detect an electronic signal, encoded or otherwise, that provides information regarding a physical locale as band **200** passes. The electronic signal may include, in some examples, encoded data regarding the location and information associated therewith. Electrical sensor **326** and mechanical sensor **328** may be configured to include other types (e.g., haptic, kinetic, piezoelectric, piezomechanical, pressure, touch, thermal, and others) of sensors for data input to band **200**, without limitation. Other types of sensors apart from those shown may also be used, including magnetic flux sensors such as solid-state compasses and the like, including gyroscopic sensors. While the present illustration provides numerous examples of types of sensors that may be used with band **200** (FIG. **2**), others not shown or described may be implemented with or as a substitute for any sensor shown or described.

FIG. **4** illustrates an application architecture for an exemplary data-capable band. Here, application architecture **400**

includes bus **402**, logic module **404**, communications module **406**, security module **408**, interface module **410**, data management **412**, audio module **414**, motor controller **416**, service management module **418**, sensor input evaluation module **420**, and power management module **422**. In some examples, application architecture **400** and the above-listed elements (e.g., bus **402**, logic module **404**, communications module **406**, security module **408**, interface module **410**, data management **412**, audio module **414**, motor controller **416**, service management module **418**, sensor input evaluation module **420**, and power management module **422**) may be implemented as software using various computer programming and formatting languages such as Java, C++, C, and others. As shown here, logic module **404** may be firmware or application software that is installed in memory **206** (FIG. **2**) and executed by processor **204** (FIG. **2**). Included with logic module **404** may be program instructions or code (e.g., source, object, binary executables, or others) that, when initiated, called, or instantiated, perform various functions.

For example, logic module **404** may be configured to send control signals to communications module **406** in order to transfer, transmit, or receive data stored in memory **206**, the latter of which may be managed by a database management system ("DBMS") or utility in data management module **412**. As another example, security module **408** may be controlled by logic module **404** to provide encoding, decoding, encryption, authentication, or other functions to band **200** (FIG. **2**). Alternatively, security module **408** may also be implemented as an application that, using data captured from various sensors and stored in memory **206** (and accessed by data management module **412**) may be used to provide identification functions that enable band **200** to passively identify a user or wearer of band **200**. Still further, various types of security software and applications may be used and are not limited to those shown and described.

Interface module **410**, in some examples, may be used to manage user interface controls such as switches, buttons, or other types of controls that enable a user to manage various functions of band **200**. For example, a 4-position switch may be turned to a given position that is interpreted by interface module **410** to determine the proper signal or feedback to send to logic module **404** in order to generate a particular result. In other examples, a button (not shown) may be depressed that allows a user to trigger or initiate certain actions by sending another signal to logic module **404**. Still further, interface module **410** may be used to interpret data from, for example, accelerometer **210** (FIG. **2**) to identify specific movement or motion that initiates or triggers a given response. In other examples, interface module **410** may be used to manage different types of displays (e.g., LED, IMOD, E Ink, OLED, etc.). In other examples, interface module **410** may be implemented differently in function, structure, or configuration and is not limited to those shown and described.

As shown, audio module **414** may be configured to manage encoded or unencoded data gathered from various types of audio sensors. In some examples, audio module **414** may include one or more codecs that are used to encode or decode various types of audio waveforms. For example, analog audio input may be encoded by audio module **414** and, once encoded, sent as a signal or collection of data packets, messages, segments, frames, or the like to logic module **404** for transmission via communications module **406**. In other examples, audio module **414** may be implemented differently in function, structure, configuration, or implementation and is not limited to those shown and described. Other elements that may be used by band **200** include motor controller **416**, which may be firmware or an application to control a motor or other vibratory energy source (e.g., notification facility **208** (FIG. **2**)). Power used for band **200** may be drawn from battery **214** (FIG. **2**) and managed by power management module **422**, which may be firmware or an application used to manage, with or without user input, how power is consumer, conserved, or otherwise used by band **200** and the above-described elements, including one or more sensors (e.g., sensor **212** (FIG. **2**), sensors **302-328** (FIG. **3**)). With regard to data captured, sensor input evaluation module **420** may be a software engine or module that is used to evaluate and analyze data received from one or more inputs (e.g., sensors **302-328**) to band **200**. When received, data may be analyzed by sensor input evaluation module **420**, which may include custom or "off-the-shelf" analytics packages that are configured to provide application-specific analysis of data to determine trends, patterns, and other useful information. In other examples, sensor input module **420** may also include firmware or software that enables the generation of various types and formats of reports for presenting data and any analysis performed thereupon.

Another element of application architecture **400** that may be included is service management module **418**. In some examples, service management module **418** may be firmware, software, or an application that is configured to manage various aspects and operations associated with executing software-related instructions for band **200**. For example, libraries or classes that are used by software or applications on band **200** may be served from an online or networked source. Service management module **418** may be implemented to manage how and when these services are invoked in order to ensure that desired applications are executed properly within application architecture **400**. As discrete sets, collections, or groupings of functions, services used by band **200** for various purposes ranging from communications to operating systems to call or document libraries may be managed by service management module **418**. Alternatively, service management module **418** may be implemented differently and is not limited to the examples provided herein. Further, application architecture **400** is an example of a software/system/application-level architecture that may be used to implement various software-related aspects of band **200** and may be varied in the quantity, type, configuration, function, structure, or type of programming or formatting languages used, without limitation to any given example.

FIG. **5**A illustrates representative data types for use with an exemplary data-capable band. Here, wearable device **502** may capture various types of data, including, but not limited to sensor data **504**, manually-entered data **506**, application data **508**, location data **510**, network data **512**, system/operating data **514**, and user data **516**. Various types of data may be captured from sensors, such as those described above in connection with FIG. **3**. Manually-entered data, in some examples, may be data or inputs received directly and locally by band **200** (FIG. **2**). In other examples, manually-entered data may also be provided through a third-party website that stores the data in a database and may be synchronized from server **114** (FIG. **1**) with one or more of bands **104-112**. Other types of data that may be captured including application data **508** and system/operating data **514**, which may be associated with firmware, software, or hardware installed or implemented on band **200**. Further, location data **510** may be used by wearable device **502**, as described above. User data **516**, in some examples, may be data that include profile data, preferences, rules, or other information that has been previously entered by a given user of wearable device **502**. Further, network data **512** may be data is captured by wearable device with regard to routing tables, data paths, network or access

availability (e.g., wireless network access availability), and the like. Other types of data may be captured by wearable device **502** and are not limited to the examples shown and described. Additional context-specific examples of types of data captured by bands **104-112** (FIG. **1**) are provided below.

FIG. **5**B illustrates representative data types for use with an exemplary data-capable band in fitness-related activities. Here, band **519** may be configured to capture types (i.e., categories) of data such as heart rate/pulse monitoring data **520**, blood oxygen saturation data **522**, skin temperature data **524**, salinity/emission/outgassing data **526**, location/GPS data **528**, environmental data **530**, and accelerometer data **532**. As an example, a runner may use or wear band **519** to obtain data associated with his physiological condition (i.e., heart rate/pulse monitoring data **520**, skin temperature, salinity/emission/outgassing data **526**, among others), athletic efficiency (i.e., blood oxygen saturation data **522**), and performance (i.e., location/GPS data **528** (e.g., distance or laps run), environmental data **530** (e.g., ambient temperature, humidity, pressure, and the like), accelerometer **532** (e.g., biomechanical information, including gait, stride, stride length, among others)). Other or different types of data may be captured by band **519**, but the above-described examples are illustrative of some types of data that may be captured by band **519**. Further, data captured may be uploaded to a website or online/networked destination for storage and other uses. For example, fitness-related data may be used by applications that are downloaded from a "fitness marketplace" or "wellness marketplace," where athletes, or other users, may find, purchase, or download applications, products, information, etc., for various uses, as well as share information with other users. Some applications may be activity-specific and thus may be used to modify or alter the data capture capabilities of band **519** accordingly. For example, a fitness marketplace may be a website accessible by various types of mobile and non-mobile clients to locate applications for different exercise or fitness categories such as running, swimming, tennis, golf, baseball, football, fencing, and many others. When downloaded, applications from a fitness marketplace may also be used with user-specific accounts to manage the retrieved applications as well as usage with band **519**, or to use the data to provide services such as online personal coaching or targeted advertisements. More, fewer, or different types of data may be captured for fitness-related activities.

In some examples, applications may be developed using various types of schema, including using a software development kit or providing requirements in a proprietary or open source software development regime. Applications may also be developed by using an application programming interface to an application marketplace in order for developers to design and build applications that can be downloaded on wearable devices (e.g., bands **104-106** (FIG. **1**)). Alternatively, application can be developed for download and installation on devices that may be in data communication over a shared data link or network connection, wired or wireless. For example, an application may be downloaded onto mobile computing device **116** (FIG. **1**) from server **114** (FIG. **1**), which may then be installed and executed using data gathered from one or more sensors on band **104**. Analysis, evaluation, or other operations performed on data gathered by an application downloaded from server **114** may be presented (i.e., displayed) on a graphical user interface (e.g., a micro web browser, WAP web browser, Java/Java-script-based web browser, and others, without limitation) on mobile computing device **116** or any other type of client. Users may, in some examples, search, find, retrieve, download, purchase, or otherwise obtain applications for various types of purposes from an application marketplace. Applications may be configured for various types of purposes and categories, without limitation. Examples of types of purposes include running, swimming, trail running, diabetic management, dietary, weight management, sleep management, caloric burn rate tracking, activity tracking, and others, without limitation. Examples of categories of applications may include fitness, wellness, health, medical, and others, without limitation. In other examples, applications for distribution via a marketplace or other download website or source may be implemented differently and is not limited to those described.

FIG. **5**C illustrates representative data types for use with an exemplary data-capable band in sleep management activities. Here, band **539** may be used for sleep management purposes to track various types of data, including heart rate monitoring data **540**, motion sensor data **542**, accelerometer data **544**, skin resistivity data **546**, user input data **548**, clock data **550**, and audio data **552**. In some examples, heart rate monitor data **540** may be captured to evaluate rest, waking, or various states of sleep. Motion sensor data **542** and accelerometer data **544** may be used to determine whether a user of band **539** is experiencing a restful or fitful sleep. For example, some motion sensor data **542** may be captured by a light sensor that measures ambient or differential light patterns in order to determine whether a user is sleeping on her front, side, or back. Accelerometer data **544** may also be captured to determine whether a user is experiencing gentle or violent disruptions when sleeping, such as those often found in afflictions of sleep apnea or other sleep disorders. Further, skin resistivity data **546** may be captured to determine whether a user is ill (e.g., running a temperature, sweating, experiencing chills, clammy skin, and others). Still further, user input data may include data input by a user as to how and whether band **539** should trigger notification facility **208** (FIG. **2**) to wake a user at a given time or whether to use a series of increasing or decreasing vibrations or audio tones to trigger a waking state. Clock data (**550**) may be used to measure the duration of sleep or a finite period of time in which a user is at rest. Audio data may also be captured to determine whether a user is snoring and, if so, the frequencies and amplitude therein may suggest physical conditions that a user may be interested in knowing (e.g., snoring, breathing interruptions, talking in one's sleep, and the like). More, fewer, or different types of data may be captured for sleep management-related activities.

FIG. **5**D illustrates representative data types for use with an exemplary data-capable band in medical-related activities. Here, band **539** may also be configured for medical purposes and related-types of data such as heart rate monitoring data **560**, respiratory monitoring data **562**, body temperature data **564**, blood sugar data **566**, chemical protein/analysis data **568**, patient medical records data **570**, and healthcare professional (e.g., doctor, physician, registered nurse, physician's assistant, dentist, orthopedist, surgeon, and others) data **572**. In some examples, data may be captured by band **539** directly from wear by a user. For example, band **539** may be able to sample and analyze sweat through a salinity or moisture detector to identify whether any particular chemicals, proteins, hormones, or other organic or inorganic compounds are present, which can be analyzed by band **539** or communicated to server **114** to perform further analysis. If sent to server **114**, further analyses may be performed by a hospital or other medical facility using data captured by band **539**. In other examples, more, fewer, or different types of data may be captured for medical-related activities.

FIG. **5**E illustrates representative data types for use with an exemplary data-capable band in social media/networking-related activities. Examples of social media/networking-re-

lated activities include activities related to Internet-based Social Networking Services ("SNS"), such as Facebook®, Twitter®, etc. Here, band **519**, shown with an audio data plug, may be configured to capture data for use with various types of social media and networking-related services, websites, and activities. Accelerometer data **580**, manual data **582**, other user/friends data **584**, location data **586**, network data **588**, clock/timer data **590**, and environmental data **592** are examples of data that may be gathered and shared by, for example, uploading data from band **519** using, for example, an audio plug such as those described herein. As another example, accelerometer data **580** may be captured and shared with other users to share motion, activity, or other movement-oriented data. Manual data **582** may be data that a given user also wishes to share with other users. Likewise, other user/friends data **584** may be from other bands (not shown) that can be shared or aggregated with data captured by band **519**. Location data **586** for band **519** may also be shared with other users. In other examples, a user may also enter manual data **582** to prevent other users or friends from receiving updated location data from band **519**. Additionally, network data **588** and clock/timer data may be captured and shared with other users to indicate, for example, activities or events that a given user (i.e., wearing band **519**) was engaged at certain locations. Further, if a user of band **519** has friends who are not geographically located in close or near proximity (e.g., the user of band **519** is located in San Francisco and her friend is located in Rome), environmental data can be captured by band **519** (e.g., weather, temperature, humidity, sunny or overcast (as interpreted from data captured by a light sensor and combined with captured data for humidity and temperature), among others). In other examples, more, fewer, or different types of data may be captured for medical-related activities.

FIG. **6** illustrates an exemplary communications device system implemented with multiple exemplary data-capable bands. The exemplary system **600** shows exemplary lines of communication between some of the devices shown in FIG. **1**, including network **102**, bands **104-110**, mobile communications device **118**, and laptop **122**. In FIG. **6**, examples of both peer-to-peer communication and peer-to-hub communication using bands **104-110** are shown. Using these avenues of communication, bands worn by multiple users or wearers (the term "wearer" is used herein to describe a user that is wearing one or more bands) may monitor and compare physical, emotional, mental states among wearers (e.g., physical competitions, sleep pattern comparisons, resting physical states, etc.).

Peer-to-hub communication may be exemplified by bands **104** and **108**, each respectively communicating with mobile communications device **118** or laptop **122**, exemplary hub devices. Bands **104** and **108** may communicate with mobile communications device **118** or laptop **122** using any number of known wired communication technologies (e.g., Universal Service Bus (USB) connections, TRS/TRRS connections, telephone networks, fiber-optic networks, cable networks, etc.). In some examples, bands **104** and **108** may be implemented as lower power or lower energy devices, in which case mobile communications device **118**, laptop **122** or other hub devices may act as a gateway to route the data from bands **104** and **108** to software applications on the hub device, or to other devices. For example, mobile communications device **118** may comprise both wired and wireless communication capabilities, and thereby act as a hub to further communicate data received from band **104** to band **110**, network **102** or laptop **122**, among other devices. Mobile communications device **118** also may comprise software applications that interact with social or professional networking services ("SNS") (e.g., Facebook®, Twitter®, LinkedIn®, etc.), for example via network **102**, and thereby act also as a hub to further share data received from band **104** with other users of the SNS. Band **104** may communicate with laptop **122**, which also may comprise both wired and wireless communication capabilities, and thereby act as a hub to further communicate data received from band **104** to, for example, network **102** or laptop **122**, among other devices. Laptop **122** also may comprise software applications that interact with SNS, for example via network **102**, and thereby act also as a hub to further share data received from band **104** with other users of the SNS. The software applications on mobile communications device **118** or laptop **122** or other hub devices may further process or analyze the data they receive from bands **104** and **108** in order to present to the wearer, or to other wearers or users of the SNS, useful information associated with the wearer's activities:

In other examples, bands **106** and **110** may also participate in peer-to-hub communications with exemplary hub devices such as mobile communications device **118** and laptop **122**. Bands **106** and **110** may communicate with mobile communications device **118** and laptop **122** using any number of wireless communication technologies (e.g., local wireless network, near field communication, Bluetooth®, Bluetooth® low energy, ANT, etc.). Using wireless communication technologies, mobile communications device **118** and laptop **122** may be used as a hub or gateway device to communicate data captured by bands **106** and **110** with other devices, in the same way as described above with respect to bands **104** and **108**. Mobile communications device **118** and laptop **122** also may be used as a hub or gateway device to further share data captured by bands **106** and **110** with SNS, in the same way as described above with respect to bands **104** and **108**.

Peer-to-peer communication may be exemplified by bands **106** and **110**, exemplary peer devices, communicating directly. Band **106** may communicate directly with band **110**, and vice versa, using known wireless communication technologies, as described above. Peer-to-peer communication may also be exemplified by communications between bands **104** and **108** and bands **106** and **110** through a hub device, such as mobile communications device **118** or laptop **122**.

Alternatively, exemplary system **600** may be implemented with any combination of communication capable devices, such as any of the devices depicted in FIG. **1**, communicating with each other using any communication platform, including any of the platforms described above. Persons of ordinary skill in the art will appreciate that the examples of peer-to-hub communication provided herein, and shown in FIG. **6**, are only a small subset of the possible implementations of peer-to-hub communications involving the bands described herein.

FIG. **7** illustrates an exemplary wellness tracking system for use with or within a distributed wellness application. System **700** comprises aggregation engine **710**, conversion module **720**, band **730**, band **732**, textual input **734**, other input **736**, and graphical representation **740**. Bands **730** and **732** may be implemented as described above. In some examples, aggregation engine **710** may receive input from various sources. For example, aggregation engine **710** may receive sensory input from band **730**, band **732**, and/or other data-capable bands. This sensory input may include any of the above-described sensory data that may be gathered by data-capable bands. In other examples, aggregation engine **710** may receive other (e.g., manual) input from textual input **734** or other input **736**. Textual input **734** and other input **736** may include information that a user types, uploads, or otherwise inputs into an application (e.g., a web application, an

iPhone® application, etc.) implemented on any of the data and communications capable devices referenced herein (e.g., computer, laptop, computer, mobile communications device, mobile computing device, etc.). In some examples, aggregation engine **720** may be configured to process (e.g., interpret) the data and information received from band **730**, band **732**, textual input **734** and other input **736**, to determine an aggregate value from which graphical representation **740** may be generated. In an example, system **700** may comprise a conversion module **720**, which may be configured to perform calculations to convert the data received from band **730**, band **732**, textual input **734** and other input **736** into values (e.g., numeric values). Those values may then be aggregated by aggregation engine **710** to generate graphical representation **740**. Conversion module **720** may be implemented as part of aggregation engine **710** (as shown), or it may be implemented separately (not shown). In some examples, aggregation engine **710** may be implemented with more or different modules. In other examples, aggregation engine **710** may be implemented with fewer or more input sources. In some examples, graphical representation **740** may be implemented differently, using different facial expressions, or any image or graphic according to any intuitive or predetermined set of graphics indicating various levels and/or aspects of wellness. As described in more detail below, graphical representation **740** may be a richer display comprising more than a single graphic or image (e.g., FIGS. **10** and **11**).

In some examples, aggregation engine **710** may receive or gather inputs from one or more sources over a period of time, or over multiple periods of time, and organize those inputs into a database (not shown) or other type of organized form of information storage. In some examples, graphical representation **740** may be a simple representation of a facial expression, as shown. In other examples, graphical representation **740** may be implemented as a richer graphical display comprising inputs gathered over time (e.g., FIGS. **10** and **11** below).

FIG. **8** illustrates representative calculations executed by an exemplary conversion module to determine an aggregate value for producing a graphical representation of a user's wellness. In some examples, conversion module **820** may be configured to process data associated with exercise, data associated with sleep, data associated with eating or food intake, and data associated with other miscellaneous activity data (e.g., sending a message to a friend, gifting to a friend, donating, receiving gifts, etc.), and generate values from the data. For example, conversion module **820** may perform calculations using data associated with activities ("activity data") to generate values for types of exercise (e.g., walking, vigorous exercise, not enough exercise, etc.) (**810**), types of sleep (e.g., deep sleep, no sleep, not enough deep sleep, etc.) (**812**), types of meals (e.g., a sluggish/heavy meal, a good meal, an energizing meal, etc.) (**814**), or other miscellaneous activities (e.g., sending a message to a friend, gifting to a friend, donating, receiving gifts, etc.) (**816**). Note that while in this example types of sleep **812**, types of meals **814**, and miscellaneous activities **816** are expressed in numbers of steps, FIG. **8** is not intended to be limiting is one of numerous ways in which to express types of sleep **812**, types of meals **814**, and miscellaneous activities **816**. For example, types of sleep **812**, types of meals **814**, and miscellaneous activities **816** can correspond to different point values of which one or more scores can be derived to determine aggregate value **830**, which can be expressed in terms of points or a score. In some implementations, these values may include positive values for activities that are beneficial to a user's wellness and negative values for activities that are detrimental to a user's wellness, or for lack of activity (e.g., not enough sleep, too many minutes without exercise, etc.). In one example, the values may be calculated using a reference activity. For example, conversion module **820** may equate a step to the numerical value 0.0001, and then equate various other activities to a number of steps (**810**, **812**, **814**, **816**). In some examples, these values may be weighted according to the quality of the activity. For example, each minute of deep sleep equals a higher number of steps than each minute of other sleep (**812**). As described in more detail below (FIGS. **10** and **11**), these values may be modulated by time. For example, positive values for exercise may be modulated by negative values for extended time periods without exercise (**810**). In another example, positive values for sleep or deep sleep may be modulated by time without sleep or not enough time spent in deep sleep (**812**). In some examples, conversion module **820** is configured to aggregate these values to generate an aggregate value **830**. In some examples, aggregate value **830** may be used by an aggregation engine (e.g., aggregation engine **710** described above) to generate a graphical representation of a user's wellness (e.g., graphical representation **740** described above, FIGS. **10** and **11** described below, or others).

FIG. **9** illustrates an exemplary process for generating and displaying a graphical representation of a user's wellness based upon the user's activities. Process **900** may be implemented as an exemplary process for creating and presenting a graphical representation of a user's wellness. In some examples, process **900** may begin with receiving activity data from a source (**902**). For example, the source may comprise one of the data-capable bands described herein (e.g., band **730**, band **732**, etc.). In another example, the source may comprise another type of data and communications capable device, such as those described above (e.g., computer, laptop, computer, mobile communications device, mobile computing device, etc.), which may enable a user to provide activity data via various inputs (e.g., textual input **734**, other input **736**, etc.). For example, activity data may be received from a data-capable band. In another example, activity data may be received from data manually input using an application user interface via a mobile communications device or a laptop. In other examples, activity data may be received from sources or combinations of sources. After receiving the activity data, another activity data is received from another source (**904**). The another source also may be any of the types of sources described above. Once received, the activity data from the source, and the another activity data from another source, is then used to determine (e.g., by conversion module **720** or **730**, etc.) an aggregate value (**906**). Once determined, the aggregate value is used to generate a graphical representation of a user's present wellness (**908**) (e.g., graphical representation **740** described above, etc.). The aggregate value also may be combined with other information, of the same type or different, to generate a richer graphical representation (e.g., FIGS. **10** and **11** described below, etc.).

In other examples, activity data may be received from multiple sources. These multiple sources may comprise a combination of sources (e.g., a band and a mobile communications device, two bands and a laptop, etc.) (not shown). Such activity data may be accumulated continuously, periodically, or otherwise, over a time period. As activity data is accumulated, the aggregate value may be updated and/or accumulated, and in turn, the graphical representation may be updated. In some examples, as activity data is accumulated and the aggregate value updated and/or accumulated, additional graphical representations may be generated based on the updated or accumulated aggregate value(s). In other examples, the above-described process may be varied in the

implementation, order, function, or structure of each or all steps and is not limited to those provided.

FIG. **10** illustrates an exemplary graphical representation of a user's wellness over a time period. Here, exemplary graphical representation **1000** shows a user's wellness progress over the course of a partial day. Exemplary graphical representation **1000** may comprise a rich graph displaying multiple vectors of data associated with a user's wellness over time, including a status **1002**, a time **1004**, alarm graphic **1006**, points progress line **1008**, points gained for completion of activities **1012-1016**, total points accumulated **1010**, graphical representations **1030-1034** of a user's wellness at specific times over the time period, activity summary data and analysis over time (**1018-1022**), and an indication of syncing activity **1024**. Here, status **1002** may comprise a brief (e.g., single word) general summary of a user's wellness. In some examples, time **1004** may indicate the current time, or in other examples, it may indicate the time that graphical representation **1000** was generated or last updated. In some other examples, time **1004** may be implemented using different time zones. In still other examples, time **1004** may be implemented differently. In some examples, alarm graphic **1006** may indicate the time that the user's alarm rang, or in other examples, it may indicate the time when a band sensed the user awoke, whether or not an alarm rang. In other examples, alarm graphic **1006** may indicate the time when a user's band began a sequence of notifications to wake up the user (e.g., using notification facility **208**, as described above), and in still other examples, alarm graphic **1006** may represent something different. As shown here, graphical representation **1000** may include other graphical representations of the user's wellness at specific times of the day (**1030**, **1032**, **1034**), for example, indicating a low level of wellness or low energy level soon after waking up (**1030**) and a more alert or higher energy or wellness level after some activity (**1032**, **1034**). Graphical representation **1000** may also include displays of various analyses of activity over time. For example, graphical representation may include graphical representations of the user's sleep (**1018**), including how many total hours slept and the quality of sleep (e.g., bars may represent depth of sleep during periods of time). In another example, graphical representation may include graphical representations of various aspects of a user's exercise level for a particular workout, including the magnitude of the activity level (**1020**), duration (**1020**), the number of steps taken (**1022**), the user's heart rate during the workout (not shown), and still other useful information (e.g., altitude climbed, laps of a pool, number of pitches, etc.). Graphical representation **1000** may further comprise an indication of syncing activity (**1024**) showing that graphical representation **1000** is being updated to include additional information from a device (e.g., a data-capable band) or application. Graphical representation **1000** may also include indications of a user's total accumulated points **1010**, as well as points awarded at certain times for certain activities (**1012**, **1014**, **1016**). For example, shown here graphical representation **1000** displays the user has accumulated 2,017 points in total (e.g., over a lifetime, over a set period of time, etc.) (**1010**).

In some examples, points awarded may be time-dependent or may expire after a period of time. For example, points awarded for eating a good meal may be valid only for a certain period of time. This period of time may be a predetermined period of time, or it may be dynamically determined. In an example where the period of time is dynamically determined, the points may be valid only until the user next feels hunger. In another example where the period of time is dynamically determined, the points may be valid depending on the glycemic load of the meal (e.g., a meal with low glycemic load may have positive effects that meal carry over to subsequent meals, whereas a meal with a higher glycemic load may have a positive effect only until the next meal). In some examples, a user's total accumulated points **1010** may reflect that certain points have expired and are no longer valid.

In some examples, these points may be used for obtaining various types of rewards, or as virtual or actual currency, for example, in an online wellness marketplace, as described herein (e.g., a fitness marketplace). For example, points may be redeemed for virtual prizes (e.g., for games, challenges, etc.), or physical goods (e.g., products associated with a user's goals or activities, higher level bands, which may be distinguished by different colors, looks and/or features, etc.). In some examples, the points may automatically be tracked by a provider of data-capable bands, such that a prize (e.g., higher level band) is automatically sent to the user upon reaching a given points threshold without any affirmative action by the user. In other examples, a user may redeem a prize (e.g., higher level band) from a store. In still other examples, a user may receive deals. These deals or virtual prizes may be received digitally via a data-capable band, a mobile communications device, or otherwise.

FIG. **11** illustrates another exemplary graphical representation of a user's wellness over a time period. Here, exemplary graphical representation **1100** shows a summary of a user's wellness progress over the course of a week. Exemplary graphical representation **1100** may comprise a rich graph displaying multiple vectors of data associated with a user's wellness over time, including a status **1102**, a time **1104**, summary graphical representations **1106-1116** of a user's wellness on each days, points earned each day **1120-1130**, total points accumulated **1132**, points progress line **1134**, an indication of syncing activity **1118**, and bars **1136-1140**. Here, as with status **1002** in FIG. **10**, status **1102** may comprise a brief (e.g., single word) general summary of a user's wellness. In some examples, time **1104** may indicate the current time, or in other examples, it may indicate the time that graphical representation **1100** was generated or last updated. In some other examples, time **1104** may be implemented using different time zones. In still other examples, time **1104** may be implemented differently. As shown here, graphical representation **1100** may include summary graphical representations **1106-1116** of the user's wellness on each day, for example, indicating a distress or tiredness on Wednesday (**1110**) or a positive spike in wellness on Friday (**1116**). In some examples, summary graphical representations **1106-1116** may indicate a summary wellness for that particular day. In other examples, summary graphical representations **1106-1116** may indicate a cumulative wellness, e.g., at the end of each day. Graphical representation **1100** may further comprise an indication of syncing activity **1118** showing that graphical representation **1100** is being updated to include additional information from a device (e.g., a data-capable band) or application. Graphical representation **1100** may also include indications of a user's total accumulated points **1132**, as well as points earned each day **1120-1130**. For example, shown here graphical representation **1100** displays the user has accumulated 2,017 points thus far, which includes 325 points earned on Saturday (**1130**), 263 points earned on Friday (**1128**), 251 points earned on Thursday (**1126**), and so on. As described above, these points may be used for obtaining various types of rewards, or as virtual or actual currency, for example, in an online wellness marketplace (e.g., a fitness marketplace as described above). In some examples, graphical representation **1100** also may comprise bars **1136-1140**. Each bar may represent an aspect of a user's

wellness (e.g., food, exercise, sleep, etc.). In some examples, the bar may display the user's daily progress toward a personal goal for each aspect (e.g., to sleep eight hours, complete sixty minutes of vigorous exercise, etc.). In other examples, the bar may display the user's daily progress toward a standardized goal (e.g., a health and fitness expert's published guidelines, a government agency's published guidelines, etc.), or other types of goals.

FIGS. **12**A-**12**F illustrate exemplary wireframes of exemplary webpages associated with a wellness marketplace. Here, wireframe **1200** comprises navigation **1202**, selected page **1204**A, sync widget **1216**, avatar and goals element **1206**, statistics element **1208**, information ticker **1210**, social feed **1212**, check-in/calendar element **1214**, deal element **1218**, and team summary element **1220**. As described above, a wellness marketplace may be implemented as a portal, website or application where users, may find, purchase, or download applications, products, information, etc., for various uses, as well as share information with other users (e.g., users with like interests). Here, navigation **1202** comprises buttons and widgets for navigating through various pages of the wellness marketplace, including the selected page **1204**A-**1204**F (e.g., the Home page, Team page, Public page, Move page, Eat page, Live page, etc.) and sync widget **1216**. In some examples, sync widget **1216** may be implemented to sync a data-capable band to the user's account on the wellness marketplace. In some examples, the Home page may include avatar and goals element **1206**, which may be configured to display a user's avatar and goals. Avatar and goals element **1206** also may enable a user to create an avatar, either by selecting from predetermined avatars, by uploading a user's own picture or graphic, or other known methods for creating an avatar. Avatar and goals element **1206** also may enable a user to set goals associated with the user's health, eating/drinking habits, exercise, sleep, socializing, or other aspects of the user's wellness. The Home page may further include statistics element **1208**, which may be implemented to display statistics associated with the user's wellness (e.g., the graphical representations described above). As shown here, in some examples, statistics element **1208** may be implemented as a dynamic graphical, and even navigable, element (e.g., a video or interactive graphic), wherein a user may view the user's wellness progress over time. In other examples, the statistics element **1208** may be implemented as described above (e.g., FIGS. **10** and **11**). The Home page may further include information ticker **1210**, which may stream information associated with a user's activities, or other information relevant to the wellness marketplace. The Home page may further include social feed **1212**, which may be implemented as a scrolling list of messages or information (e.g., encouragement, news, feedback, recommendations, comments, etc.) from friends, advisors, coaches, or other users. The messages or information may include auto-generated encouragement, comments, news, recommendations, feedback, achievements, opinions, actions taken by teammates, or other information, by a wellness application in response to data associated with the user's wellness and activities (e.g., gathered by a data-capable band). In some examples, social feed **1212** may be searchable. In some examples, social feed **1212** may enable a user to filter or select the types of messages or information that shows up in the feed (e.g., from the public, only from the team, only from the user, etc.). Social feed **1212** also may be configured to enable a user to select an action associated with each feed message (e.g., cheer, follow, gift, etc.). In some examples, check-in/calendar element **1214** may be configured to allow a user to log their fitness and nutrition. In some examples, check-in/calendar element **1214** also may be configured to enable a user to maintain a calendar. Deal element **1218** may provide a daily deal to the user. The daily deal may be featured for the marketplace, it may be associated with the user's activities, or it may be generated using a variety of known advertising models. Team summary element **1220** may provide summary information about the user's team. As used herein, the term "team" may refer to any group of users that elect to use the wellness marketplace together. In some examples, a user may be part of more than one team. In other examples, a group of users may form different teams for different activities, or they may form a single team that participates in, tracks, and shares information regarding, more than one activity. A Home page may be implemented differently than described here.

Wireframe **1230** comprises an exemplary Team page, which may include a navigation **1202**, selected page **1204**B, sync widget **1216**, team manager element **1228**, leaderboard element **1240**, comparison element **1242**, avatar and goals element **1206**A, statistics element **1208**A, social feed **1212**A, and scrolling member snapshots element **1226**. Avatar and goals element **1206**A and statistics element **1208**A may be implemented as described above with regard to like-numbered or corresponding elements. Navigation **1202**, selected page **1204**B and sync widget **1216** also may be implemented as described above with regard to like-numbered or corresponding elements. In some examples, team manager element **1228** may be implemented as an area for displaying information, or providing widgets, associated with team management. Access to team manager element **1228** may be restricted, in some examples, or access may be provided to the entire team. Leaderboard element **1240** may be implemented to display leaders in various aspects of an activity in which the team is participating (e.g., various sports, social functions (e.g., clubs), drinking abstinence, etc.). In some examples, leaderboard element **1240** may be implemented to display leaders among various groupings (e.g., site-wide, team only, other users determined to be "like" the user according to certain criteria (e.g., similar activities), etc.). In other examples, leaderboard element **1240** may be organized or filtered by various parameters (e.g., date, demographics, geography, activity level, etc.). Comparison element **1242** may be implemented, in some examples, to provide comparisons regarding a user's performance with respect to an activity, or various aspects of an activity, with the performance of the user's teammates or with the team as a whole (e.g., team average, team median, team favorites, etc.). Scrolling member snapshots element **1226** may be configured to provide brief summary information regarding each of the members of the team in a scrolling fashion. A Team page may be implemented differently than described here.

Wireframe **1250** comprises an exemplary Public page, which may include navigation **1202**, selected page **1204**C, sync widget **1216**, leaderboard element **1240**A, social feed **1212**B, statistics report engine **1254**, comparison element **1242**A, and challenge element **1256**. Navigation **1202**, selected page **1204**C and sync widget **1216** may be implemented as described above with regard to like-numbered or corresponding elements. Leaderboard element **1240**A also may be implemented as described above with regard to leaderboard element **1240**, and in some examples, may display leaders amongst all of the users of the wellness marketplace. Social feed **1212**B also may be implemented as described above with regard social feed **1212** and social feed **1212**A. Comparison element **1242**A may be implemented as described above with regard to comparison element **1242**, and in some examples, may display comparisons of a user's performance of an activity against the performance of all of

the other users of the wellness marketplace. Statistics report engine **1254** may generate and display statistical reports associated with various activities being monitored by, and discussed in, the wellness marketplace. In some examples, challenge element **1256** may enable a user to participate in marketplace-wide challenges with other users. In other examples, challenge element **1256** may display the status of, or other information associated with, ongoing challenges among users. A Public page may be implemented differently than described here.

Wireframe **1260** comprises an exemplary Move page, which may include navigation **1202**, selected page **1204**D, sync widget **1216**, leaderboard element **1240**B, statistics report engine **1254**, comparison element **1242**B, search and recommendations element **1272**, product sales element **1282**, exercise science element **1264**, daily movement element **1266**, maps element **1280** and titles element **1258**. Navigation **1202**, selected page **1204**D, sync widget **1216**, leaderboard element **1240**B, statistics report engine **1254**, and comparison element **1242**B may be implemented as described above with regard to like-numbered or corresponding elements. The Move page may be implemented to include a search and recommendations element **1272**, which may be implemented to enable searching of the wellness marketplace. In some examples, in addition to results of the search, recommendations associated with the user's search may be provided to the user. In other examples, recommendations may be provided to the user based on any other data associated with the user's activities, as received by, gathered by, or otherwise input into, the wellness marketplace. Product sales element **1282** may be implemented to display products for sale and provide widgets to enable purchases of products by users. The products may be associated with the user's activities or activity level. Daily movement element **1266** may be implemented to suggest an exercise each day. Maps element **1280** may be implemented to display information associated with the activity of users of the wellness marketplace on a map. In some examples, maps element **1280** may display a percentage of users that are physically active in a geographical region. In other examples, maps element **1280** may display a percentage of users that have eaten well over a particular time period (e.g., currently, today, this week, etc.). In still other examples, maps element **1280** may be implemented differently. In some examples, titles element **1258** may display a list of users and the titles they have earned based on their activities and activity levels (e.g., a most improved user, a hardest working user, etc.). A Move page may be implemented differently than described here.

Wireframe **1270** comprises an exemplary Eat page, which may include navigation **1202**, selected page **1204**E, sync widget **1216**, leaderboard elements **1240**C and **1240**D, statistics report engine **1254**, comparison element **1242**C, search and recommendations element **1272**, product sales element **1282**, maps element **1280**A, nutrition science element **1276**, and daily food/supplement element **1278**. Navigation **1202**, selected page **1204**E, sync widget **1216**, leaderboard elements **1240**C and **1240**D, statistics report engine **1254**, comparison element **1242**C, search and recommendations element **1272**, product sales element **1282**, and maps element **1280**A may be implemented as described above with regard to like-numbered or corresponding elements. The Eat page may be implemented to include a nutrition science element **1276**, which may display, or provide widgets for accessing, information associated with nutrition science. The Eat page also may be implemented with a daily food/supplement element **1278**, which may be implemented to suggest an food and/or supplement each day. An Eat page may be implemented differently than described here.

Wireframe **1280** comprises an exemplary Live page, which may include navigation **1202**, selected page **1204**F, sync widget **1216**, leaderboard element **1240**E, search and recommendations element **1272**, product sales element **1282**, maps element **1280**B, social feed **1212**C, health research element **1286**, and product research element **1290**. Navigation **1202**, selected page **1204**F, sync widget **1216**, leaderboard element **1240**E, search and recommendations element **1272**, product sales element **1282**, maps element **1280**B and social feed **1212**C may be implemented as described above with regard to like-numbered or corresponding elements. In some examples, the Live page may include health research element **1286** configured to display, or to enable a user to research, information regarding health topics. In some examples, the Live page may include product research element **1290** configured to display, or to enable a user to research, information regarding products. In some examples, the products may be associated with a user's particular activities or activity level. In other examples, the products may be associated with any of the activities monitored by, or discussed on, the wellness marketplace. A Live page may be implemented differently than described here.

FIG. **13** illustrates an exemplary computer system suitable for implementation of a wellness application and use with a data-capable band. In some examples, computer system **1300** may be used to implement computer programs, applications, methods, processes, or other software to perform the above-described techniques. Computer system **1300** includes a bus **1302** or other communication mechanism for communicating information, which interconnects subsystems and devices, such as processor **1304**, system memory **1306** (e.g., RAM), storage device **1308** (e.g., ROM), disk drive **1310** (e.g., magnetic or optical), communication interface **1312** (e.g., modem or Ethernet card), display **1314** (e.g., CRT or LCD), input device **1316** (e.g., keyboard), and cursor control **1318** (e.g., mouse or trackball).

According to some examples, computer system **1300** performs specific operations by processor **1304** executing one or more sequences of one or more instructions stored in system memory **1306**. Such instructions may be read into system memory **1306** from another computer readable medium, such as static storage device **1308** or disk drive **1310**. In some examples, hard-wired circuitry may be used in place of or in combination with software instructions for implementation.

The term "computer readable medium" refers to any tangible medium that participates in providing instructions to processor **1304** for execution. Such a medium may take many forms, including but not limited to, non-volatile media and volatile media. Non-volatile media includes, for example, optical or magnetic disks, such as disk drive **1310**. Volatile media includes dynamic memory, such as system memory **1306**.

Common forms of computer readable media includes, for example, floppy disk, flexible disk, hard disk, magnetic tape, any other magnetic medium, CD-ROM, any other optical medium, punch cards, paper tape, any other physical medium with patterns of holes, RAM, PROM, EPROM, FLASH-EPROM, any other memory chip or cartridge, or any other medium from which a computer can read.

Instructions may further be transmitted or received using a transmission medium. The term "transmission medium" may include any tangible or intangible medium that is capable of storing, encoding or carrying instructions for execution by the machine, and includes digital or analog communications signals or other intangible medium to facilitate communication

of such instructions. Transmission media includes coaxial cables, copper wire, and fiber optics, including wires that comprise bus **1302** for transmitting a computer data signal.

In some examples, execution of the sequences of instructions may be performed by a single computer system **1300**. According to some examples, two or more computer systems **1300** coupled by communication link **1320** (e.g., LAN, PSTN, or wireless network) may perform the sequence of instructions in coordination with one another. Computer system **1300** may transmit and receive messages, data, and instructions, including program, i.e., application code, through communication link **1320** and communication interface **1312**. Received program code may be executed by processor **1304** as it is received, and/or stored in disk drive **1310**, or other non-volatile storage for later execution.

FIG. **14** depicts an example of an aggregation engine, according to some examples. Diagram **1400** depicts an aggregation engine **1410** including one or more of the following: a sleep manager **1430**, an activity manager **1432**, a nutrition manager **1434**, a general health/wellness manager **1436**, and a conversion module **1420**. As described herein, aggregation engine **1410** is configured to process data, such as data representing parameters based on sensor measurements or the like, as well as derived parameters that can be derived (e.g., mathematically) based on data generated by one or more sensors. Aggregation engine **1410** also can be configured to determine an aggregate value (or score) from which a graphical representation or any other representation can be generated. Conversion module **1420** is configured to convert data or scores representing parameters into values or scores indicating relative states of sleep, activity, nutrition, or general fitness or health (e.g., based on combined states of sleep, activity, nutrition). Further, values or scores generated by conversion module **1420** can be based on team achievements (e.g., one or more other users' sensor data or parameters).

Sleep manager **1430** is configured to receive data representing parameters relating to sleep activities of a user, and configured to maintain data representing one or more sleep profiles. Parameters describe characteristics, factors or attributes of, for example, sleep, and can be formed from sensor data or derived based on computations. Examples of parameters include a sleep start time (e.g., in terms of Coordinated Universal. Time, "UTC," or Greenwich Mean Time), a sleep end time, and a duration of sleep, which is derived from determining the difference between the sleep end and start times. Sleep manager **1430** cooperates with conversion module **1420** to form a target sleep score to which a user strives to attain. As such, sleep manager **1430** is configured to track a user's progress and to motivate the user to modify sleep patterns to attain an optimal sleep profile. Sleep manager **1430**, therefore, is configured to coach a user to improve the user's health and wellness by improving the user's sleep activity. According to various one or more examples, sleep-related parameters can be acquired or derived by any of the sensors or sensor functions described in, for example, FIGS. **3** to **5**E. For example, other parameters (e.g., location-related parameters describing a home/bedroom location or social-related parameters describing proximity with family members) can be used to determine whether a user is engaged in a sleep-related activity and a quality or condition thereof.

Activity manager **1432** is configured to receive data representing parameters relating to one or more motion or movement-related activities of a user and to maintain data representing one or more activity profiles. Activity-related parameters describe characteristics, factors or attributes of motion or movements in which a user is engaged, and can be established from sensor data or derived based on computations. Examples of parameters include motion actions, such as a step, stride, swim stroke, rowing stroke, bike pedal stroke, and the like, depending on the activity in which a user is participating. As used herein, a motion action is a unit of motion (e.g., a substantially repetitive motion) indicative of either a single activity or a subset of activities and can be detected, for example, with one or more accelerometers and/or logic configured to determine an activity composed of specific motion actions. Activity manager **1432** cooperates with conversion module **1420** to form a target activity score to which a user strives to attain. As such, activity manager **1432** is configured to track a user's progress and to motivate the user to modify anaerobic and/or aerobic activities to attain or match the activities defined by an optimal activity profile. Activity manager **1432**, therefore, is configured to coach a user to improve the user's health and wellness by improving the user's physical activity, including primary activities of exercise and incidental activities (e.g., walking and climbing stairs in the home, work, etc.). According to various one or more examples, activity-related parameters can be acquired or derived by any of the sensors or sensor functions described in, for example, FIGS. **3** to **5**E. For example, other parameters (e.g., location-related parameters describing a gym location or social-related parameters describing proximity to other persons working out) can be used to determine whether a user is engaged in a movement-related activity, as well as the aspects thereof.

Nutrition manager **1434** is configured to receive data representing parameters relating to one or more activities relating to nutrition intake of a user and to maintain data representing one or more nutrition profiles. Nutrition-related parameters describe characteristics, factors or attributes of consumable materials (e.g., food and drink), including nutrients, such as vitamins, minerals, etc. that a user consumes. Nutrition-related parameters also include calories. The nutrition-related parameters can be formed from sensor data or derived based on computations. In some cases, a user provides or initiates data retrieval representing the nutrition of food and drink consumed. Nutrition-related parameters also can be derived, such as calories burned or expended. Examples of parameters include an amount (e.g., expressed in international units, "IU") of a nutrient, such as a vitamin, fiber, mineral, fat (various types), or a macro-nutrient, such as water, carbohydrate, and the like. Nutrition manager **1434** cooperates with conversion module **1420** to form a target nutrition score to which a user strives to attain. As such, nutrition manager **1434** is configured to track a user's progress and to motivate the user to modify dietary-related activities and consumption to attain an optimal nutrition profile. Nutrition manager **1434**, therefore, is configured to motivate a user to improve the user's health and wellness by improving the user's eating habits and nutrition. According to various one or more examples, nutrition-related parameters can be acquired or derived by any of the sensors or sensor functions described in, for example, FIGS. **3** to **5**E. For example, other parameters (e.g., location-related parameters identifying the user is at a restaurant, or social-related parameters describing proximity to others during meal times) can be used to determine whether a user is engaged in a nutrition intake-related activity as well the aspects thereof. In one example, acquired parameters include detected audio converted to text that describes the types of food or drink being consumed. For example, a user in the restaurant may verbally convey an order to a server, such as "I will take the cooked beef, a crab appetizer and an ice tea." Logic can decode the audio to perform voice recognition. Location data received from a sensor can be used to confirm the audio is detected in

the context of a restaurant, whereby the logic determines that the utterances likely constitute an order of food. This logic can reside in nutrition manager **1434**, which can be disposed in or distributed across any of a wearable computing device, an application, a mobile device, a server, in the cloud, or any other structure.

General health/wellness manager **1436** is configured to manage any aspect of a user's health or wellness in a manner similar to sleep manager **1430**, activity manager **1432**, and nutrition manager **1434**. For example, general health/wellness manager **1436** can be configured to manage electromagnetic radiation exposure (e.g., in microsieverts), such as radiation generated by a mobile phone or any other device, such as an airport body scanner. Also, general health/wellness manager **1436** can be configured to manage amounts or doses of sunlight sufficient for vitamin D production while advising a user against an amount likely to cause damage to the skin. According to various embodiments, general health/wellness manager **1436** can be configured to perform or control any of the above-described managers or any generic managers (not shown) configured to monitor, detect, or characterize, among other things, any one or more acquired parameters for determining a state or condition of any aspect of health and wellness that can be monitored for purposes of determining trend data and/or progress of an aspect of health and wellness of a user against a target value or score. As the user demonstrates consistent improvement (or deficiencies) in meeting one or more scores representing one or more health and wellness scores, the target value or score can be modified dynamically to motivate a user to continue toward a health and wellness goal, which can be custom-designed for a specific user. The dynamic modification of a target goal can also induce a user to overcome slow or deficient performance by recommending various activities or actions in which to engage to improve nutrition, sleep, movement, cardio goals, or any other health and wellness objective. Further, a wearable device or any structure described herein can be configured to provide feedback related to the progress of attaining a goal as well as to induce the user to engage in or refrain from certain activities. The feedback can be graphical or haptic in nature, but is not so limiting. Thus, the feedback can be transmitted to the user in any medium to be perceived by the user by any of the senses of sight, auditory, touch, etc.

Therefore, that general health/wellness manager **1436** is not limited to controlling or facilitating sleep, activity and nutrition as aspects of health and wellness, but can monitor, track and generate recommendations for health and wellness based on other acquired parameters, including those related to the environment, such as location, and social interactions, including proximity to others (e.g., other users wearing similar wearable computing devices) and communications via phone, text or emails that can be analyzed to determine whether a user is scheduling time with other persons for a specific activity (e.g., playing ice hockey, dining at a relative's house for the holidays, or joining colleagues for happy hour). Furthermore, general health/wellness manager **1436** and/or aggregator engine **1410** is not limited to the examples described herein to generate scores, the relative weightings of activities, or by the various instances by which scores can be calculated. The use of points and values, as well as a use of a target score are just a few ways to implement the variety of techniques and/or structures described herein. A target score can be a range of values or can be a function of any number of health and wellness representations. In some examples, specific point values and ways of calculating scores are described herein for purposes of illustration and are not intended to be limiting.

Conversion module **1420** includes a score generator **1422** and an emphasis manager **1424**. Score generator **1422** is configured to generate a sub-score, score or target score based on sleep-related parameters, activity-related parameters, and nutrition-related parameters, or a combination thereof. Emphasis manger **1424** is configured emphasize one or more parameters of interest to draw a user's attention to addressing a health-related goal. For example, a nutrition parameter indicating an amount of sodium consumed by a user can be emphasized by weighting the amount of sodium such that it contributes, at least initially, to a relatively larger portion of a target score. As the user succeeds in attaining the goal of reducing sodium, the amount of sodium and its contribution to the target score can be deemphasized.

Status manager **1450** includes a haptic engine **1452** and a display engine **1454**. Haptic engine **1452** can be configured to impart vibratory energy, for example, from a wearable device **1470** to a user's body, as a notification, reminder, or alert relating to the progress or fulfillment of user's sleep, activity, nutrition, or other health and wellness goals relative to target scores. Display engine **1454** can be configured to generate a graphical representation on an interface, such as a touch-sensitive screen on a mobile phone **1472**. In various embodiments, elements of aggregation engine **1410** and elements of status manager **1450** can be disposed in either wearable device **1470** or mobile phone **1472**, or can be distributed among device **1470**, phone **1472** or any other device not shown. Elements of aggregation engine **1410** and elements of status manager **1450** can be implemented in either hardware or software, or a combination thereof.

FIG. **15**A depicts an example of an aggregation engine including a general health and wellness manager configured to operate with and/or control one or more managers, according to some examples. Diagram **1500** depicts a sleep manager **1530**, an activity manager **1532**, a nutrition manager **1534**, a general health/wellness manager **1536**, an environmental manager **1537**, a social manager **1535**, any number of generic managers **1531***a*, and a conversion module **1520**. Any of managers **1525**, including general health/wellness manager **1536**, can be implemented in hardware or software, or a combination thereof. For instance, a manager can be implemented as downloadable executable instructions that can be obtained via a on-line marketplace. In the example shown, general health/wellness manager **1536** is configured to assist, facilitate and/or control operations of managers **1525** to obtain acquired parametric for respective aspects of health and nutrition identified for monitoring, tracking and generating feedback. Any of managers **1525** can communicate data with any other manager **1525** to more readily detect actions, environments and socially-related events in which the use is engaged. For example, an environmental manager **1537** can determine and monitor locations, which can be used to determine whether a user is at a restaurant (e.g., engaged in nutrition intake) or on a running track (e.g., engaged in exercise).

An example of activity manager **1532** is disclosed in U.S. patent application Ser. No. 13/433,204 filed on Mar. 28, 2012, which is hereby incorporated by reference for all purposes. An example of sleep manager **1530** is disclosed in U.S. patent application Ser. 13/433,208 filed on Mar. 28, 2012, which is hereby incorporated by reference for all purposes. An example of nutrition manager **1534** is disclosed in U.S. patent application Ser. No. 13/433,213 filed on Mar. 28, 2012, which is hereby incorporated by reference for all purposes. Generic manager(s) **1531***a* represents any number of hardware and/or software implementations configured to manage the acquisition of acquired parameters for monitoring any aspect of health and wellness for purposes of, for example, tracking a

user's progress and improvements toward a goal for an aspect of health and wellness (e.g., limiting amounts of sun light, limiting consumption of fish with known levels of mercury, limiting exposure to electromagnetic radiation, and any other state or conditions that affect one's health). Further, generic manager(s) **1531***a* facilitate score calculations relating to any specific aspect of health and wellness and can provide recommendations for improving such scores.

Environmental manager **1537** is configured to receive data representing parameters relating to an environment in which a user (or other persons of interest) is disposed, and configured to maintain data representing one or more environmental profiles. Environment-related parameters describe characteristics, factors or attributes of, for example, an environment, and can be formed from sensor data or derived based on computations. In some examples, environment-related parameters can be acquired or derived by any of the sensors or sensor functions described in, for example, FIGS. **3** to **5**E. Examples of environmentally-related parameters include a location (e.g., absolute in terms of geometric coordinates via GPS, or approximate coordinates based on triangulation of radio signals, etc.), and perceptible aspects of an environment, such as audio aspects (e.g., spoken words detectable to determine certain activities related to nutrition intake, exercise, etc.) or visual aspects. Examples of environmentally-related parameters also include data representing vibrations or motion that a wearable device is experiencing (e.g., the user is traveling in a car), locations of identified friends or users of other wearable computing devices in communication with each other, locations of destinations or originations, locations of places to avoid (e.g., a food court in a mall) or to migrate toward (e.g., another user that is participating in a similar activity), numbers of people on a jogging route (e.g., to ensure an optimal running route), atmospheric pressures, whether the wearable device is submerged in water, and any other parameter that defines or describes an environment of interest. Other environmentally-related parameters include data representing health and wellness characteristics of a location (e.g., general health or characteristics of people visiting a location), such as a stadium, restaurant, or a home, or of a region (e.g., general health or characteristics of people living in a region, such as rates of alcoholism, obesity, etc. of a city, county or state). Such data can be used to influence score calculations and/or recommendations. The above-described examples are not intended to be limiting. Environmental manager **1537** is configured to also generate trend data relating to locations and other activities a user is engaged to predict a future activity (e.g., a dance class) that is possible based on past visits to a location (e.g., a gym).

Social manager **1538** is configured to receive data representing parameters relating to social interactions and proximities to others relative to a user (or other persons of interest). In some examples, social-related parameters can be acquired or derived by any of the sensors or sensor functions described in, for example, FIGS. **3** to **5**E, including mobile phones and computing devices. Social-related parameters describe characteristics, factors or attributes of, for example, a social network of a user, and can be formed from sensor data or derived based on computations. Examples of social-related parameters include data representing family and friends, and, optionally, aspects of their health and wellness, and data representing other users of wearable devices, and, optionally, aspects of their health and wellness, too. For example, friends **1**, **4** and **7** can be identified from their health and wellness profiles, overall scores or targets scores to be active friends. Examples of other social-related parameters include data representing proximities to other wearable devices and information describing interactions or future interactions with others. For example, social-related parameters can include data derived from phone calls (e.g., decoded audio and speech into text, caller ID information, date, time, etc.), emails, texts, and other communications in which a user is arranging an activity with other persons. Social-related parameters can also include data from or exchanged with various networking web sites in which users exchange information between one or more levels of permissions (e.g., usually based on friendships or as acquaintances). General health/wellness manager **1536** can use this information to generate recommendations on whether to associate with active persons rather than inactive persons and to predict types of activities a user is engaged in base on, at least in part, the information derived from communications and interactions with others. Also, social manager **1538** is configured to generate recommendations to induce users to socialize with others with similar goals or to reinforce favorable habits (e.g., telling a person next to the user a good reasons to drink water). The above-described examples are not intended to be limiting.

Conversion module **1520** includes a score generator **1522** and an emphasis generator **1524**, according to some examples. The functionality and/or structure can be equivalent to similarly-named elements described herein. Score generator **1522** can include an activity-sleep-nutrition ("A/S/N") score generator **1540** configured to calculate one or more scores based on activity, sleep, nutrition-intake or any other aspect of health and wellness for a user, and a context score generator **1540** configured to calculate one or more scores based on the environment and/or social interactions (or proximities) between a user and other people. In some examples, context score generator **1540** generates a context score that indicates a context in which a user is disposed or in which a user is performing an activity. The context score can be used to influence a score to provide motivation and inducements to a user to meet one or more health and wellness objectives, responsive to environmental and social factors.

FIG. **15**B depicts an example of a flow to modify a target score to enhance a general health and wellness of a user, according to some examples. At **1552**, parameters describing any aspect of health and wellness is captured (i.e., acquired), and one or more scores are calculated at **1554** (e.g., a score can represent a user's ability to attain a targeted goal for one aspect of health and wellness, such as sleep, nutrition, etc.). At **1556**, the one or more scores are aggregated to form an overall health and wellness score, which can be compared against a target score indicative of an optimal state or conditions of health and wellness for a user. At **1558**, once requirements are met to change the methods of calculating a target score, the new target score is dynamically changed at **1560** based on the user's progress or continued progress. In particular, a determination is adjusted upon which to modify the target score, the determination being based on, for example, a calculation expressing activities in which a user is to engage to meet its health goals. In some cases, the requirements to change the calculations of a target score are based on the user consistently attaining a certain level or overall score. The new target score calculations ensure the user is motivated or induced to continue to improve his or her health at least until the target scoring is again modified. At **1562**, modified activities are implemented for the user. That is, the types and amounts of an activity can be "leveled up," so that user is challenged further. The flow continues monitoring at **1564**.

FIG. **16**A depicts examples of a social manager and an environmental manager configured to generate a context score, according to some examples. Diagram **1600** shows a user **1602** at a location **1620** subject to its environment from

which environmental parameters **1630** (e.g., location, temperature, noise levels, atmospheric pressure, talking or speech levels, etc.) can be acquired. Further, social parameters **1640** can be acquired. Examples of social parameters **1640** include a number of people wearing wearable devices **1608** contemporaneously, in proximity to the user, and/or engaged in similar activities or movements. User **1602** (or accompanying devices) can be interacting in a manner with others to receive and/or exchange social parameters **1640** from a social network of friends **1642** have a certain level of authorization or permissions to interact with user **1602** (and/or mobile devices **1604** and wearable device **1606**). Persons described as friends may or may not include wearable devices **1608** as part of a social network based on networked wearable devices. In some cases, mobile devices **1604** and/or wearable device **1606** are configured to communicate with a larger subset of persons (e.g., a universe of users using wearable devices **1608** in networks **1644** and **1646**). In some cases, nutrition parameters **1632** and/or physical parameters **1634** of user **1602** (and other authorized users), or an overall score based on those and others parameters, can be exchanged one or more social networks **1642**, **1644**, and **1646**.

Diagram **1600** also shows social manager **1538** and an environmental manager **1537** configured to exchange data with context score generator **1542**. For example, social manager **1538** and environmental manager **1537** can transmit to context score generator **1542** values of acquired environmental parameters **1630** and values of acquired social parameters **1640**. Social manager **1538** and/or environmental manager **1537**, as well as general health/wellness manager **1536**, can be configured to facilitate social networks and the functionalities and/or structures are described in FIGS. **12**A to **12**F.

Context score generator **1542** generates a context score that is indicative of the degree of impact caused by either an aspect of the environment or social interactions, or both, in relation to user **1602**. For example, a context score can be negatively impacted if user **1602** lives or spends time in regions of high rates of obesity, or with a group of people that tend to be sedentary, or at bars and nightclubs. However, the context score can be positively influenced by spending time at or near areas of relatively high occurrences of physical activities (e.g., spending time on a basketball court) or having a network of active friends. The context score is provided to general health and wellness manager **1536** to optionally influence an overall score (e.g., including sleep, nutrition and activity scores) relative to a target score. Responsive to a context score, general health and wellness manager **1536** can generate recommendations. For example, general health and wellness manager **1536** can determine that a user is at a specific location and can recommend one or more activities associated with that location or a structure at that location. If user **1602** is at a stadium, general health and wellness manager **1536** can generate recommendations to climb a number of stairs associated with the stadium structure, or can suggest a glass of water rather than a beer with a hot dog. If user **1602** is at a shopping mall, mobile devices **1604** and/or wearable device **1606** can project a path **1622** that passes a food court and recommend altering course onto another path **1624** to avoid the food court or to connect socially with another user sharing, for example, similar health and wellness profiles (i.e., goals). Therefore, general health and wellness manager **1536** can generate recommendations based on acquired parameters received by any sleep manager, activity manager, nutrition manager, environmental manager, social manager, or any number of generic managers to determine an overall score relative to an overall target score and can propose actions that affect one aspect of health, and wellness (e.g., sleeping) based on one or more other aspects of health and wellness (e.g., environment, nutrition, etc.).

In some embodiments, wearable device **1606** can generate messages encoded in vibratory messaging. For example, two long vibratory pulses can indicate that user **1602** ought to turn right and three short vibratory pulses can indicate that a user **1602** turn left. This vibratory messaging scheme can assist navigation of user **1602** to avoid detrimental locations, such as a food court, or can assist user to select a less populous running route based on data originating from a server that describes a number of pedestrians and cyclists based on locations of other wearable devices **1606** or cell phone locations (e.g., base on triangulation, GPS, or other means). The vibratory energy can increase as the user **1602** comes closer to a point at which to turn and decreases once the user passes that point.

FIG. **16**B is an example flow diagram **1650** to determine recommendations based on a context score to manage health and wellness, according to some examples. At **1652**, data representing one or more location-related reference parameters are received. For example, the one or more location-related reference parameters can include data representing what structures exist at the location and what activities typically occur there. At **1654**, acquired parameters associated with the location of a user are obtained. Optionally, data representing one or more social-related reference parameters are received at **1653**. For example, the one or more social-related reference parameters can include data representing the degree to which one or more friends, colleagues or people are active or participate in similar activities. At **1655**, acquired parameters associated with the social participation of a user are obtained. At **1656**, one or more scores are calculated relative to reference parameters. For example, positive values may be used in calculations when a user is interacting with active people, and negative values may be used when a user spends more than a certain amount of time at a bar or sitting at a location in front of a television. Scores can be adjusted optionally at **1658** to emphasize or deemphasize either positive actions or detrimental actions of a user. At **1660**, scores are combined to determine an overall score that represents the overall heath and wellness of one or more users. That is, an overall score can be based on a single user or a group of users, whereby those in the group are linked together to induce encouragement in achieving health and wellness goals. At **1662**, data signals representing one or more scores are generated to present to a user, for example, via visual means, such as a display, or haptic means, such as vibratory energy. Feedback can be determined at **1664** based on context score, and one or more proposals incorporating the feedback can be embodied in data signals at **1666** to propose actions for improving one or more scores. A determination whether to implement the feedback is made at **1670**. If it is, then flow **1650** continues to monitor acquired parameters and calculating scores to determine, if applicable, to dynamically change the target score to reflect the user's improvements and to further incentivize or motivate the user.

FIGS. **16**C and **16**D depict examples of displays including feedback based on environmental or social parameters, according to some examples. In FIG. **16**C, a display **1680** of a mobile device can depict a target score **1682** and a recommendation **1686** based on social parameters to encourage the user to alter score **1684** to meet target score **1682**. In FIG. **16**D, a display **1690** of a mobile device can depict a target score **1692** and a recommendation **1694** based on environmental parameters to encourage the user to achieve target score **1692**. Note displays are not limited to displays **1680** and

1690 and can be disposed on a wearable device and can convey information via different media other than visual (e.g., auditory, perceptible by touch, etc.).

FIG. 17A depicts an example of a general health and wellness manager, according to some examples. Diagram 1700 depicts general health and Wellness 1536 including one or more of the following: a data interface 1701, a health and wellness evaluator 1702, a manager coordinator 1706, a repository 1703 configured to store data representing trend or archival data files 1713, a repository 1707 configured to store data representing one or more profiles 1709, and a profile generator 1710. A bus 1705 couples each of the elements for purposes of communication. Profile generator 1710 can generate one or more profiles representative of a user's patterns of various activities associated with certain aspects of health and wellness based on trend analysis (e.g., empirically over time and various cycles of meals, sleep, time at certain locations, social interactions, and the like. A profile for a user can be input or entered via data 1720 to establish an initial over health and wellness profile based on one or more aspects thereof. Profile generator 1710 can generate data representing a subset of acquired parameters to establish a baseline profile against which a user's progress can be measured in modifying behavior when working toward a goal (e.g., overall target score) that is consistent with a healthy lifestyle. For example, the profile generated by profile generator 1710 can represent a daily average of activities affecting various aspects of health and wellness over one or more days during which acquired parameters were used to determine the trends for a user. Or, the profile generated by profile generator 1710 can represent a current interval of time (e.g., a specific day) in which an aspect of a user's health and wellness is monitored, and optionally modified to conform the user's behavior to a set of behaviors associated with a target score, which can be determined by a profile 1709.

Data interface 1701 is configured to receive data representing parameters, such as physical parameters 1711, environmental parameters 1712, and nutrition parameters 1714. Such parameters can originate at any type of sensor, such as those described herein, or can be derived (e.g., computationally), or can be input as data extracted, for example, from a networked database. Examples of physical parameters 1711 include a sleep start time, a sleep end time, a duration of light sleep (and/or a total duration of light sleep between the start and sleep end times), a duration of deep sleep (and/or a total duration of deep sleep between the start and sleep end times), a heart rate, a body temperature, and the like. Examples of environmental parameters 1712 include an amount of light, a level of sound energy, an ambient temperature, a location of a user, a location of another user, and the like. Environmental parameters, as well as any other parameter, can be archived in archived data files 1713 so that trends can be established to determine, for example, the locations at which a user tends to participate in positive activities (i.e., in terms of achieving a target score). This information can be used to generate recommendations to induce a user toward achieving a target score. Parameters also can include nutrient-related parameters that causes physiological manifestations in, for example, types of gases, such as CO2 expelled from the lungs or skin, as well as steps, minutes of activity/motion, minutes of inactivity/no motion, intensity of activity, aerobic minutes, aerobic intensity, calories burned, training sessions, length, of training sessions, intensity of training sessions, calories burned during training session(s), type of activities, duration of each type of activity, intensity of each type of activity, calories burned during each type of activity, instantaneous body temperature, average body temperature, instantaneous skin galvanization, average skin galvanization, instantaneous heart rate, average heart rate, instantaneous perspiration, average perspiration, instantaneous blood sugar level, average blood sugar level, instantaneous respiration rate, average respiration rate, and the like.

Examples of nutrition parameters 1714 include types of consumable materials and their nutrient compositions for specific unit amounts or volume. As used herein, the term "consumable material" refers to any material consumed as either food or drink and has at least one or more nutrients from which to provide a user. A consumable material can be medicine or any other substance that enters the body (e.g., orally or by any other means, such as through the skin or is inhaled). A "consumable material component" is a component of a meal, such as a side salad, French fries, or a main entrée, that, when combined with other meal components, form a meal. Each of the consumable material components can have equivalent nutrients, such as sodium, that can be isolated, measured, monitored and reported as an aggregate amount of the specific nutrient for the meal (i.e., over all the parts of the meal containing that nutrient). In some embodiments, nutrition parameters 1714 can be stored as nutrition parameter data 1713. Types of consumable materials include unprocessed foods and drink, such as fruits, vegetables, unprocessed meats, water, etc., and processed foods and drink, such as restaurant meals, processed and packaged foods, etc. Nutrition parameters 1714 can include descriptors specifying amounts of the nutrients, such as units (e.g., real numbers representing units of measure, such as IUs, mg, g, ml, cups, etc.), and types of nutrients. Types of nutrients can include carbohydrates (of a various subtypes, including fiber), fats, minerals, proteins, vitamins, water, and any combination or variation thereof. Data representing nutrition parameters can be acquired (e.g., as acquired parameters) by way of input by a user. A social parameter includes data representing a social interaction between a user and another person via any form of communication, such as face-to-face, phone, email, text, amounts of time spent with a person, and the like. Social parameters can be archived in archived data files 1713 so that trends can be established to determine, for example, the people with which a user tends to participate in positive activities (i.e., in terms of achieving a target score). This information can be used to generate recommendations to induce a user toward achieving a target score. Any other characteristics of social interactions, including proximity to other persons (or the proximities of wearable devices relative to each other) and data derived from social networking web sites and other databases are also included in social parameters 1716. As used herein, the term "acquired parameter" refers to one or more parameters that are obtained for purposes of analyzing nutritional intake (e.g., nutrition parameters describing nutrition of food or drink that is consumed or to be consumed). Data representing an acquired parameter can include an amount (e.g., units) of a nutrient and a type of the nutrient. In some embodiments, an acquired parameter is associated with data originating from a wearable computing device. In some embodiments, nutrition parameters 1714 can be retrieved from repository 1703 or over a network from a remote database. For example, a restaurant or food producer may provide access to nutrition data in a remote database that is accessible by customers for purposes of evaluating nutrition for health and wellness. In at least some examples, nutrition parameters 1714 can be determined via image capture with image recognition logic and/or user input. An example of the use of image recognition logic is shown in FIG. 17B.

Health and wellness evaluator 1702 is configured to acquire data representing acquired parameters describing the

various aspects of health and wellness of a user, including, but not limited to, nutrition-related characteristics, sleep-related characteristics, movement-related characteristics, environmental characteristics, social-related characteristics, among others. In particular, health and wellness evaluator **1702** is configured to determine characteristics of an activity, state or condition for a user. Health and wellness evaluator **1702** is further configured to identify the a specific activity and type of activity (e.g., type of sleep, movement, nutritional intake, etc.) and generate data representing the units and types of the activities for specific aspects of health and wellness. In some examples, health and wellness evaluator **1702** is configured to control manager coordinator **1706**, which, in turn, is configured to facilitate, assist with or control operations of various managers, as well as interactions between the managers. The managers can operate cooperatively to tune or modify the interrelationships between multiple behaviors or activities of a user to maximize various aspects of health and wellness. For example, manager coordinator **1706** can cause generation of recommendations to improve one or more scores of the same or different aspects of health and wellness. Exemplary operation of manager coordinator **1706** is described by way of several examples of tuning the interrelationships between multiple behaviors and activities of a user, as described in FIGS. **18**A to **18**D.

In some embodiments, health and wellness evaluator **1702** also is configured to compare a user's profile (i.e., trend data representing aspects of health and wellness of a user) against data representing one or more health and wellness deficiency profiles **1708** to determine whether a deficiency exists (e.g., an irregular eating schedule, a lack of proper hydration, whether a nutrient deficit exists, whether a user spends extraordinary time in the ice cream isle of a supermarket, etc.). As described above, manager coordinator **1706** is configured to provide recommendations to modify the user's behavior to optimize one or more scores, including an overall score, thereby optimizing the various user activities to facilitate improved health and wellness. Health and wellness evaluator **1702** can generate notifications and alerts (e.g., graphical, haptic, audio, or otherwise perceptible to a user) to induce a user to modify user behavior, or environmental, social, nutritional, and/or physical parameters to improve a user's health. For example, a wearable device can vibrate to notify a user that a meal ought to be consumed at a certain time, or a certain movement ought to be performed. In some examples, health and wellness evaluator **1702** is configured to cause generation of a graphical representation on an interface to induce modification of an acquired parameter, or to cause generation of a haptic-related signal for providing vibratory feedback to induce modification of the acquired parameter.

FIG. **17**B is an example flow diagram for a technique of managing overall health and wellness using, for example, wearable devices that include sensors, according to some examples. At **1752**, data representing one or more baseline parameters is received. The baseline parameters can include any health-related characteristics that define parameters upon which a target score is established. Further, the target score can be established based on one or more health-related activities. For instance, the baseline parameters can be set forth in a data arrangement constituting a profile **1709** of FIG. **17**B. In some cases, the values of the baseline parameters are such that if the user attains or fulfils the goals of optimizing one or more aspects of health and wellness, the target score having a value of 100. At **1754**, parameters are acquired that describe a state or characteristics of a user's activity. Examples of acquired parameters can include—via derivation or measurement—a heart rate, a duration of sleep, a location, a duration of wakefulness, a sleep start time, a sleep end time, a body temperature, an ambient temperature, an amount of light, an amount of sound energy, a unit and type of one or more consumable materials (e.g., food and/or drink), an indication of participating in an activity with other users, etc.

Scores are calculated at **1756** relative to or associated with baseline parameters, which can be associated with a reference value. For example, data representing values (e.g., points) for one or more subsets of acquired parameters (e.g., data via measurement, sensor, derivation, etc.) are determined based on reference values, such as a total number of points, for parameters set forth in the profile. For example, a user may set as its goal to consume 45 milligrams of vitamin C per day (per World Health Organization standards). At breakfast, the user consumes a meal and receives about 22 milligrams. A profile includes data that equates 45 milligrams as 20 points (i.e., a target score for this nutrient). In this case, 20 points is a reference value (i.e., the baseline parameter). As 22 milligrams, which represents an acquired parameter (e.g., units of: 22 mg, and type of: vitamin C nutrient), is approximately half of the goal, the user receives 10 points as the value. Scores can be calculated at a first processor based on data representing the values, whereby the score representing an attained portion of the one or more health-related activities. That is, a score can be determined as an "overall score" to include one or more of nutrition scores, sleep scores, activity scores, context scores or any other score, and the like. The overall score is indicative of an ability of a user to achieve a targeted level of health and wellness and can represent the user's progress, for example, on a daily basis in meeting a target score. The overall score can be express as a percentage of the target score, such as 71% with 100 points set as the target score.

At **1758**, at least one score can be adjusted toward or away from the target score. For example, if the user is agrees to spend time with active friends, then the user is awarded positive points to encourage socializing with people more likely to assist the user in reaching its health and wellness goals. But if a user spends a certain amount of time at a bar or in the dessert isle of a supermarket, then points are deducted from its overall score to encourage the user to avoid tempting locations. At **1760**, a decision is made as to whether to implement feedback. If so, flow **1750** moves to **1762**, at which characteristics of health and wellness are identified for modification to urge the user to improve scores, which, in turn, represents improved health. At **1766**, the modifications are implemented.

At **1764**, the determination of a score can be modified relative to a threshold. For example, when the overall score exceeds the target score, the rate at which the overall score can be reduced as a function of the difference between the overall score and the target score. That is, it gets more difficult to accrue points for the overall score when exceeding the target score. For example, for overall scores between 100 and 110, it is 50% harder to obtain overall score points (e.g., 25% fewer points are rewarded), for overall scores between 111 and 125, it is 75% harder to obtain overall score points, and for overall scores above 126 it is 100% harder. At **1768**, a classification for a user can be either leveled up or down. For example, a subset of overall scores can be determined and the classification associated with a user can be changed based on the subset of overall scores. The classification can be changed by leveling up to a first health and wellness profile if the subset of overall scores is associated with a first range, or the classification can be changed by leveling down to a second health and wellness profile if the subset of overall scores is associated with a second range. The first range of activity scores are nearer to the target score than the second range of activity

scores. To illustrate, if the overall score is 95% of the target score (e.g., for a duration), the user is either leveled up or provided the opportunity to level up to implement, for example, a new value of a parameter of a different health and wellness profile. But if the sleep score is 70% or less of the target score, the user is given the option to level down (e.g., to a less ambitious or rigorous health and wellness profile). In this manner, the target score is dynamically altered just beyond the current limitations of the user to induce or otherwise motivate the user to work harder and strive to attain the new target score, and, ultimately, a healthy lifestyle. At **1770**, flow **1750** determines whether to continue monitoring and moves to **1772** to do so. At **1772**, other parameters are acquired and further monitoring is performed. Note that more or less blocks, elements, actions or steps of flow **1750** can be implemented, and note further that flow **1750** is not intended to be limiting.

FIGS. **18**A to **18**D depict interrelationships between different aspects of health and wellness and different managers cooperating to optimize the same, according to various examples. FIG. **18**A depicts data **1802** representing sleep and data **1804** representing nutrition-intake activity relative to time, whereby the data can represent instantaneous (e.g., in real or near real time) sleep data and nutrition data, or data **1802** and **1804** can represent archived or trend data, or projected activity occurring typically at different times during a day. Sleep manager **1530** and nutrition manager **1534** cooperate to modify one aspect of health and wellness, such as nutrition, to optimize another aspect. For example, sleep manager **1530** can determine instantaneous or predicted states of wakefulness and sleep for a user, and nutrition manager **1534** can determine or predict nutrition intake as breakfast **1806**, lunch **1807**, and dinner **1808**. In some cases, either manager coordinator **1706** or health and wellness evaluator **1702**, or both, can control sleep manager **1530** and nutrition manager **1534**. In operation, manager coordinator **1706** or health and wellness evaluator **1702** can be configured to propose a time or duration **1810** in which a user is recommended to have breakfast **1806** after waking up. Positive or no points can be awarded if this meal occurs during interval **1810**, and negative points can be applied if the user fails to eat breakfast. Further, manager coordinator **1706** or health and wellness evaluator **1702** can be configured to recommend to a user to have dinner no later than an amount of time **1812** before bedtime. Positive points can be awarded if dinner **1808** occurs before time **1812** or include a meal conducive to enhance sleep, such as foods with tryptophan. Negative points may be applied if caffeine or other stimulants are consumed during time **1812**.

FIG. **18**B depicts data **1802** representing sleep and data **1814** representing activity relative to time, whereby the data can represent instantaneous (e.g., in real or near real time) sleep data and activity data, or data **1802** and **1804** can represent archived or trend data, or projected activity occurring typically at different times during a day. Sleep manager **1530** and activity manager **1532** cooperate to modify one aspect of health and wellness, such as activity, to optimize another aspect, such as sleep. For example, sleep manager **1530** can determine instantaneous or predicted states of wakefulness and sleep for a user, and activity manager **1532** can determine or predict times at which user engages in walking **1816** and running **1818**. In operation, manager coordinator **1706** or health and wellness evaluator **1702** can be configured to propose a time or duration **1820** in which a user is recommended to take a walk after waking up to take advantage of the most energetic part of the user's day or circadian rhythm. Positive or no points can be awarded if this activity is performed within time **1820**. Further, manager coordinator **1706** or health and wellness evaluator **1702** can be configured to recommend to engage in exercise no later than an amount of time **1822** before bedtime. Positive points can be awarded if the user runs **1818** before time **1822**. Negative points may be applied if the user runs **1818** during time **1812**, as sleep likely is to be affected by exercising so close to sleep time.

FIG. **18**C depicts data **1830** representing activity and data **1850** representing nutrition relative to time, whereby the data can represent instantaneous (e.g., in real or near real time) activity data and nutrition data, or data **1830** and **1850** can represent archived or trend data, or projected activity occurring typically at different times during a day. Activity manager **1532** and nutrition manager **1530** cooperate to modify one aspect of health and wellness, such as activity, to optimize another aspect, such as sleep. For example, activity manager **1530** can determine instantaneous or predicted states of movement for a user, such as a workout activity **1840** (e.g., a marathon), and nutrition manager **1532** can be used to recommend times at which user consumes different foods or drink prior to working out. In operation, manager coordinator **1706** or health and wellness evaluator **1702** can be configured to propose a time or duration **1832** in which a user is recommended to consume fresh fruit, bagels, energy bars, pasta, and other like types of food **1852** (e.g., 3 to 5 hours before a competition). But during the time or duration **1834**, the user is advised to consume fresh fruits, bagels, water, and like consumables **1854** (e.g., 2 to 3 hours before the competition), whereas the user is advised to consume specific fruits, such as watermelon and oranges, limited amounts of sport drink and like consumables **1856** during time or duration **1836** (e.g., 1 hour or less before competition). In various embodiments, activity manager **1532** and nutrition manager **1530** can cooperate to improve the overall health and wellness of a user based on the interplay between movement and nutrition. As such, the above-described is but one example. Positive can be awarded specific foods are consumed at the appropriate times.

FIG. **18**D depicts data **1860** representing location, data **1864** representing social interactions or proximity relative to time, data **1868** and **1869** representing environmental parameters including audio, and data **1880** and **1881** representing movement relative to time. The data shown can represent instantaneous activity data, social data, environmental data and activity data, or any of the data can represent archived or trend data, or projected activity occurring typically at different times during a day. In the example shown, environmental manager **1537**, social manager **1538**, and environmental manager **1537** are configured to assist activity manager **1532** in determining the type of activity a user is engaged. As shown, environmental manager **1537** can determine locations of a user at different times of the times, such as at home **1861**, at work **1862**, and at a gym **1863**. Social manager **1538** is configured to determine that user associated with colleagues **1865** during a first time period, with other persons **1866** during a second time period, and family **1867** later on in the day. Environmental manager **1537** is configured to detect voiced words **1868**, such as "walk" and "lunch," and further to detect voiced works **1869**, such as "yoga" and "Fred." During the first time period, activity manager **1532** detects motion, and uses information that the person is at work, is associating with colleagues and is in an environment in which speech is detected to conclude that the user is likely walking with colleagues to lunch. As such, activity ("1") **1880** is determined to be walking. During the second time period, activity manager **1532** detects another type of motion, and uses information that the person is at a gym, is associating with other

persons (e.g., wearing similar wearable devices and participating in similar motions) and is in an environment in which speech is detected to conclude that the user is likely participating in a yoga class. As such, activity ("2") **1882** is determined to be yoga. Note that the above-described examples are not intended to be limiting, but rather to provide examples of the various functionalities and/or structures that can be used to manage a user's overall health and wellness by optimizing one aspect of health and wellness to improve another, and to use acquired parameters (e.g., location, social interactions/proximities, etc.) to determine an activity in which a user is participating. An ordinarily skilled artisan ought to appreciate that many different implementations disclosed herein that can be modified to address any aspect of managing user health by motivating the user to challenge oneself to meet its health goals.

Although the foregoing examples have been described in some detail for purposes of clarity of understanding, the above-described inventive techniques are not limited to the details provided. There are many alternative ways of implementing the above-described invention techniques. The disclosed examples are illustrative and not restrictive.

What is claimed:

1. A method comprising:

receiving data representing a profile defining parameters upon which a target score is established based on one or more health-related activities;

acquiring data representing one or more subsets of acquired parameters based on one or more sensors disposed in a wearable computing device;

determining data representing values for the one or more subsets of the acquired parameters based on reference values for the parameters set forth in the profile;

calculating at a first processor a score based on data representing the values, the score representing an attained portion of the one or more health-related activities;

causing presentation of a representation of the score relative to the target score; and

adjusting a determination upon which to modify the target score,

wherein the target score is indicative of one or more standards against which to compare one or more groups of the values aggregated to form the score.

2. The method of claim **1**, wherein the score is indicative of an ability of a user to achieve a targeted level of health and wellness associated with the target score.

3. The method of claim **1**, wherein the first processor is disposed in the wearable computing device.

4. The method of claim **1**, wherein the one or more subsets of acquired parameters comprises:

data representing one or more of

a first subset of acquired parameters associated with sleep-related activities,

a second subset of acquired parameters associated with nutrition-related activities, and

a third subset of acquired parameters associated with movement-related activities.

5. The method of claim **4**, wherein calculating the score based on the data representing the values comprises:

aggregating one or more of a sleep score, a nutrition score and an activity score.

6. The method of claim **1**, wherein the one or more subsets of acquired parameters comprises:

data representing one or more of

a fourth subset of acquired parameters associated with location-related activities, and

a fifth subset of acquired parameters associated with social-related activities.

7. The method of claim **6**, wherein calculating the score based on the data representing the values comprises:

generating a context score based on the fourth and fifth subsets of acquired parameters; and

aggregating the score and the context score to form the target score.

8. The method of claim **1**, further comprising:

adjusting the score for one or more of the values to form an adjusted score; and

using the adjusted score to form an overall score.

9. The method of claim **8**, further comprising:

determining a context score based on either one or more location-related parameters or one or more social-related parameters; and

forming the adjusted score using the context score.

10. The method of claim **1**, further comprising:

determining a magnitude of a difference between the score and the target score;

predicting a subset of the acquired parameters to reduce the difference between the score and the target score; and

generating data representing a recommendation to present to a user to engage in engage in a health-related activity.

11. The method of claim **10**, wherein generating the data representing the recommendation comprises:

generating data representing a suggestion to interact socially with a subset of people who are associated with activity scores indicative of active users; and

causing presentation of the suggestion to contact interact with the subset of people to reduce the difference between the score and the target score.

12. The method of claim **10**, wherein generating the data representing the recommendation comprises:

generating data representing a suggestion to interact physically with a structure associated with a location of the user; and

causing presentation of the suggestion to physically interact with the structure to reduce the difference between the score and the target score.

13. The method of claim **1**, wherein acquiring data representing the acquired parameters comprises:

obtaining for an acquired parameter data representing a type of parameter and units of the acquired parameter.

14. The method of claim **13**, wherein receiving data representing the profile comprises:

obtaining data representing a value per unit of a parameter and a reference value representing a target number of units of the parameter,

wherein the parameter corresponds to the acquired parameter.

15. The method of claim **1**, further comprising:

causing generation of a graphical representation on an interface to induce modification of the values for at least one subset of the acquired parameters or

causing generation of a haptic signal for providing vibratory feedback to induce modification of the values for at least one subset of the acquired parameters.

16. The method of claim **1**, further comprising:

determining trend data representing one or more calculated scores, the trend data being stored in a memory;

identifying at least one acquired parameter as deviating by a threshold amount from a corresponding parameter defined by the profile;

recommending modification of the at least one acquired parameter to reduce the threshold amount; and

detecting whether the at least one acquired parameter is modified.

17. The method of claim **1**, further comprising:

detecting the score exceeds the target score; and

reducing a rate at which the score as a function of the difference between the score and the target score.

18. The method of claim **1**, further comprising:

determining a subset of scores;

changing a classification associated with a user based on the subset of scores,

wherein changing the classification including leveling up to a first classification or leveling down to a second classification.

19. A device comprising:

a first interface configured to receive data representing acquired parameters from one or more sensors, at least one sensor being disposed in a wearable computing device;

an aggregation engine comprising:

a repository configured to store data representing a profile defining parameters upon which a target score is established; and

one or more managers including one or more processors, at least one manager being configured to receive data representing a subset of the acquired parameters and further configured to determine data representing values for the subset of the acquired parameters, the values representing a point value relative to reference values for the parameters set forth in the profile;

a score generator configured to:

calculate a score based on data representing the values; and

adjust the score based on threshold amounts for one or more of the values to form an adjusted score;

a general health and wellness module configured to facilitate modification of a value of an acquired parameter associated with a state of a user to change the target score; and

a status manager configured to cause presentation of a representation of the target score, wherein the score is indicative of relative proximity to the target score.

* * * * *

Exhibit B

US008073707B2

(12) **United States Patent**
Teller et al.

(10) **Patent No.: US 8,073,707 B2**
(45) **Date of Patent: *Dec. 6, 2011**

(54) **SYSTEM FOR DETECTING, MONITORING, AND REPORTING AN INDIVIDUAL'S PHYSIOLOGICAL OR CONTEXTUAL STATUS**

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This patent is subject to a terminal disclaimer.

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G06Q 50/00 (2006.01)

(52) **U.S. Cl.** **705/2**; 600/300

(58) **Field of Classification Search** 600/300, 600/301, 365, 500, 509, 549; 705/2, 3, 1
See application file for complete search history.

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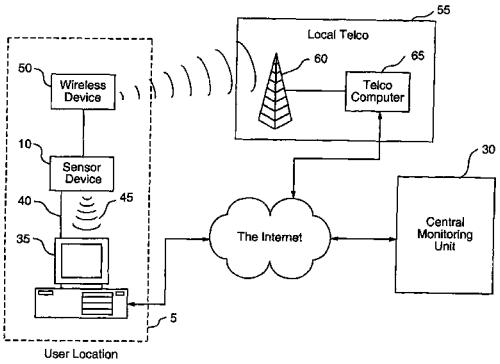
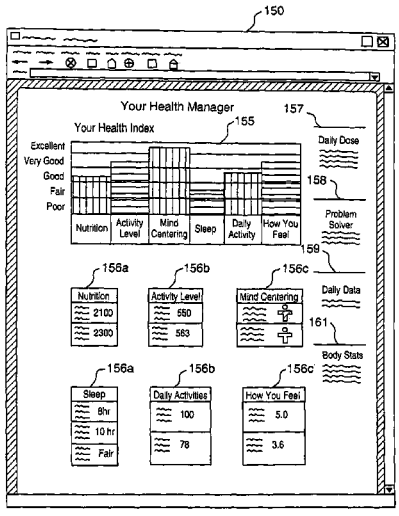
(57) **ABSTRACT**

The invention is a system for detecting, monitoring, and reporting an individual's physiological or contextual status. The system works deriving a physiological or contextual status parameter of an individual using the system. The derivation utilizes two sensed parameters of the individual. The system is able to present the derived parameter in relation to any other sensed parameters, entered information, life activities data, or other derived data.

24 Claims, 11 Drawing Sheets





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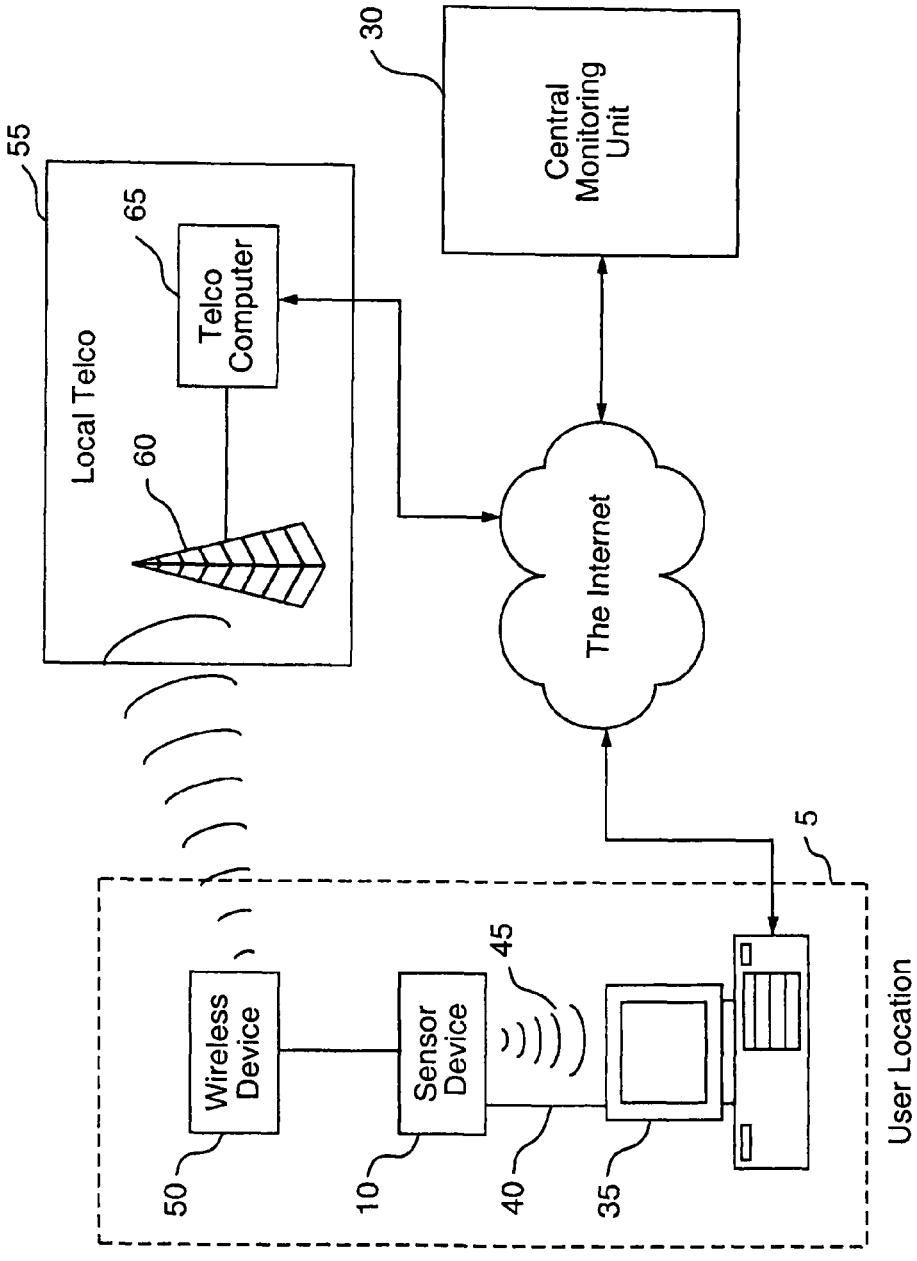
30
Central Monitoring Unit
55
Local Telco
65
Telco Computer
60
The Internet
5
User Location
45
Wireless Device
Sensor Device
50
10
40
35

FIG. 1

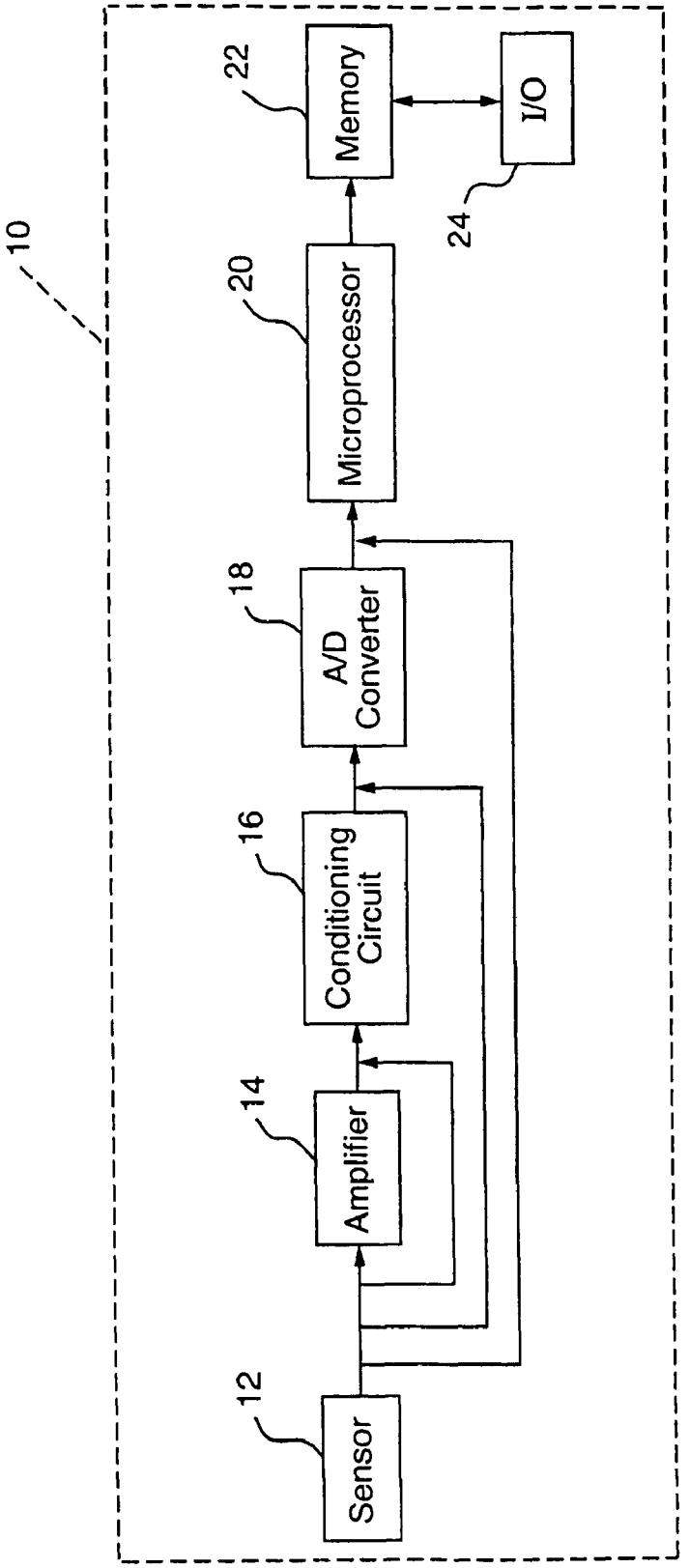
10
12
Sensor
14
Amplifier
16
Conditioning Circuit
18
A/D Converter
20
Microprocessor
22
Memory
24
I/O

FIG. 2

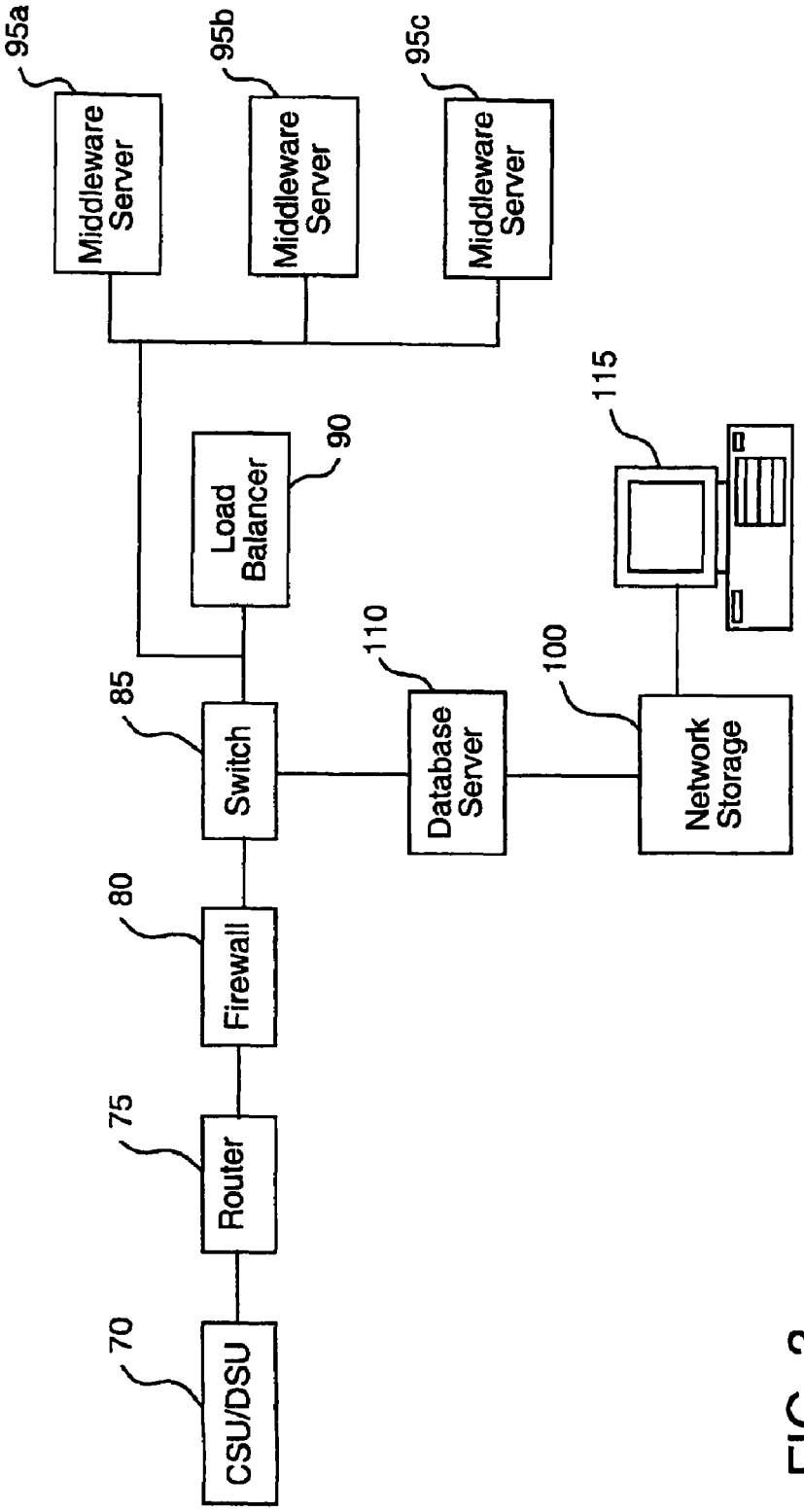
95a
Middleware Server
95b
Middleware Server
95c
Middleware Server
115
90
Load Balancer
110
100
85
Switch
Database Server
Network Storage
80
Firewall
75
Router
70
CSU/DSU

FIG. 3

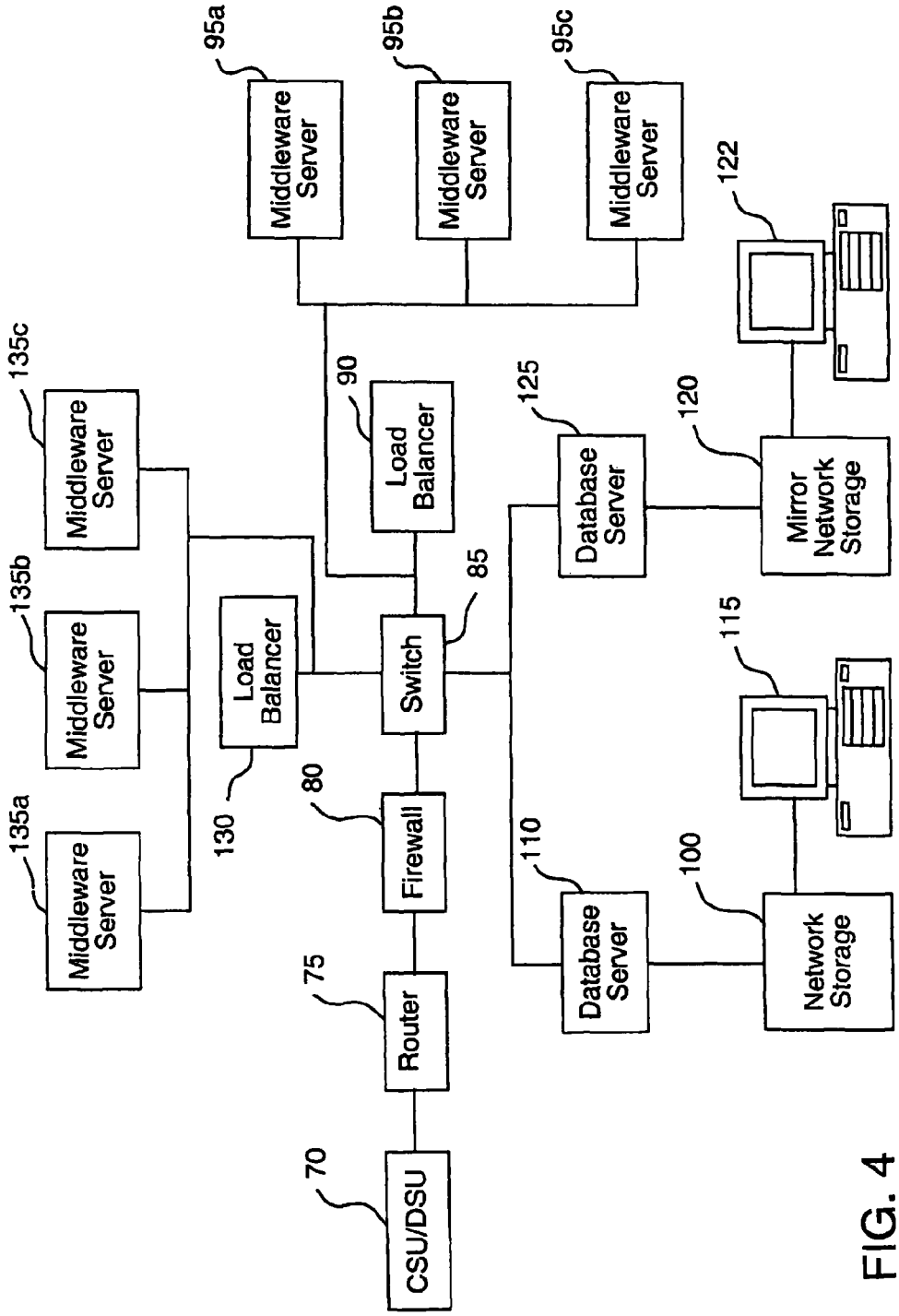
95a
Middleware Server
95b
Middleware Server
95c
Middleware Server
122
135c
Middleware Server
90
Load Balancer
125
Database Server
120
Mirror Network Storage
135b
Middleware Server
Load Balancer
85
Switch
115
135a
Middleware Server
130
80
Firewall
110
100
Database Server
Network Storage
75
Router
70
CSU/DSU

FIG. 4

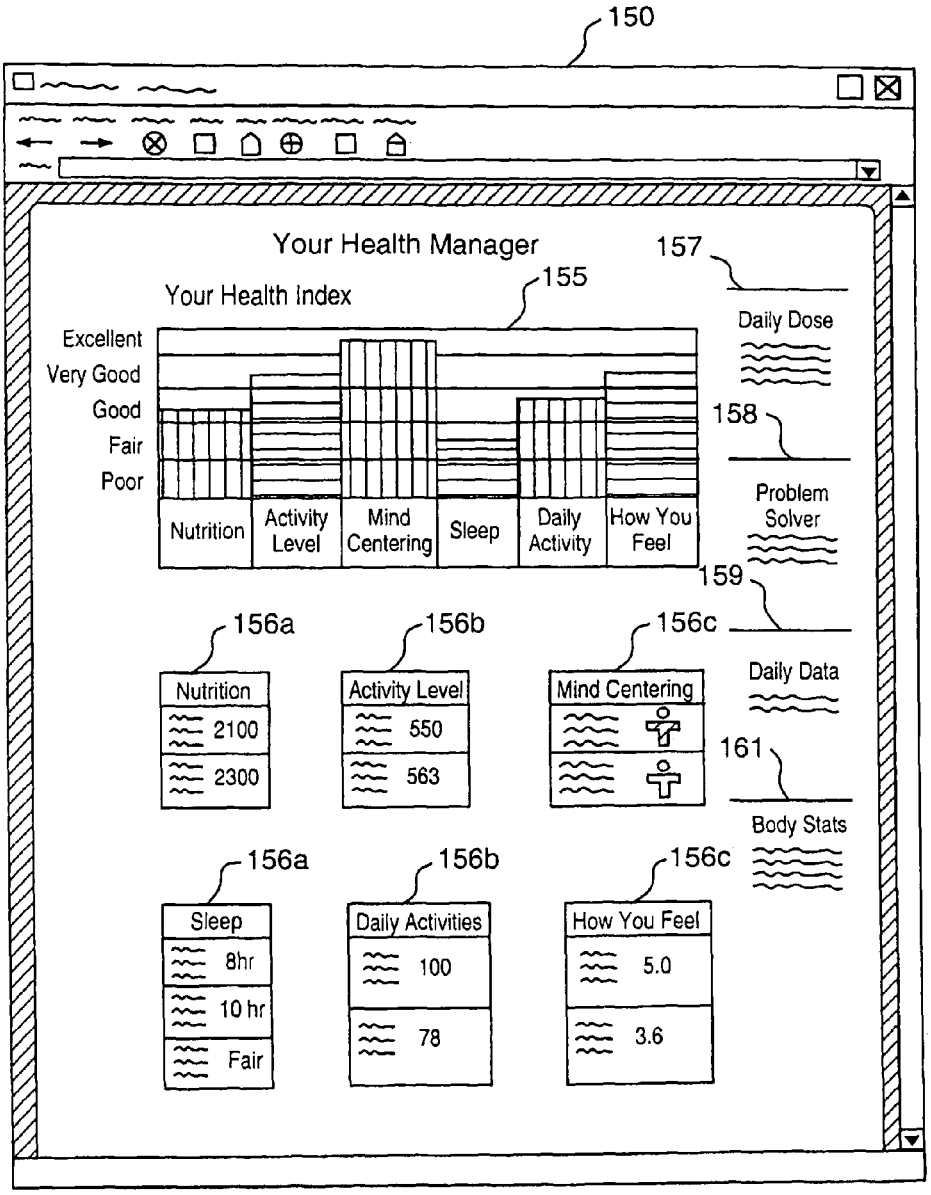
150
Your Health Manager
157
Your Health Index
155
Excellent
Very Good
Good
Fair
Poor
Nutrition
Activity Level
Mind Centering
Sleep
Daily Activity
How You Feel
Daily Dose
158
Problem Solver
159
156a
156b
156c
Nutrition
2100
2300
Activity Level
550
563
Mind Centering
Daily Data
161
Body Stats
156a
156b
156c
Sleep
8hr
10 hr
Fair
Daily Activities
100
78
How You Feel
5.0
3.6

FIG. 5

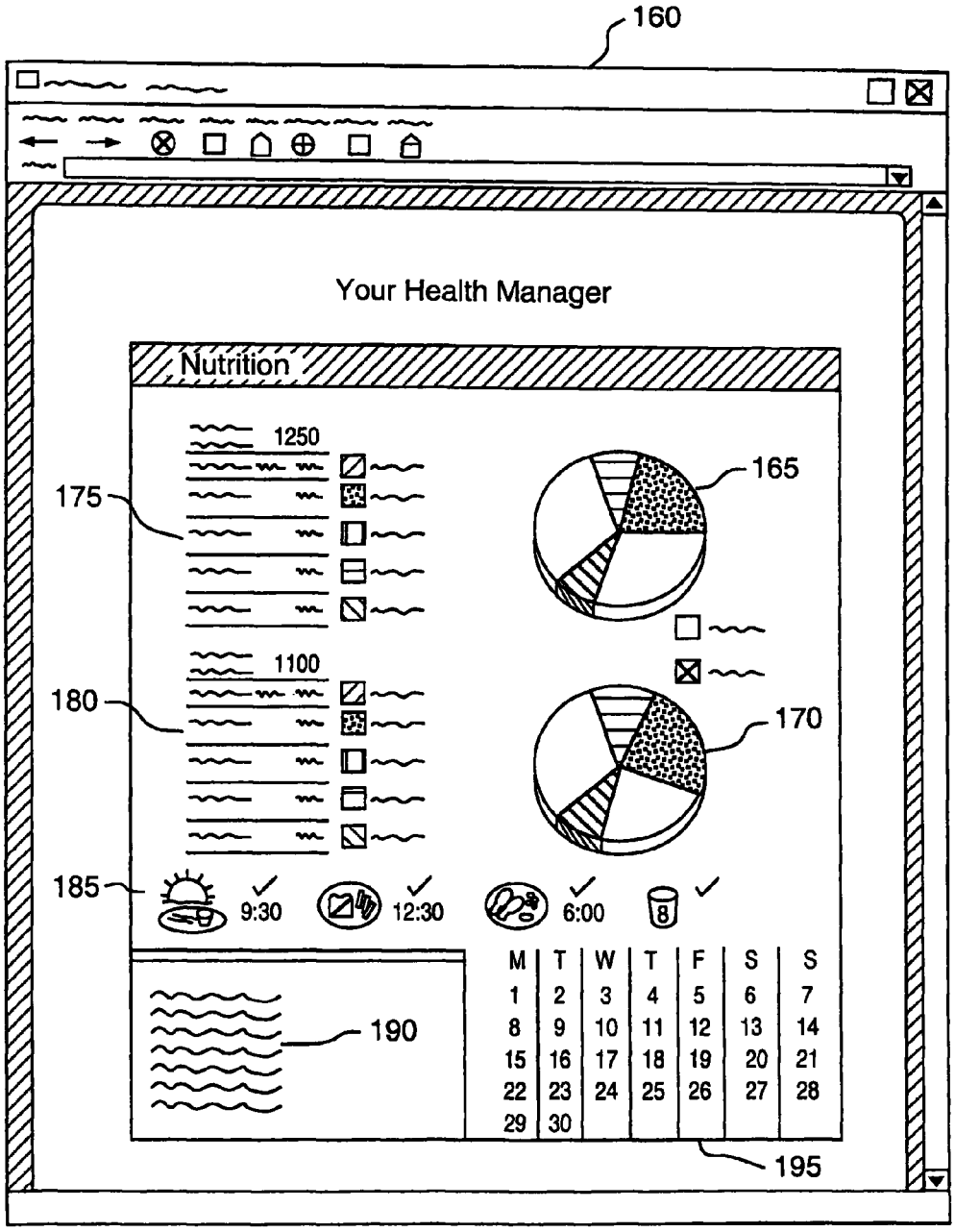
160
Your Health Manager
Nutrition
1250
175
165
1100
180
170
185
9:30
12:30
6:00
M T W T F S S
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
190
195

FIG. 6

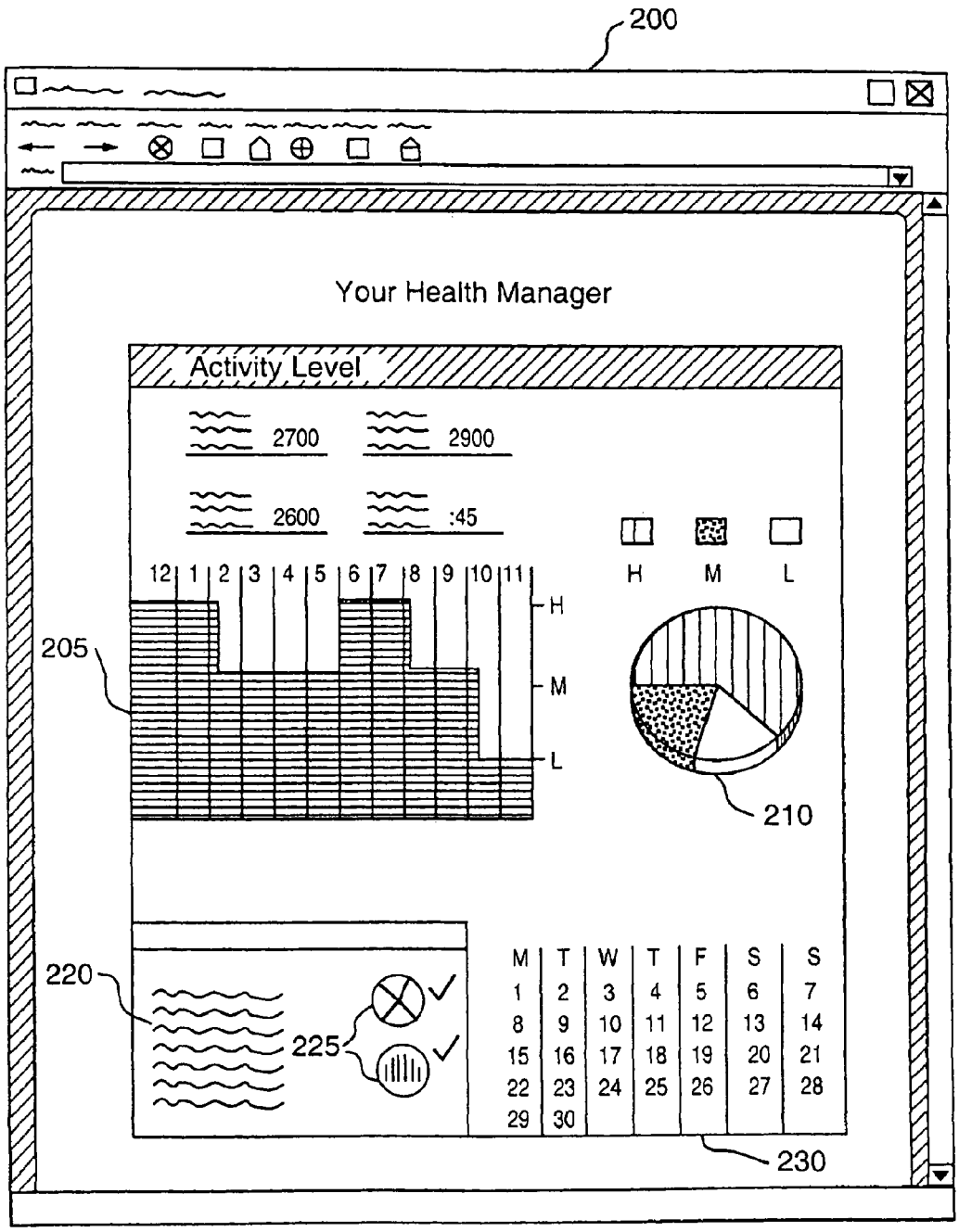
200
Your Health Manager
Activity Level
2700
2900
2600
:45
12 1 2 3 4 5 6 7 8 9 10 11
H
M
L
205
H
M
L
H M L
210
220
225
M T W T F S S
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
230

FIG. 7

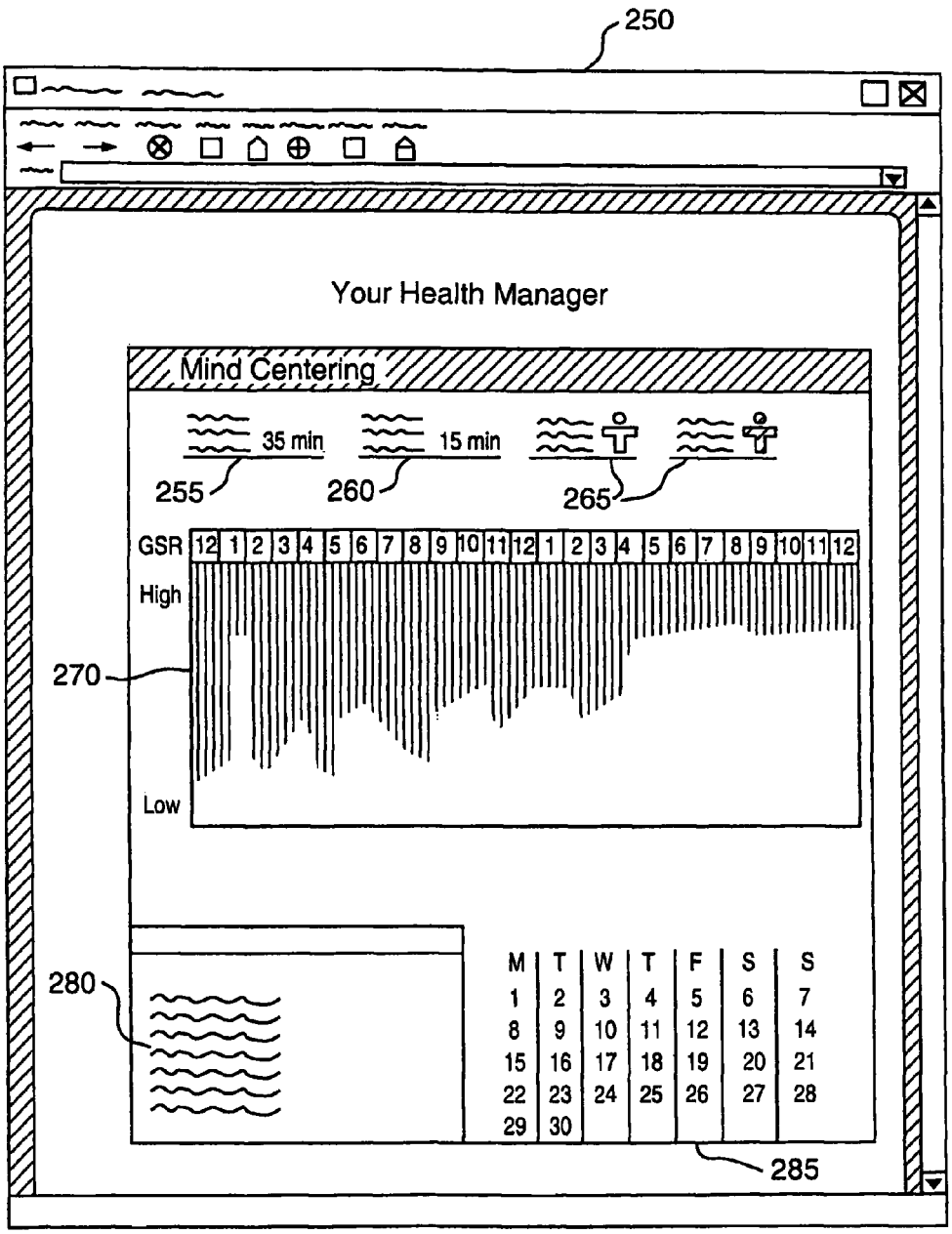
250
Your Health Manager
Mind Centering
35 min
15 min
255
260
265
GSR
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
High
Low
270
280
M T W T F S S
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
285

FIG. 8

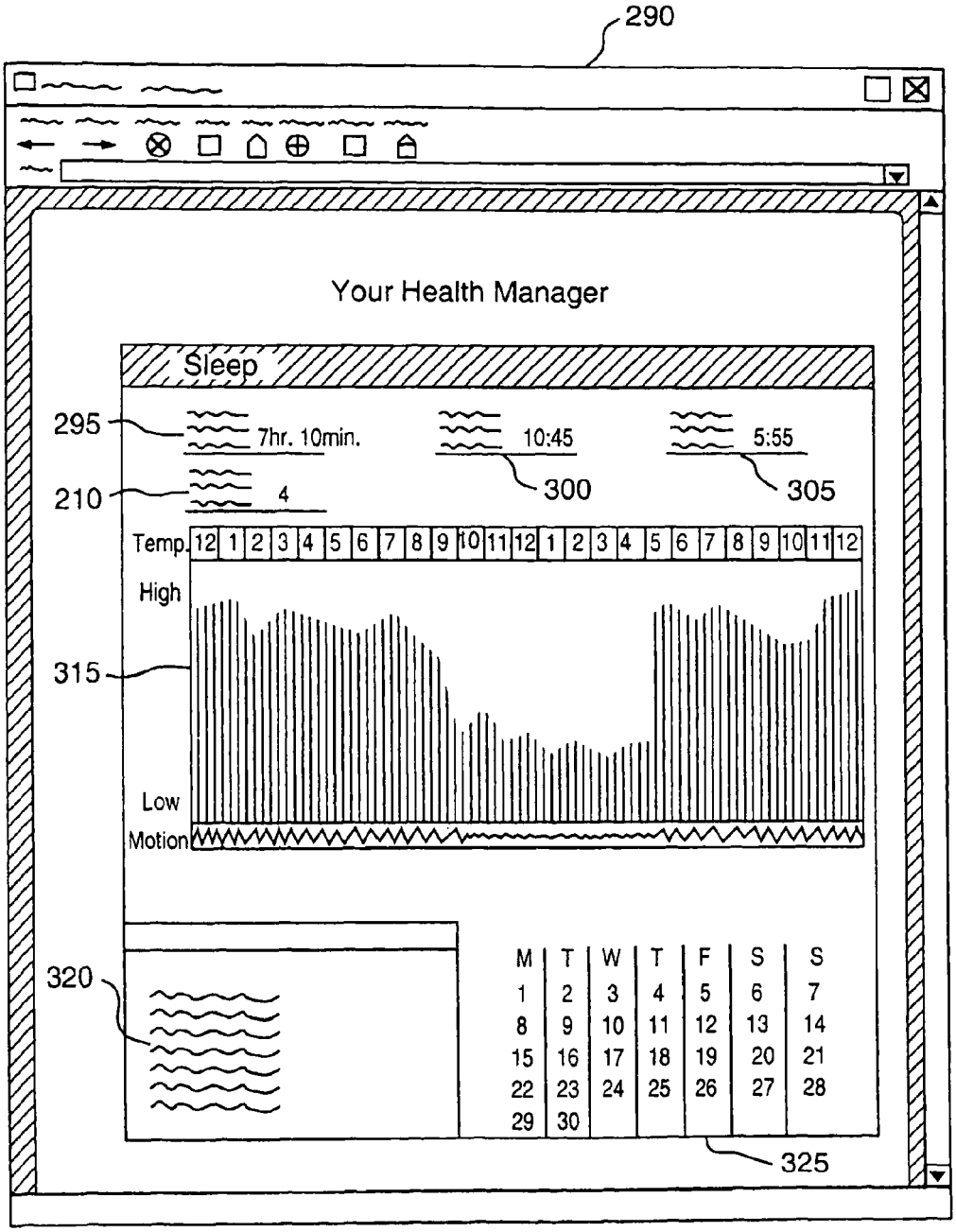
290
Your Health Manager
Sleep
295
7hr. 10min.
10:45
5:55
210
4
300
305
Temp.
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
High
315
Low
Motion
320
M T W T F S S
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
325

FIG. 9

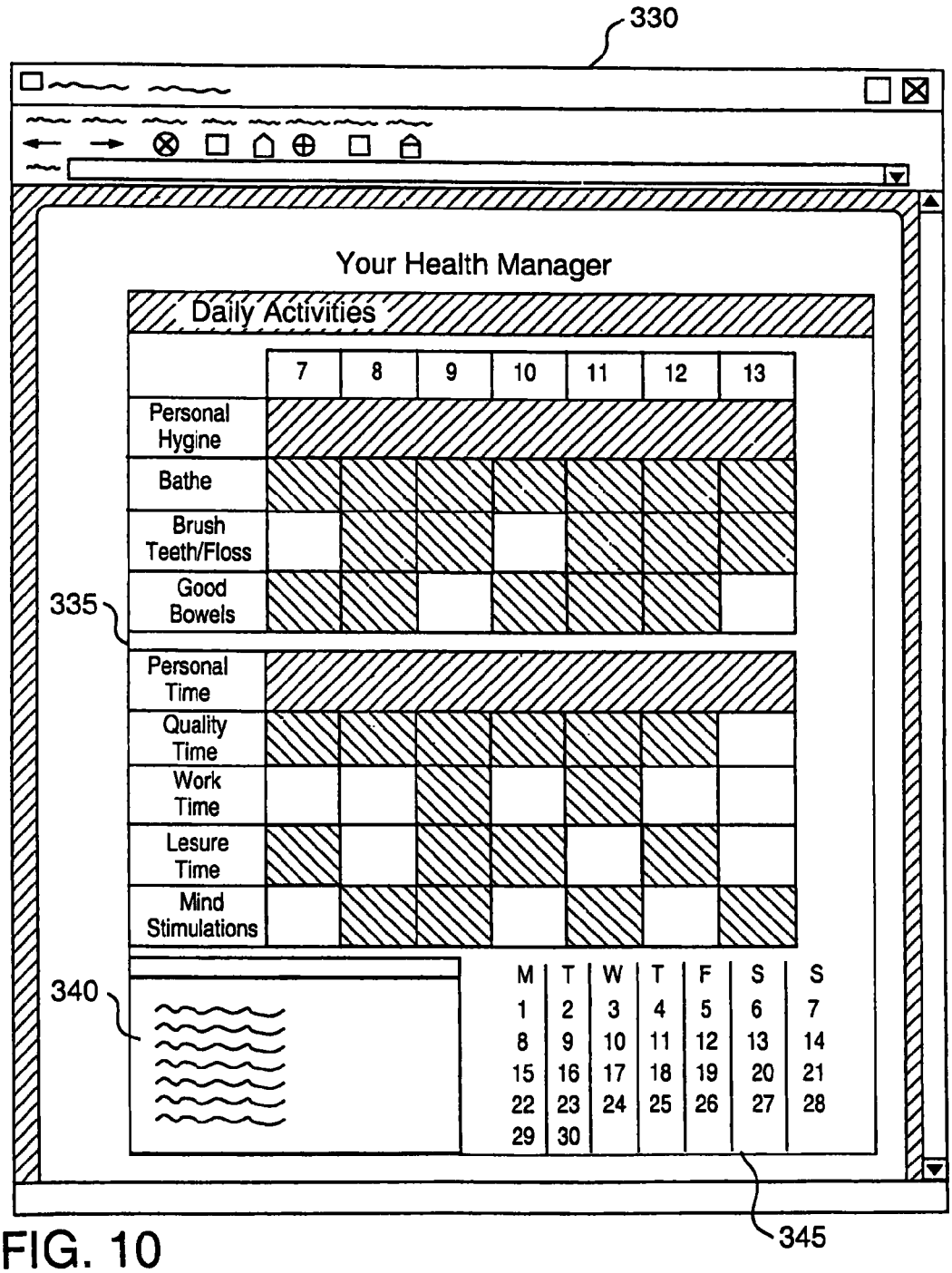
330
Your Health Manager
Daily Activities
7
8
9
10
11
12
13
Personal Hygine
Bathe
Brush Teeth/Floss
Good Bowels
335
Personal Time
Quality Time
Work Time
Lesure Time
Mind Stimulations
340
M T W T F S S
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
345

FIG. 10

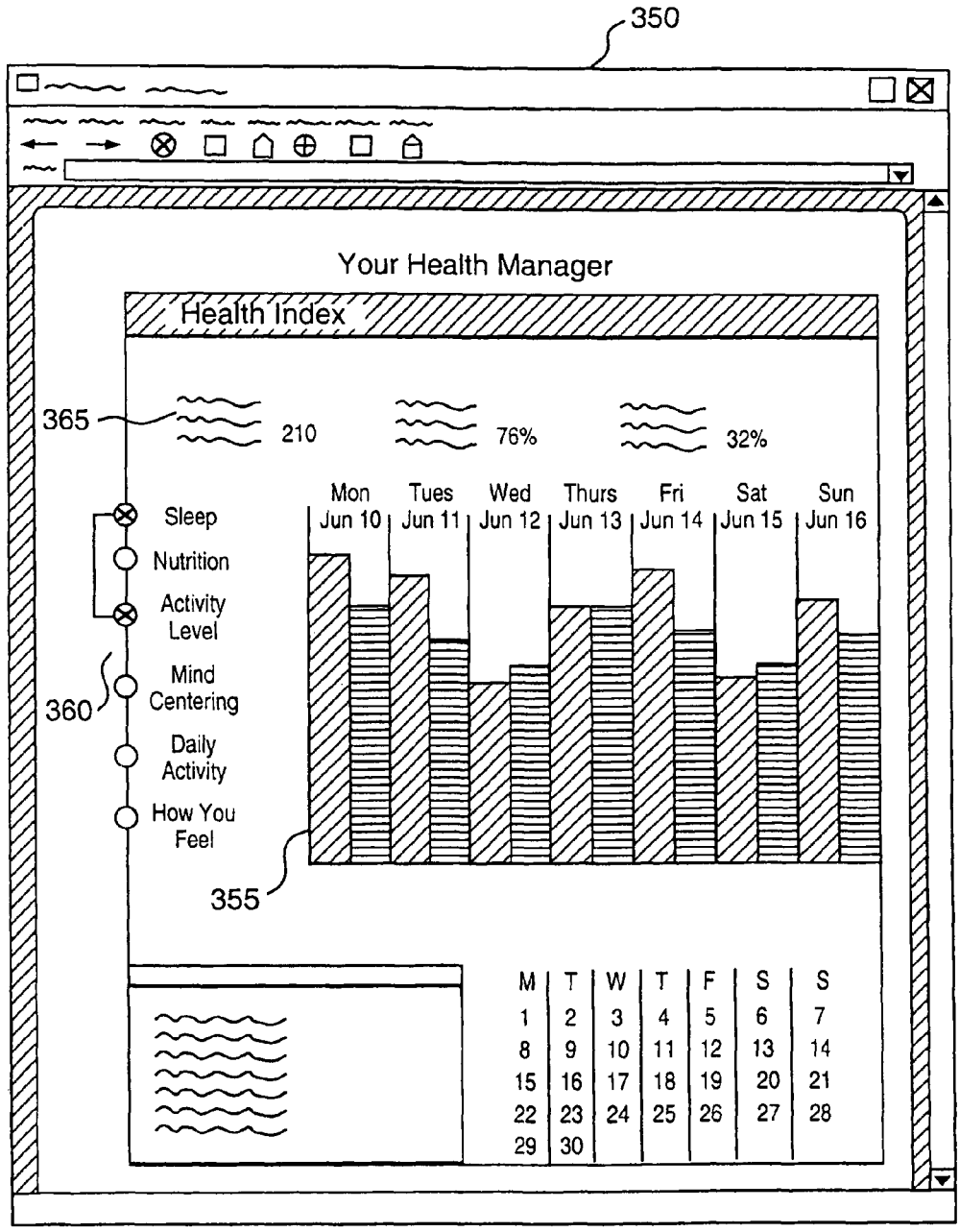
350
Your Health Manager
Health Index
365
210
76%
32%
Mon Jun 10
Tues Jun 11
Wed Jun 12
Thurs Jun 13
Fri Jun 14
Sat Jun 15
Sun Jun 16
Sleep
Nutrition
Activity Level
Mind Centering
360
Daily Activity
How You Feel
355
M T W T F S S
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30

FIG. 11

SYSTEM FOR DETECTING, MONITORING, AND REPORTING AN INDIVIDUAL'S PHYSIOLOGICAL OR CONTEXTUAL STATUS

RELATED APPLICATION DATA

This patent application is a continuation of U.S. application Ser. No. 09/595,660 filed Jun. 16, 2000, now issued as U.S. Pat. No. 7,689,437 and owned by the assignee of the present application.

FIELD OF THE INVENTION

The present invention relates to a system for monitoring health, wellness and fitness, and in particular, to a system for collecting and storing at a remote site data relating to an individual's physiological state, lifestyle, and various contextual parameters, and making such data and analytical information based on such data available to the individual, preferably over an electronic network.

BACKGROUND OF THE INVENTION

Research has shown that a large number of the top health problems in society are either caused in whole or in part by an unhealthy lifestyle. More and more, our society requires people to lead fast-paced, achievement-oriented lifestyles that often result in poor eating habits, high stress levels, lack of exercise, poor sleep habits and the inability to find the time to center the mind and relax. Recognizing this fact, people are becoming increasingly interested in establishing a healthier lifestyle.

Traditional medicine, embodied in the form of an HMO or similar organizations, does not have the time, the training, or the reimbursement mechanism to address the needs of those individuals interested in a healthier lifestyle. There have been several attempts to meet the needs of these individuals, including a profusion of fitness programs and exercise equipment, dietary plans, self-help books, alternative therapies, and most recently, a plethora of health information web sites on the Internet. Each of these attempts is targeted to empower the individual to take charge and get healthy. Each of these attempts, however, addresses only part of the needs of individuals seeking a healthier lifestyle and ignores many of the real barriers that most individuals face when trying to adopt a healthier lifestyle. These barriers include the fact that the individual is often left to himself or herself to find motivation, to implement a plan for achieving a healthier lifestyle, to monitor progress, and to brainstorm solutions when problems arise; the fact that existing programs are directed to only certain aspects of a healthier lifestyle, and rarely come as a complete package; and the fact that recommendations are often not targeted to the unique characteristics of the individual or his life circumstances.

SUMMARY OF THE INVENTION

A system is disclosed for detecting, monitoring and reporting human physiological information. The system includes a sensor device which generates at least one of data indicative of one or more physiological parameters and derived data from at least a portion of the data indicative of one or more physiological parameters when placed in proximity with at least a portion of the human body. The system also includes a central monitoring unit located remote from the sensor device. The central monitoring unit generates analytical status data from at least one of the data indicative of one or more physiological parameters, the derived data, and analytical status data that has previously been generated. The central monitoring unit also includes a data storage device for retrievably storing the data it receives and generates. The disclosed system also includes means for establishing electronic communication between the sensor device and the central monitoring unit. Examples may include various known types of long range wireless transmission devices, or a physical or a short range wireless coupling to a computer which in turn establishes electronic communication with the central monitoring unit over an electronic network such as the Internet. Also included in the system is a means for transmitting the data indicative of one or more physiological parameters, the derived data, and/or the analytical status data to a recipient, such as the individual or a third party authorized by the individual.

Also disclosed is a method of detecting, monitoring and reporting human physiological information. The method includes generating at least one of data indicative of one or more physiological parameters of an individual and derived data from at least a portion of the data indicative of one or more physiological parameters using a sensor device adapted to be placed in proximity with at least a portion of the human body. The at least one of the data indicative of one or more physiological parameters and the derived data are transmitted to a central monitoring unit remote from said sensor device and retrievably stored in a storage device. Analytical status data is generated from at least a portion of at least one of the data indicative of one or more physiological parameters, the derived data and the analytical status data, and at least one of the data indicative of one or more physiological parameters, the derived data and the analytical status data is transmitted to a recipient.

The sensor device includes one or more sensors for generating signals in response to physiological characteristics of the individual. The sensor device may also include a processor that is adapted to generate the data indicative of one or more physiological parameters from the signals generated by the one or more sensors. The processor may also be adapted to generate the derived data. Alternatively, the derived data may be generated by the central monitoring unit.

The central monitoring unit may be adapted to generate one or more web pages containing the data indicative of one or more physiological parameters, the derived data, and/or the analytical status data. The web pages generated by the central monitoring unit are accessible by the recipient over an electronic network, such as the Internet. Alternatively, the data indicative of one or more physiological parameters, the derived data, and/or the analytical status data may be transmitted to the recipient in a physical form such as mail or facsimile.

The system and method may also obtain life activities data of the individual and may use such life activities data when generating the analytical status data. Furthermore, the sensor device may also be adapted to generate data indicative of one or more contextual parameters of the individual. The system and method may then use the data indicative of one or more contextual parameters when generating the analytical status data.

Also disclosed is a system for monitoring the degree to which an individual has followed a suggested routine. The system includes a sensor device adapted to generate at least one of data indicative of one or more physiological parameters of the individual and derived data from at least a portion of the data indicative of one or more physiological parameters when the sensor device is placed in proximity with at least a

portion of the human body. Also included is a means for transmitting the data that is generated by the sensor device to a central monitoring unit remote from the sensor device and means for providing life activities data of the individual to the central monitoring unit. The central monitoring unit is adapted to generate and provide feedback to a recipient relating to the degree to which the individual has followed the suggested routine. The feedback is generated from at least a portion of at least one of the data indicative of one or more physiological parameters, the derived data, and the life activities data.

Also disclosed is a method of monitoring the degree to which an individual has followed a suggested routine. The method includes receiving, at a central monitoring unit, at least one of data indicative of one or more physiological parameters of said individual and derived data based on at least a portion of the data indicative of one or more physiological parameters, wherein the data indicative of one or more physiological parameters and the derived data are generated by a sensor device when placed in proximity with at least a portion of the human body. Also received at the central monitoring unit is life activities data of the individual. The method further includes generating at the central monitoring unit feedback relating to the degree to which the individual has followed the suggested routine, the feedback being generated from at least a portion of at least one of the data indicative of one or more physiological parameters of the individual, the derived data, and the life activities data, and providing the feedback to a recipient.

The suggested routine may include a plurality of categories, wherein the feedback is generated and provided with respect to each of the categories. Examples of the categories include nutrition, activity level, mind centering, sleep, and daily activities. The feedback may be provided in graphical form and may be contained in one or more web pages generated by the central monitoring unit. Alternatively, the feedback may be transmitted to the recipient in a physical form.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the present invention will be apparent upon consideration of the following detailed description of the present invention, taken in conjunction with the following drawings, in which like reference characters refer to like parts, and in which:

FIG. **1** is a diagram of an embodiment of a system for monitoring physiological data and lifestyle over an electronic network according to the present invention;

FIG. **2** is a block diagram of an embodiment of the sensor device shown in FIG. **1**;

FIG. **3** is a block diagram of an embodiment of the central monitoring unit shown in FIG. **1**;

FIG. **4** is a block diagram of an alternate embodiment of the central monitoring unit shown in FIG. **1**;

FIG. **5** is a representation of a preferred embodiment of the Health Manager web page according to an aspect of the present invention;

FIG. **6** is a representation of a preferred embodiment of the nutrition web page according to an aspect of the present invention;

FIG. **7** is a representation of a preferred embodiment of the activity level web page according to an aspect of the present invention;

FIG. **8** is a representation of a preferred embodiment of the mind centering web page according to an aspect of the present invention;

FIG. **9** is a representation of a preferred embodiment of the sleep web page according to an aspect of the present invention;

FIG. **10** is a representation of a preferred embodiment of the daily activities web page according to an aspect of the present invention; and

FIG. **11** is a representation of a preferred embodiment of the Health Index web page according to an aspect of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In general, according to the present invention, data relating to the physiological state, the lifestyle and certain contextual parameters of an individual is collected and transmitted, either subsequently or in real-time, to a site, preferably remote from the individual, where it is stored for later manipulation and presentation to a recipient, preferably over an electronic network such as the Internet. Contextual parameters as used herein means parameters relating to the environment, surroundings and location of the individual, including, but not limited to, air quality, sound quality, ambient temperature, global positioning and the like. Referring to FIG. **1**, located at user location **5** is sensor device **10** adapted to be placed in proximity with at least a portion of the human body. Sensor device **10** is preferably worn by an individual user on his or her body, for example as part of a garment such as a form fitting shirt, or as part of an arm band or the like. Sensor device **10**, includes one or more sensors, which are adapted to generate signals in response to physiological characteristics of an individual, and a microprocessor. Proximity as used herein means that the sensors of sensor device **10** are separated from the individual's body by a material or the like, or a distance such that the capabilities of the sensors are not impeded.

Sensor device **10** generates data indicative of various physiological parameters of an individual, such as the individual's heart rate, pulse rate, beat-to-beat heart variability, EKG or ECG, respiration rate, skin temperature, core body temperature, heat flow off the body, galvanic skin response or GSR, EMG, EEG, EOG, blood pressure, body fat, hydration level, activity level, oxygen consumption, glucose or blood sugar level, body position, pressure on muscles or bones, and UV radiation absorption. In certain cases, the data indicative of the various physiological parameters is the signal or signals themselves generated by the one or more sensors and in certain other cases the data is calculated by the microprocessor based on the signal or signals generated by the one or more sensors. Methods for generating data indicative of various physiological parameters and sensors to be used therefor are well known. Table 1 provides several examples of such well known methods and shows the parameter in question, the method used, the sensor device used, and the signal that is generated. Table 1 also provides an indication as to whether further processing based on the generated signal is required to generate the data.

TABLE 1

Parameter	Method	Sensor	Signal	Further Processing
Heart Rate	EKG	2 Electrodes	DC Voltage	Yes
Pulse Rate	BVP	LED Emitter and Optical Sensor	Change in Resistance	Yes
Beat-to-Beat Variability	Heart Rate	2 Electrodes	DC Voltage	Yes
EKG	Skin Surface Potentials	3-10 Electrodes	DC Voltage	No
Respiration Rate	Chest Volume Change	Strain Gauge	Change in Resistance	Yes
Skin Temperature	Surface Temperature Probe	Thermistors	Change in Resistance	Yes
Core Temperature	Esophageal or Rectal Probe	Thermistors	Change in Resistance	Yes
Heat Flow	Heat Flux	Thermopile	DC Voltage	Yes
Galvanic Skin Response	Skin Conductance	2 Electrodes	Change in Resistance	No
EMG	Skin Surface Potentials	3 Electrodes	DC Voltage	No
EEG	Skin Surface Potentials	Multiple Electrodes	DC Voltage	Yes
EOG	Eye Movement	Thin Film Piezoelectric Sensors	DC Voltage	Yes
Blood Pressure	Non-Invasive Korotkuff Sounds	Electronic Sphygromarometer	Change in Resistance	Yes
Body Fat	Body Impedance	2 Active Electrodes	Change in Impedance	Yes
Activity in Interpreted G Shocks per Minute	Body Movement	Accelerometer	DC Voltage, Capacitance Changes	Yes
Oxygen Consumption	Oxygen Uptake	Electro-chemical	DC Voltage Change	Yes
Glucose Level	Non-Invasive	Electro-chemical	DC Voltage Change	Yes
Body Position (e.g. supine, erect, sitting)	N/A	Mercury Switch Array	DC Voltage Change	Yes
Muscle Pressure	N/A	Thin Film Piezoelectric Sensors	DC Voltage Change	Yes
UV Radiation Absorption	N/A	UV Sensitive Photo Cells	DC Voltage Change	Yes

The types of data listed in Table 1 are intended to be examples of the types of data that can be generated by sensor device **10**. It is to be understood that other types of data relating to other parameters can be generated by sensor device **10** without departing from the scope of the present invention.

The microprocessor of sensor device **10** may be programmed to summarize and analyze the data. For example, the microprocessor can be programmed to calculate an average, minimum or maximum heart rate or respiration rate over a defined period of time, such as ten minutes. Sensor device **10** may be able to derive information relating to an individual's physiological state based on the data indicative of one or more physiological parameters. The microprocessor of sensor device **10** is programmed to derive such information using known methods based on the data indicative of one or more physiological parameters. Table 2 provides examples of the type of information that can be derived, and indicates some of the types of data that can be used therefor.

TABLE 2

Derived Information	Data Used
Ovulation	Skin temperature, core temperature, oxygen consumption
Sleep onset/wake	Beat-to-beat variability, heart rate, pulse rate, respiration rate, skin temperature, core temperature, heat flow, galvanic skin response, EMG, EEG, EOG, blood pressure, oxygen consumption
Calories burned	Heart rate, pulse rate, respiration rate, heat flow, activity, oxygen consumption
Basal metabolic rate	Heart rate, pulse rate, respiration rate, heat flow, activity, oxygen consumption
Basal temperature	Skin temperature, core temperature
Activity level	Heart rate, pulse rate, respiration rate, heat flow, activity, oxygen consumption
Stress level	EKG, beat-to-beat variability, heart rate, pulse rate, respiration rate, skin temperature, heat flow, galvanic skin response, EMG, EEG, blood pressure, activity, oxygen consumption

TABLE 2-continued

Derived Information	Data Used
Relaxation level	EKG, beat-to-beat variability, heart rate, pulse rate, respiration rate, skin temperature, heat flow, galvanic skin response, EMG, EEG, blood pressure, activity, oxygen consumption
Maximum oxygen consumption rate	EKG, heart rate, pulse rate, respiration rate, heat flow, blood pressure, activity, oxygen consumption
Rise time or the time it takes to rise from a resting rate to 85% of a target maximum	Heart rate, pulse rate, heat flow, oxygen consumption
Time in zone or the time heart rate was above 85% of a target maximum	Heart rate, pulse rate, heat flow, oxygen consumption
Recovery time or the time it takes heart rate to return to a resting rate after heart rate was above 85% of a target maximum	Heart rate, pulse rate, heat flow, oxygen consumption

Additionally, sensor device **10** may also generate data indicative of various contextual parameters relating to the environment surrounding the individual. For example, sensor device **10** can generate data indicative of the air quality, sound level/quality, light quality or ambient temperature near the individual, or even the global positioning of the individual. Sensor device **10** may include one or more sensors for generating signals in response to contextual characteristics relating to the environment surrounding the individual, the signals ultimately being used to generate the type of data described above. Such sensors are well known, as are methods for generating contextual parametric data such as air quality, sound level/quality, ambient temperature and global positioning.

FIG. **2** is a block diagram of an embodiment of sensor device **10**. Sensor device **10** includes at least one sensor **12** and microprocessor **20**. Depending upon the nature of the signal generated by sensor **12**, the signal can be sent through one or more of amplifier **14**, conditioning circuit **16**, and analog-to-digital converter **18**, before being sent to microprocessor **20**. For example, where sensor **12** generates an analog signal in need of amplification and filtering, that signal can be sent to amplifier **14**, and then on to conditioning circuit **16**, which may, for example, be a band pass filter. The amplified and conditioned analog signal can then be transferred to analog-to-digital converter **18**, where it is converted to a digital signal. The digital signal is then sent to microprocessor **20**. Alternatively, if sensor **12** generates a digital signal, that signal can be sent directly to microprocessor **20**.

A digital signal or signals representing certain physiological and/or contextual characteristics of the individual user may be used by microprocessor **20** to calculate or generate data indicative of physiological and/or contextual parameters of the individual user. Microprocessor **20** is programmed to derive information relating to at least one aspect of the individual's physiological state. It should be understood that microprocessor **20** may also comprise other forms of processors or processing devices, such as a microcontroller, or any other device that can be programmed to perform the functionality described herein.

The data indicative of physiological and/or contextual parameters can, according to one embodiment of the present invention, be sent to memory **22**, such as flash memory, where it is stored until uploaded in the manner to be described below. Although memory **22** is shown in FIG. **2** as a discrete element, it will be appreciated that it may also be part of microprocessor **20**. Sensor device **10** also includes input/output circuitry **24**, which is adapted to output and receive as input certain data signals in the manners to be described herein. Thus, memory **22** of the sensor device **10** will build up, over time, a store of data relating to the individual user's body and/or environment. That data is periodically uploaded from sensor device **10** and sent to remote central monitoring unit **30**, as shown in FIG. **1**, where it is stored in a database for subsequent processing and presentation to the user, preferably through a local or global electronic network such as the Internet. This uploading of data can be an automatic process that is initiated by sensor device **10** periodically or upon the happening of an event such as the detection by sensor device **10** of a heart rate below a certain level, or can be initiated by the individual user or some third party authorized by the user, preferably according to some periodic schedule, such as every day at 10:00 p.m. Alternatively, rather than storing data in memory **22**, sensor device **10** may continuously upload data in real time.

The uploading of data from sensor device **10** to central monitoring unit **30** for storage can be accomplished in various ways. In one embodiment, the data collected by sensor device **10** is uploaded by first transferring the data to personal computer **35** shown in FIG. **1** by means of physical connection **40**, which, for example, may be a serial connection such as an RS232 or USB port. This physical connection may also be accomplished by using a cradle, not shown, that is electronically coupled to personal computer **35** into which sensor device **10** can be inserted, as is common with many commercially available personal digital assistants. The uploading of data could be initiated by then pressing a button on the cradle or could be initiated automatically upon insertion of sensor device **10**. The data collected by sensor device **10** may be uploaded by first transferring the data to personal computer **35** by means of short-range wireless transmission, such as infrared or radio transmission, as indicated at **45**.

Once the data is received by personal computer **35**, it is optionally compressed and encrypted by any one of a variety of well known methods and then sent out over a local or global electronic network, preferably the Internet, to central monitoring unit **30**. It should be noted that personal computer **35** can be replaced by any computing device that has access to and that can transmit and receive data through the electronic network, such as, for example, a personal digital assistant such as the Palm VII sold by Palm, Inc., or the Blackberry 2-way pager sold by Research in Motion, Inc.

Alternatively, the data collected by sensor device **10**, after being encrypted and, optionally, compressed by microprocessor **20**, may be transferred to wireless device **50**, such as a 2-way pager or cellular phone, for subsequent long distance wireless transmission to local telco site **55** using a wireless protocol such as e-mail or as ASCII or binary data. Local telco site **55** includes tower **60** that receives the wireless transmission from wireless device **50** and computer **65** connected to

tower **60**. According to the preferred embodiment, computer **65** has access to the relevant electronic network, such as the Internet, and is used to transmit the data received in the form of the wireless transmission to the central monitoring unit **30** over the Internet. Although wireless device **50** is shown in FIG. **1** as a discrete device coupled to sensor device **10**, it or a device having the same or similar functionality may be embedded as part of sensor device **10**.

Sensor device **10** may be provided with a button to be used to time stamp events such as time to bed, wake time, and time of meals. These time stamps are stored in sensor device **10** and are uploaded to central monitoring unit **30** with the rest of the data as described above. The time stamps may include a digitally recorded voice message that, after being uploaded to central monitoring unit **30**, are translated using voice recognition technology into text or some other information format that can be used by central monitoring unit **30**.

In addition to using sensor device **10** to automatically collect physiological data relating to an individual user, a kiosk could be adapted to collect such data by, for example, weighing the individual, providing a sensing device similar to sensor device **10** on which an individual places his or her hand or another part of his or her body, or by scanning the individual's body using, for example, laser technology or an iStat blood analyzer. The kiosk would be provided with processing capability as described herein and access to the relevant electronic network, and would thus be adapted to send the collected data to the central monitoring unit **30** through the electronic network. A desktop sensing device, again similar to sensor device **10**, on which an individual places his or her hand or another part of his or her body may also be provided. For example, such a desktop sensing device could be a blood pressure monitor in which an individual places his or her arm. An individual might also wear a ring having a sensor device **10** incorporated therein. A base, not shown, could then be provided which is adapted to be coupled to the ring. The desktop sensing device or the base just described may then be coupled to a computer such as personal computer **35** by means of a physical or short range wireless connection so that the collected data could be uploaded to central monitoring unit **30** over the relative electronic network in the manner described above. A mobile device such as, for example, a personal digital assistant, might also be provided with a sensor device **10** incorporated therein. Such a sensor device **10** would be adapted to collect data when mobile device is placed in proximity with the individual's body, such as by holding the device in the palm of one's hand, and upload the collected data to central monitoring unit **30** in any of the ways described herein.

Furthermore, in addition to collecting data by automatically sensing such data in the manners described above, individuals can also manually provide data relating to various life activities that is ultimately transferred to and stored at central monitoring unit **30**. An individual user can access a web site maintained by central monitoring unit **30** and can directly input information relating to life activities by entering text freely, by responding to questions posed by the web site, or by clicking through dialog boxes provided by the web site. Central monitoring unit **30** can also be adapted to periodically send electronic mail messages containing questions designed to elicit information relating to life activities to personal computer **35** or to some other device that can receive electronic mail, such as a personal digital assistant, a pager, or a cellular phone. The individual would then provide data relating to life activities to central monitoring unit **30** by responding to the appropriate electronic mail message with the relevant data. Central monitoring unit **30** may also be adapted to place a telephone call to an individual user in which certain questions would be posed to the individual user. The user could respond to the questions by entering information using a telephone keypad, or by voice, in which case conventional voice recognition technology would be used by central monitoring unit **30** to receive and process the response. The telephone call may also be initiated by the user, in which case the user could speak to a person directly or enter information using the keypad or by voice/voice recognition technology. Central monitoring unit **30** may also be given access to a source of information controlled by the user, for example the user's electronic calendar such as that provided with the Outlook product sold by Microsoft Corporation of Redmond, Wash., from which it could automatically collect information. The data relating to life activities may relate to the eating, sleep, exercise, mind centering or relaxation, and/or daily living habits, patterns and/or activities of the individual. Thus, sample questions may include: What did you have for lunch today? What time did you go to sleep last night? What time did you wake up this morning? How long did you run on the treadmill today?

Feedback may also be provided to a user directly through sensor device **10** in a visual form, for example through an LED or LCD or by constructing sensor device **10**, at least in part, of a thermochromatic plastic, in the form of an acoustic signal or in the form of tactile feedback such as vibration. Such feedback may be a reminder or an alert to eat a meal or take medication or a supplement such as a vitamin, to engage in an activity such as exercise or meditation, or to drink water when a state of dehydration is detected. Additionally, a reminder or alert can be issued in the event that a particular physiological parameter such as ovulation has been detected, a level of calories burned during a workout has been achieved or a high heart rate or respiration rate has been encountered.

As will be apparent to those of skill in the art, it may be possible to "download" data from central monitoring unit **30** to sensor device **10**. The flow of data in such a download process would be substantially the reverse of that described above with respect to the upload of data from sensor device **10**. Thus, it is possible that the firmware of microprocessor **20** of sensor device **10** can be updated or altered remotely, i.e., the microprocessor can be reprogrammed, by downloading new firmware to sensor device **10** from central monitoring unit **30** for such parameters as timing and sample rates of sensor device **10**. Also, the reminders/alerts provided by sensor device **10** may be set by the user using the web site maintained by central monitoring unit **30** and subsequently downloaded to the sensor device **10**.

Referring to FIG. **3**, a block diagram of an embodiment of central monitoring unit **30** is shown. Central monitoring unit **30** includes CSU/DSU **70** which is connected to router **75**, the main function of which is to take data requests or traffic, both incoming and outgoing, and direct such requests and traffic for processing or viewing on the web site maintained by central monitoring unit **30**. Connected to router **75** is firewall **80**. The main purpose of firewall **80** is to protect the remainder of central monitoring unit **30** from unauthorized or malicious intrusions. Switch **85**, connected to firewall **80**, is used to direct data flow between middleware servers **95***a* through **95***c* and database server **110**. Load balancer **90** is provided to spread the workload of incoming requests among the identically configured middleware servers **95***a* through **95***c*. Load balancer **90**, a suitable example of which is the F5 ServerIron product sold by Foundry Networks, Inc. of San Jose, Calif. analyzes the availability of each middleware server **95***a* through **95***c*, and the amount of system resources being used

in each middleware server **95***a* through **95***c*, in order to spread tasks among them appropriately.

Central monitoring unit **30** includes network storage device **100**, such as a storage area network or SAN, which acts as the central repository for data. In particular, network storage device **100** comprises a database that stores all data gathered for each individual user in the manners described above. An example of a suitable network storage device **100** is the Symmetrix product sold by EMC Corporation of Hopkinton, Mass. Although only one network storage device **100** is shown in FIG. **3**, it will be understood that multiple network storage devices of various capacities could be used depending on the data storage needs of central monitoring unit **30**. Central monitoring unit **30** also includes database server **110** which is coupled to network storage device **100**. Database server **110** is made up of two main components: a large scale multiprocessor server and an enterprise type software server component such as the 8/8i component sold by Oracle Corporation of Redwood City, Calif., or the 506 7 component sold by Microsoft Corporation of Redmond, Wash. The primary functions of database server **110** are that of providing access upon request to the data stored in network storage device **100**, and populating network storage device **100** with new data. Coupled to network storage device **100** is controller **115**, which typically comprises a desktop personal computer, for managing the data stored in network storage device **100**.

Middleware servers **95***a* through **95***c*, a suitable example of which is the 22OR Dual Processor sold by Sun Microsystems, Inc. of Palo Alto, Calif., each contain software for generating and maintaining the corporate or home web page or pages of the web site maintained by central monitoring unit **30**. As is known in the art, a web page refers to a block or blocks of data available on the World-Wide Web comprising a file or files written in Hypertext Markup Language or HTML, and a web site commonly refers to any computer on the Internet running a World-Wide Web server process. The corporate or home web page or pages are the opening or landing web page or pages that are accessible by all members of the general public that visit the site by using the appropriate uniform resource locator or URL. As is known in the art, URLs are the form of address used on the World-Wide Web and provide a standard way of specifying the location of an object, typically a web page, on the Internet. Middleware servers **95***a* through **95***c* also each contain software for generating and maintaining the web pages of the web site of central monitoring unit **30** that can only be accessed by individuals that register and become members of central monitoring unit **30**. The member users will be those individuals who wish to have their data stored at central monitoring unit **30**. Access by such member users is controlled using passwords for security purposes. Preferred embodiments of those web pages are described in detail below and are generated using collected data that is stored in the database of network storage device **100**.

Middleware servers **95***a* through **95***c* also contain software for requesting data from and writing data to network storage device **100** through database server **110**. When an individual user desires to initiate a session with the central monitoring unit **30** for the purpose of entering data into the database of network storage device **100**, viewing his or her data stored in the database of network storage device **100**, or both, the user visits the home web page of central monitoring unit **30** using a browser program such as Internet Explorer distributed by Microsoft Corporation of Redmond, Wash., and logs in as a registered user. Load balancer **90** assigns the user to one of the middleware servers **95***a* through **95***c*, identified as the chosen middleware server. A user will preferably be assigned to a chosen middleware server for each entire session. The chosen middleware server authenticates the user using any one of many well known methods, to ensure that only the true user is permitted to access the information in the database. A member user may also grant access to his or her data to a third party such as a health care provider or a personal trainer. Each authorized third party may be given a separate password and may view the member user's data using a conventional browser. It is therefore possible for both the user and the third party to be the recipient of the data.

When the user is authenticated, the chosen middleware server requests, through database server **110**, the individual user's data from network storage device **100** for a predetermined time period. The predetermined time period is preferably thirty days. The requested data, once received from network storage device **100**, is temporarily stored by the chosen middleware server in cache memory. The cached data is used by the chosen middleware server as the basis for presenting information, in the form of web pages, to the user again through the user's browser. Each middleware server **95***a* through **95***c* is provided with appropriate software for generating such web pages, including software for manipulating and performing calculations utilizing the data to put the data in appropriate format for presentation to the user. Once the user ends his or her session, the data is discarded from cache. When the user initiates a new session, the process for obtaining and caching data for that user as described above is repeated. This caching system thus ideally requires that only one call to the network storage device **100** be made per session, thereby reducing the traffic that database server **110** must handle. Should a request from a user during a particular session require data that is outside of a predetermined time period of cached data already retrieved, a separate call to network storage device **100** may be performed by the chosen middleware server. The predetermined time period should be chosen, however, such that such additional calls are minimized. Cached data may also be saved in cache memory so that it can be reused when a user starts a new session, thus eliminating the need to initiate a new call to network storage device **100**.

As described in connection with Table 2, the microprocessor of sensor device **10** may be programmed to derive information relating to an individual's physiological state based on the data indicative of one or more physiological parameters. Central monitoring unit **30**, and preferably middleware servers **95***a* through **95***c*, may also be similarly programmed to derive such information based on the data indicative of one or more physiological parameters.

It is also contemplated that a user will input additional data during a session, for example, information relating to the user's eating or sleeping habits. This additional data is preferably stored by the chosen middleware server in a cache during the duration of the user's session. When the user ends the session, this additional new data stored in a cache is transferred by the chosen middleware server to database server **110** for population in network storage device **100**. Alternatively, in addition to being stored in a cache for potential use during a session, the input data may also be immediately transferred to database server **110** for population in network storage device **100**, as part of a write-through cache system which is well known in the art.

Data collected by sensor device **10** shown in FIG. **1** is periodically uploaded to central monitoring unit **30**. Either by long distance wireless transmission or through personal computer **35**, a connection to central monitoring unit **30** is made through an electronic network, preferably the Internet. In particular, connection is made to load balancer **90** through CSU/DSU **70**, router **75**, firewall **80** and switch **85**. Load

balancer **90** then chooses one of the middleware servers **95***a* through **95***c* to handle the upload of data, hereafter called the chosen middleware server. The chosen middleware server authenticates the user using any one of many well known methods. If authentication is successful, the data is uploaded to the chosen middleware server as described above, and is ultimately transferred to database server **110** for population in the network storage device **100**.

Referring to FIG. **4**, an alternate embodiment of central monitoring unit **30** is shown. In addition to the elements shown and described with respect to FIG. **3**, the embodiment of the central monitoring unit **30** shown in FIG. **4** includes a mirror network storage device **120** which is a redundant backup of network storage device **100**. Coupled to mirror network storage device **120** is controller **122**. Data from network storage device **100** is periodically copied to mirror network storage device **120** for data redundancy purposes.

Third parties such as insurance companies or research institutions may be given access, possibly for a fee, to certain of the information stored in mirror network storage device **120**. Preferably, in order to maintain the confidentiality of the individual users who supply data to central monitoring unit **30**, these third parties are not given access to such user's individual database records, but rather are only given access to the data stored in mirror network storage device **120** in aggregate form. Such third parties may be able to access the information stored in mirror network storage device **120** through the Internet using a conventional browser program. Requests from third parties may come in through CSU/DSU **70**, router **75**, firewall **80** and switch **85**. In the embodiment shown in FIG. **4**, a separate load balancer **130** is provided for spreading tasks relating to the accessing and presentation of data from mirror drive array **120** among identically configured middleware servers **135***a* through **135***c*. Middleware servers **135***a* through **135***c* each contain software for enabling the third parties to, using a browser, formulate queries for information from mirror network storage device **120** through separate database server **125**. Middleware servers **135***a* through **135***c* also contain software for presenting the information obtained from mirror network storage device **120** to the third parties over the Internet in the form of web pages. In addition, the third parties can choose from a series of prepared reports that have information packaged along subject matter lines, such as various demographic categories.

As will be apparent to one of skill in the art, instead of giving these third parties access to the backup data stored in mirror network storage device **120**, the third parties may be given access to the data stored in network storage device **100**. Also, instead of providing load balancer **130** and middleware servers **135***a* through **135***c*, the same functionality, although at a sacrificed level of performance, could be provided by load balancer **90** and middleware servers **95***a* through **95***c*.

When an individual user first becomes a registered user or member, that user completes a detailed survey. The purposes of the survey are to: identify unique characteristics/circumstances for each user that they might need to address in order to maximize the likelihood that they will implement and maintain a healthy lifestyle as suggested by central monitoring unit **30**; gather baseline data which will be used to set initial goals for the individual user and facilitate the calculation and display of certain graphical data output such as the Health Index pistons; identify unique user characteristics and circumstances that will help central monitoring unit **30** customize the type of content provided to the user in the Health Manager's Daily Dose; and identify unique user characteristics and circumstances that the Health Manager can guide the user to address as possible barriers to a healthy lifestyle through the problem-solving function of the Health Manager.

The specific information to be surveyed may include: key individual temperamental characteristics, including activity level, regularity of eating, sleeping, and bowel habits, initial response to situations, adaptability, persistence, threshold of responsiveness, intensity of reaction, and quality of mood; the user's level of independent functioning, i.e., self-organization and management, socialization, memory, and academic achievement skills; the user's ability to focus and sustain attention, including the user's level of arousal, cognitive tempo, ability to filter distractions, vigilance, and self-monitoring; the user's current health status including current weight, height, and blood pressure, most recent general physician visit, gynecological exam, and other applicable physician/healthcare contacts, current medications and supplements, allergies, and a review of current symptoms and/or health-related behaviors; the user's past health history, i.e., illnesses/surgeries, family history, and social stress events, such as divorce or loss of a job, that have required adjustment by the individual; the user's beliefs, values and opinions about health priorities, their ability to alter their behavior and, what might contribute to stress in their life, and how they manage it; the user's degree of self-awareness, empathy, empowerment, and self-esteem, and the user's current daily routines for eating, sleeping, exercise, relaxation and completing activities of daily living; and the user's perception of the temperamental characteristics of two key persons in their life, for example, their spouse, a friend, a co-worker, or their boss, and whether there are clashes present in their relationships that might interfere with a healthy lifestyle or contribute to stress.

Each member user will have access, through the home web page of central monitoring unit **30**, to a series of web pages customized for that user, referred to as the Health Manager. The opening Health Manager web page **150** is shown in FIG. **5**. The Health Manager web pages are the main workspace area for the member user. The Health Manager web pages comprise a utility through which central monitoring unit **30** provides various types and forms of data, commonly referred to as analytical status data, to the user that is generated from the data it collects or generates, namely one or more of: the data indicative of various physiological parameters generated by sensor device **10**; the data derived from the data indicative of various physiological parameters; the data indicative of various contextual parameters generated by sensor device **10**; and the data input by the user. Analytical status data is characterized by the application of certain utilities or algorithms to convert one or more of the data indicative of various physiological parameters generated by sensor device **10**, the data derived from the data indicative of various physiological parameters, the data indicative of various contextual parameters generated by sensor device **10**, and the data input by the user into calculated health, wellness and lifestyle indicators. For example, based on data input by the user relating to the foods he or she has eaten, things such as calories and amounts of proteins, fats, carbohydrates, and certain vitamins can be calculated. As another example, skin temperature, heart rate, respiration rate, heat flow and/or GSR can be used to provide an indicator to the user of his or her stress level over a desired time period. As still another example, skin temperature, heat flow, beat-to-beat heart variability, heart rate, pulse rate, respiration rate, core temperature, galvanic skin response, EMG, EEG, EOG, blood pressure, oxygen consumption, ambient sound and body movement or motion as detected by a device such as an accelerometer can be used to provide indicators to the user of his or her sleep patterns over a desired time period.

Located on the opening Health Manager web page **150** is Health Index **155**. Health Index **155** is a graphical utility used to measure and provide feedback to member users regarding their performance and the degree to which they have succeeded in reaching a healthy daily routine suggested by central monitoring unit **30**. Health Index **155** thus provides an indication for the member user to track his or her progress. Health Index **155** includes six categories relating to the user's health and lifestyle: Nutrition, Activity Level, Mind Centering, Sleep, Daily Activities and How You Feel. The Nutrition category relates to what, when and how much a person eats and drinks. The Activity Level category relates to how much a person moves around. The Mind Centering category relates to the quality and quantity of time a person spends engaging in some activity that allows the body to achieve a state of profound relaxation while the mind becomes highly alert and focused. The Sleep category relates to the quality and quantity of a person's sleep. The Daily Activities category relates to the daily responsibilities and health risks people encounter. Finally, the How You Feel category relates to the general perception that a person has about how they feel on a particular day. Each category has an associated level indicator or piston that indicates, preferably on a scale ranging from poor to excellent, how the user is performing with respect to that category.

When each member user completes the initial survey described above, a profile is generated that provides the user with a summary of his or her relevant characteristics and life circumstances. A plan and/or set of goals is provided in the form of a suggested healthy daily routine. The suggested healthy daily routine may include any combination of specific suggestions for incorporating proper nutrition, exercise, mind centering, sleep, and selected activities of daily living in the user's life. Prototype schedules may be offered as guides for how these suggested activities can be incorporated into the user's life. The user may periodically retake the survey, and based on the results, the items discussed above will be adjusted accordingly.

The Nutrition category is calculated from both data input by the user and sensed by sensor device **10**. The data input by the user comprises the time and duration of breakfast, lunch, dinner and any snacks, and the foods eaten, the supplements such as vitamins that are taken, and the water and other liquids consumed during a relevant, pre-selected time period. Based upon this data and on stored data relating to known properties of various foods, central monitoring unit **30** calculates well known nutritional food values such as calories and amounts of proteins, fats, carbohydrates, vitamins, etc., consumed.

The Nutrition Health Index piston level is preferably determined with respect to the following suggested healthy daily routine: eat at least three meals; eat a varied diet consisting of 6-11 servings of bread, pasta, cereal, and rice, 2-4 servings fruit, 3-5 servings of vegetables, 2-3 servings of fish, meat, poultry, dry beans, eggs, and nuts, and 2-3 servings of milk, yogurt and cheese; and drink 8 or more 8 ounce glasses of water. This routine may be adjusted based on information about the user, such as sex, age, height and/or weight. Certain nutritional targets may also be set by the user or for the user, relating to daily calories, protein, fiber, fat, carbohydrates, and/or water consumption and percentages of total consumption. Parameters utilized in the calculation of the relevant piston level include the number of meals per day, the number of glasses of water, and the types and amounts of food eaten each day as input by the user.

Nutritional information is presented to the user through nutrition web page **160** as shown in FIG. **6**. The preferred nutritional web page **160** includes nutritional fact charts **165** and **170** which illustrate actual and target nutritional facts, respectively as pie charts, and nutritional intake charts **175** and **180** which show total actual nutritional intake and target nutritional intake, respectively as pie charts. Nutritional fact charts **165** and **170** preferably show a percentage breakdown of items such as carbohydrates, protein and fat, and nutritional intake charts **175** and **180** are preferably broken down to show components such as total and target calories, fat, carbohydrates, protein, and vitamins. Web page **160** also includes meal and water consumption tracking **185** with time entries, hyperlinks **190** which allow the user to directly access nutrition-related news items and articles, suggestions for refining or improving daily routine with respect to nutrition and affiliate advertising elsewhere on the network, and calendar **195** for choosing between views having variable and selectable time periods. The items shown at **190** may be selected and customized based on information learned about the individual in the survey and on their performance as measured by the Health Index.

The Activity Level category of Health Index **155** is designed to help users monitor how and when they move around during the day and utilizes both data input by the user and data sensed by sensor device **10**. The data input by the user may include details regarding the user's daily activities, for example the fact that the user worked at a desk from 8 a.m. to 5 p.m. and then took an aerobics class from 6 p.m. to 7 p.m. Relevant data sensed by sensor device **10** may include heart rate, movement as sensed by a device such as an accelerometer, heat flow, respiration rate, calories burned, GSR and hydration level, which may be derived by sensor device **60** or central monitoring unit **30**. Calories burned may be calculated in a variety of manners, including: the multiplication of the type of exercise input by the user by the duration of exercise input by the user; sensed motion multiplied by time of motion multiplied by a filter constant; or sensed heat flux multiplied by time multiplied by a filter constant.

The Activity Level Health Index piston level is preferably determined with respect to a suggested healthy daily routine that includes: exercising aerobically for a pre-set time period, preferably 20 minutes, or engaging in a vigorous lifestyle activity for a pre-set time period, preferably one hour, and burning at least a minimum target number of calories, preferably 205 calories, through the aerobic exercise and/or lifestyle activity. The minimum target number of calories may be set according to information about the user, such as sex, age, height and/or weight. Parameters utilized in the calculation of the relevant piston level include the amount of time spent exercising aerobically or engaging in a vigorous lifestyle activity as input by the user and/or sensed by sensor device **10**, and the number of calories burned above pre-calculated energy expenditure parameters.

Information regarding the individual user's movement is presented to the user through activity level web page **200** shown in FIG. **7**, which may include activity graph **205** in the form of a bar graph, for monitoring the individual user's activities in one of three categories: high, medium and low intensity with respect to a pre-selected unit of time. Activity percentage chart **210**, in the form or a pie chart, may also be provided for showing the percentage of a pre-selected time period, such as one day, that the user spent in each category. Activity level web page **200** may also include calorie section **215** for displaying items such as total calories burned, daily target calories burned, total caloric intake, and duration of aerobic activity. Finally, activity level web page **200** may include at least one hyperlink **220** to allow a user to directly access relevant news items and articles, suggestions for refining or improving daily routine with respect to activity level

and affiliate advertising elsewhere on the network. Activity level web page **200** may be viewed in a variety of formats, and may include user-selectable graphs and charts such as a bar graph, pie chart, or both, as selectable by Activity level check boxes **225**. Activity level calendar **230** is provided for selecting among views having variable and selectable time periods. The items shown at **220** may be selected and customized based on information learned about the individual in the survey and on their performance as measured by the Health Index.

The Mind Centering category of Health Index **155** is designed to help users monitor the parameters relating to time spent engaging in certain activities which allow the body to achieve a state of profound relaxation while the mind becomes focused, and is based upon both data input by the user and data sensed by the sensor device **10**. In particular, a user may input the beginning and end times of relaxation activities such as yoga or meditation. The quality of those activities as determined by the depth of a mind centering event can be measured by monitoring parameters including skin temperature, heart rate, respiration rate, and heat flow as sensed by sensor device **10**. Percent change in GSR as derived either by sensor device **10** or central monitoring unit **30** may also be utilized.

The Mind Centering Health Index piston level is preferably calculated with respect to a suggested healthy daily routine that includes participating each day in an activity that allows the body to achieve profound relaxation while the mind stays highly focused for at least fifteen minutes. Parameters utilized in the calculation of the relevant piston level include the amount of time spent in a mind centering activity, and the percent change in skin temperature, heart rate, respiration rate, heat flow or GSR as sensed by sensor device **10** compared to a baseline which is an indication of the depth or quality of the mind centering activity.

Information regarding the time spent on self-reflection and relaxation is presented to the user through mind centering web page **250** shown in FIG. **8**. For each mind centering activity, referred to as a session, the preferred mind centering web page **250** includes the time spent during the session, shown at **255**, the target time, shown at **260**, comparison section **265** showing target and actual depth of mind centering, or focus, and a histogram **270** that shows the overall level of stress derived from such things as skin temperature, heart rate, respiration rate, heat flow and/or GSR. In comparison section **265**, the human figure outline showing target focus is solid, and the human figure outline showing actual focus ranges from fuzzy to solid depending on the level of focus. The preferred mind centering web page may also include an indication of the total time spent on mind centering activities, shown at **275**, hyperlinks **280** which allow the user to directly access relevant news items and articles, suggestions for refining or improving daily routine with respect to mind centering and affiliate advertising, and a calendar **285** for choosing among views having variable and selectable time periods. The items shown at **280** may be selected and customized based on information learned about the individual in the survey and on their performance as measured by the Health Index.

The Sleep category of Health Index **155** is designed to help users monitor their sleep patterns and the quality of their sleep. It is intended to help users learn about the importance of sleep in their healthy lifestyle and the relationship of sleep to circadian rhythms, being the normal daily variations in body functions. The Sleep category is based upon both data input by the user and data sensed by sensor device **10**. The data input by the user for each relevant time interval includes the times the user went to sleep and woke up and a rating of the quality of sleep. As noted in Table 2, the data from sensor device **10** that is relevant includes skin temperature, heat flow, beat-to-beat heart variability, heart rate, pulse rate, respiration rate, core temperature, galvanic skin response, EMG, EEG, EOG, blood pressure, and oxygen consumption. Also relevant is ambient sound and body movement or motion as detected by a device such as an accelerometer. This data can then be used to calculate or derive sleep onset and wake time, sleep interruptions, and the quality and depth of sleep.

The Sleep Health Index piston level is determined with respect to a healthy daily routine including getting a minimum amount, preferably eight hours, of sleep each night and having a predictable bed time and wake time. The specific parameters which determine the piston level calculation include the number of hours of sleep per night and the bed time and wake time as sensed by sensor device **10** or as input by the user, and the quality of the sleep as rated by the user or derived from other data.

Information regarding sleep is presented to the user through sleep web page **290** shown in FIG. **9**. Sleep web page **290** includes a sleep duration indicator **295**, based on either data from sensor device **10** or on data input by the user, together with user sleep time indicator **300** and wake time indicator **305**. A quality of sleep rating **310** input by the user may also be utilized and displayed. If more than a one day time interval is being displayed on sleep web page **290**, then sleep duration indicator **295** is calculated and displayed as a cumulative value, and sleep time indicator **300**, wake time indicator **305** and quality of sleep rating **310** are calculated and illustrated as averages. Sleep web page **290** also includes a user-selectable sleep graph **315** which calculates and displays one sleep related parameter over a pre-selected time interval. For illustrative purposes, FIG. **9** shows heat flow over a one-day period, which tends to be lower during sleeping hours and higher during waking hours. From this information, a person's bio-rhythms can be derived. Sleep graph **315** may also include a graphical representation of data from an accelerometer incorporated in sensor device **10** which monitors the movement of the body. The sleep web page **290** may also include hyperlinks **320** which allow the user to directly access sleep related news items and articles, suggestions for refining or improving daily routine with respect to sleep and affiliate advertising available elsewhere on the network, and a sleep calendar **325** for choosing a relevant time interval. The items shown at **320** may be selected and customized based on information learned about the individual in the survey and on their performance as measured by the Health Index.

The Activities of Daily Living category of Health Index **155** is designed to help users monitor certain health and safety related activities and risks and is based entirely on data input by the user. The Activities of Daily Living category is divided into four sub-categories: personal hygiene, which allows the user to monitor activities such as brushing and flossing his or her teeth and showering; health maintenance, that tracks whether the user is taking prescribed medication or supplements and allows the user to monitor tobacco and alcohol consumption and automobile safety such as seat belt use; personal time, that allows the user to monitor time spent socially with family and friends, leisure, and mind centering activities; and responsibilities, that allows the user to monitor certain work and financial activities such as paying bills and household chores.

The Activities of Daily Living Health Index piston level is preferably determined with respect to the healthy daily routine described below. With respect to personal hygiene, the

routine requires that the users shower or bathe each day, brush and floss teeth each day, and maintain regular bowel habits. With respect to health maintenance, the routine requires that the user take medications and vitamins and/or supplements, use a seat belt, refrain from smoking, drink moderately, and monitor health each day with the Health Manager. With respect to personal time, the routine requires the users to spend at least one hour of quality time each day with family and/or friends, restrict work time to a maximum of nine hours a day, spend some time on a leisure or play activity each day, and engage in a mind stimulating activity. With respect to responsibilities, the routine requires the users to do household chores, pay bills, be on time for work, and keep appointments. The piston level is calculated based on the degree to which the user completes a list of daily activities as determined by information input by the user.

Information relating to these activities is presented to the user through daily activities web page **330** shown in FIG. **10**. In preferred daily activities web page **330**, activities chart **335**, selectable for one or more of the sub-categories, shows whether the user has done what is required by the daily routine. A colored or shaded box indicates that the user has done the required activity, and an empty, non-colored or shaded box indicates that the user has not done the activity. Activities chart **335** can be created and viewed in selectable time intervals. For illustrative purposes, FIG. **10** shows the personal hygiene and personal time sub-categories for a particular week. In addition, daily activities web page **330** may include daily activity hyperlinks **340** which allow the user to directly access relevant news items and articles, suggestions for improving or refining daily routine with respect to activities of daily living and affiliate advertising, and a daily activities calendar **345** for selecting a relevant time interval. The items shown at **340** may be selected and customized based on information learned about the individual in the survey and on their performance as measured by the Health Index.

The How You Feel category of Health Index **155** is designed to allow users to monitor their perception of how they felt on a particular day, and is based on information, essentially a subjective rating, that is input directly by the user. A user provides a rating, preferably on a scale of 1 to 5, with respect to the following nine subject areas: mental sharpness; emotional and psychological well being; energy level; ability to cope with life stresses; appearance; physical well being; self-control; motivation; and comfort in relating to others. Those ratings are averaged and used to calculate the relevant piston level.

Referring to FIG. **11**, Health Index web page **350** is shown. Health Index web page **350** enables users to view the performance of their Health Index over a user selectable time interval including any number of consecutive or non-consecutive days. Using Health Index selector buttons **360**, the user can select to view the Health Index piston levels for one category, or can view a side-by-side comparison of the Health Index piston levels for two or more categories. For example, a user might want to just turn on Sleep to see if their overall sleep rating improved over the previous month, much in the same way they view the performance of their favorite stock. Alternatively, Sleep and Activity Level might be simultaneously displayed in order to compare and evaluate Sleep ratings with corresponding Activity Level ratings to determine if any day-to-day correlations exist. Nutrition ratings might be displayed with How You Feel for a pre-selected time interval to determine if any correlation exists between daily eating habits and how they felt during that interval. For illustrative purposes, FIG. **11** illustrates a comparison of Sleep and Activity Level piston levels for the week of June 10 through June 16. Health Index web page **350** also includes tracking calculator **365** that displays access information and statistics such as the total number of days the user has logged in and used the Health Manager, the percentage of days the user has used the Health Manager since becoming a subscriber, and percentage of time the user has used the sensor device **10** to gather data.

Referring again to FIG. **5**, opening Health Manager web page **150** may include a plurality of user selectable category summaries **156***a* through **156***f*, one corresponding to each of the Health Index **155** categories. Each category summary **156***a* through **156***f* presents a pre-selected filtered subset of the data associated with the corresponding category. Nutrition category summary **156***a* displays daily target and actual caloric intake. Activity Level category summary **156***b* displays daily target and actual calories burned. Mind Centering category summary **156***c* displays target and actual depth of mind centering or focus. Sleep category summary **156***d* displays target sleep, actual sleep, and a sleep quality rating. Daily Activities category summary **156***e* displays a target and actual score based on the percentage of suggested daily activities that are completed. The How You Feel category summary **156***f* shows a target and actual rating for the day.

Opening Health Manager web page **150** also may include Daily Dose section **157** which provides, on a daily time interval basis, information to the user, including, but not limited to, hyperlinks to news items and articles, commentary and reminders to the user based on tendencies, such as poor nutritional habits, determined from the initial survey. The commentary for Daily Dose **157** may, for example, be a factual statement that drinking **8** glasses of water a day can reduce the risk of colon cancer by as much as 32%, accompanied by a suggestion to keep a cup of water by your computer or on your desk at work and refill often. Opening Health Manager web page **150** also may include a Problem Solver section **158** that actively evaluates the user's performance in each of the categories of Health Index **155** and presents suggestions for improvement. For example, if the system detects that a user's Sleep levels have been low, which suggest that the user has been having trouble sleeping, Problem Solver **158** can provide suggestions for way to improve sleep. Problem Solver **158** also may include the capability of user questions regarding improvements in performance. Opening Health Manager web page **150** may also include a Daily Data section **159** that launches an input dialog box. The input dialog box facilitates input by the user of the various data required by the Health Manager. As is known in the art, data entry may be in the form of selection from pre-defined lists or general free form text input. Finally, opening Health Manager web page **150** may include Body Stats section **161** which may provide information regarding the user's height, weight, body measurements, body mass index or BMI, and vital signs such as heart rate, blood pressure or any of the identified physiological parameters.

The terms and expressions which have been employed herein are used as terms of description and not as limitation, and there is no intention in the use of such terms and expressions of excluding equivalents of the features shown and described or portions thereof, it being recognized that various modifications are possible within the scope of the invention claimed. Although particular embodiments of the present invention have been illustrated in the foregoing detailed description, it is to be further understood that the present invention is not to be limited to just the embodiments disclosed, but that they are capable of numerous rearrangements, modifications and substitutions.

What is claimed is:

1. A system for detecting, monitoring, and reporting a status of an individual to a user, the system comprising:

a first sensor adapted to generate data indicative of a first physiological parameter of the individual if said first sensor is in proximity to the individual;

a second sensor adapted to generate data indicative of a second physiological parameter of the individual if said second sensor is in proximity to the individual;

a processing unit in electronic communication with said first sensor and said second sensor;

a central monitoring unit in electronic communication with at least one of said sensors and said processing unit; and

an output device in electronic communication with at least one of said processing unit and said central monitoring unit, wherein at least one of said processing unit and said central monitoring unit is programmed

(a) to generate at least one of a derived physiological status parameter of the individual and a derived parameter related to an activity in which the individual has engaged said derived parameters based on both of said data indicative of said first physiological parameter of the individual and said data indicative of said second physiological parameter of the individual, and

(b) to cause said output device to present to a user indicators of at least one of said derived parameters of the individual in relation to indicators of at least one of (i) said data indicative of said first physiological parameter of the individual, and (ii) said data indicative of said second physiological parameter of the individual.

2. The system of claim **1** wherein at least one of said first sensor, said second sensor, and said processing unit is in a unitary wearable device.

3. The system of claim **1** wherein the system further comprises an input device to enable a user to enter data into the system.

4. The system of claim **3** wherein at least one of said processing unit and said central monitoring unit is programmed to cause said output device to present to a user said indicators of at least one of said derived parameters in relation to said indicators of at least one of data entered by a user and another derived parameter of the individual, said another derived parameter of the individual being at least one of a derived physiological parameter of the individual and a derived parameter related to an activity in which the individual has engaged.

5. The system of claim **1** further comprising an input device for providing life activities data of the individual to the system.

6. The system of claim **5** wherein at least one of said processing unit and said central monitoring unit is programmed to cause said output device to present to a user said indicators of at least one of said derived parameters in relation to said indicators of at least one of said life activities data of the individual and another derived parameter of the individual, said another derived parameter of the individual being at least one of a derived physiological parameter of the individual and a derived parameter related to an activity in which the individual has engaged.

7. The system of claim **1** wherein at least one of said derived parameters is energy expenditure.

8. The system of claim **1** wherein said data generated by the system is aggregated into a database accessible to a user.

9. The system of claim **3** wherein said data generated by the system and said data entered by the user is aggregated into a database accessible to a user.

10. The system of claim **5** wherein said data generated by the system and said life activities data is aggregated into a database accessible to a user.

11. The system of any one of claim **1**, **8**, **9**, or **10** wherein the user is at least one of an authorized user and the individual.

12. The system of any one of claims **8-10** wherein said database is stored on a network storage device.

13. The system of any one of claims **8-10** wherein at least one of said processing unit and said central monitoring unit is programmed to receive a query from a user, to access said database, and to cause said output device to generate a report based on said query with said data from said database.

14. The system of claim **1** wherein at least one of said processing unit and said central monitoring unit is programmed to generate feedback data relating to a degree to which the individual has achieved one or more preset goals, said feedback data being generated from at least a portion of at least one of said data indicative of said first physiological parameter of the individual, said data indicative of said second physiological parameter of the individual, and at least one of said derived parameters, wherein at least one of said processing unit and said central monitoring unit is programmed to cause said output device to provide said feedback data to a user.

15. The system of claim **14** wherein said one or more preset goals comprise a target caloric burn for the individual or a target caloric intake of the individual.

16. The system of claim **1** wherein said output device is at least one of a personal computer, a personal digital assistant, a pager, and a mobile phone.

17. The system of claim **1** wherein said indicators presented to a user by the output device are visual for at least one of (a) at least one of said derived parameters of the individual, (b) said data indicative of said first physiological parameter of the individual, and (c) said data indicative of said second physiological parameter of the individual.

18. The system of claim **1** wherein said indicators presented to a user by the output device are in audio form for at least one of (a) at least one of said derived parameters of the individual, (b) said data indicative of said first physiological parameter of the individual, and (c) said data indicative of said second physiological parameter of the individual.

19. The system of claim **1** wherein said indicators presented to a user by the output device are tactile for at least one of (a) at least one of said derived parameters of the individual, (b) said data indicative of said first physiological parameter of the individual, and (c) said data indicative of said second physiological parameter of the individual.

20. The system of claim **1** wherein said central monitoring unit is adapted to generate one or more web pages comprising said data generated by the system, and wherein said output device makes one or more of said web pages accessible to a user over the Internet.

21. The system of claim **1** wherein the system is fee based.

22. The system of claim **1** wherein at least one of said indicators represents at least one of life activities, activities of daily living, data entered by the user, an activity level of the individual, stress of the individual, mind centering of the individual, sleep of the individual, energy expenditure of the individual, or how the individual feels.

23. The system of claim **1** wherein at least one of said indicators are compared to a baseline parameter of the individual.

24. The system of claim **1** wherein at least one of said central monitoring unit and said processing unit is programmed to provide suggestions, said suggestions being based on said relation of said indicators of at least one of said derived parameters of the individual to said indicators of at least one of said data indicative of said first physiological parameter of the individual and said data indicative of said second physiological parameter of the individual.

* * * * *

Exhibit C

US008398546B2

(12) **United States Patent**
Pacione et al.

(10) **Patent No.: US 8,398,546 B2**
(45) **Date of Patent: Mar. 19, 2013**

(54) **SYSTEM FOR MONITORING AND MANAGING BODY WEIGHT AND OTHER PHYSIOLOGICAL CONDITIONS INCLUDING ITERATIVE AND PERSONALIZED PLANNING, INTERVENTION AND REPORTING CAPABILITY**

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(51) **Int. Cl.**
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(52) **U.S. Cl.** **600/300**; 600/301; 128/920; 128/921; 705/2; 705/3; 706/45

(58) **Field of Classification Search** 600/300–301, 600/509, 500, 529, 356, 485, 549; 128/920–925; 434/262, 127, 326, 107, 219, 238, 247; 705/2–3
See application file for complete search history.

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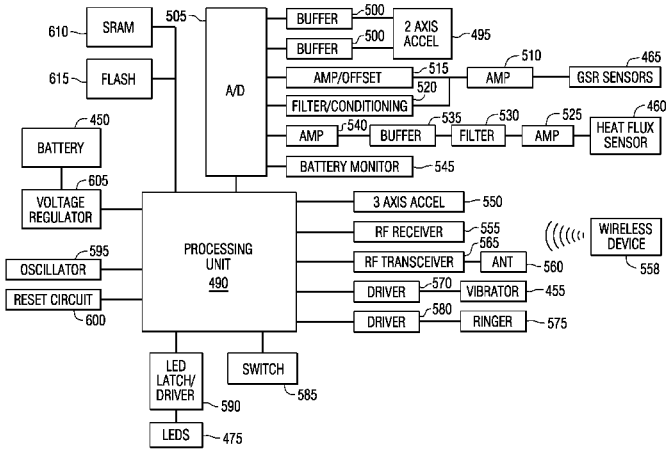
(57) **ABSTRACT**

A nutrition and activity management system is disclosed that monitors energy expenditure of an individual through the use of a body-mounted sensing apparatus. The apparatus is particularly adapted for continuous wear. The system is also adaptable or applicable to measuring a number of other physiological parameters and reporting the same and derivations of such parameters. A weight management embodiment is directed to achieving an optimum or preselected energy balance between calories consumed and energy expended by the user. An adaptable computerized nutritional tracking system is utilized to obtain data regarding food consumed, Relevant and predictive feedback is provided to the user regarding the mutual effect of the user's energy expenditure, food consumption and other measured or derived or manually input physiological contextual parameters upon progress toward said goal.

29 Claims, 27 Drawing Sheets



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WO	97/47239		12/1997
WO	98/50873		11/1998
WO	99/27483		11/1998
WO	9859227		12/1998
WO	99/44494		9/1999
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WO	00/52604		3/2000
WO	00/26882		5/2000
WO	00/32098		6/2000
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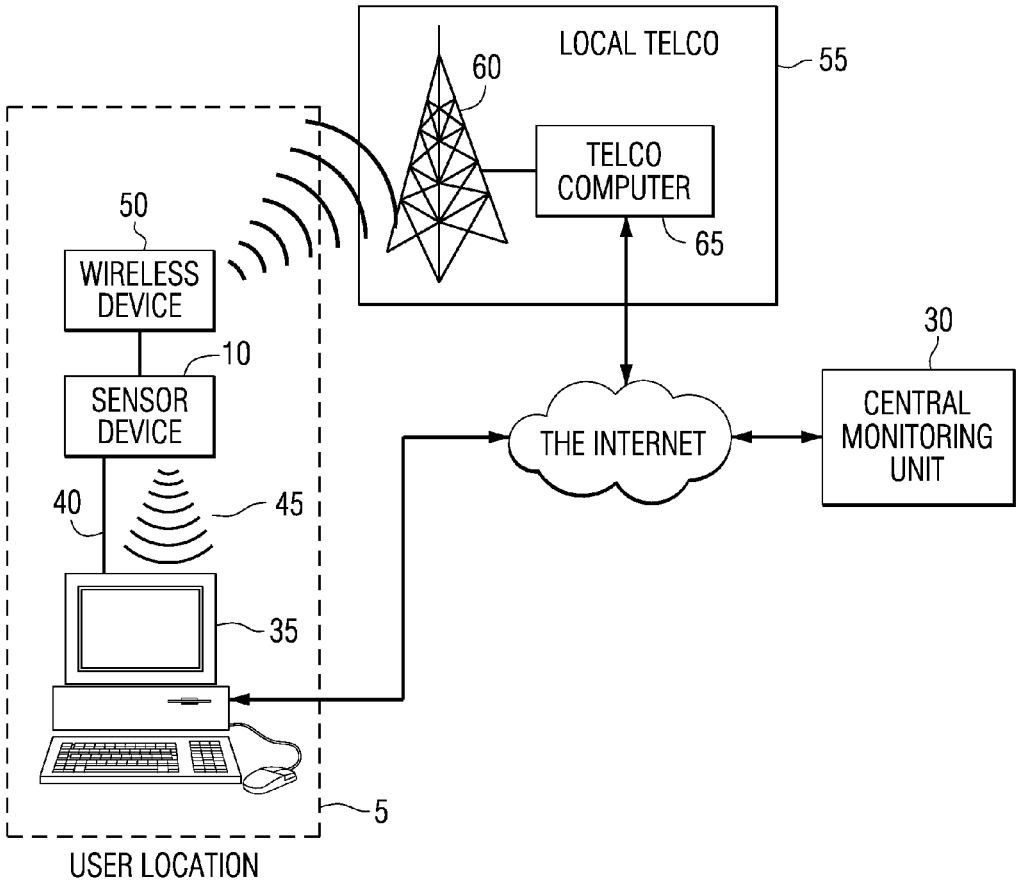
LOCAL TELCO
55
60
TELCO COMPUTER
65
50
WIRELESS DEVICE
10
SENSOR DEVICE
40
45
35
5
USER LOCATION
THE INTERNET
30
CENTRAL MONITORING UNIT

FIG. 1

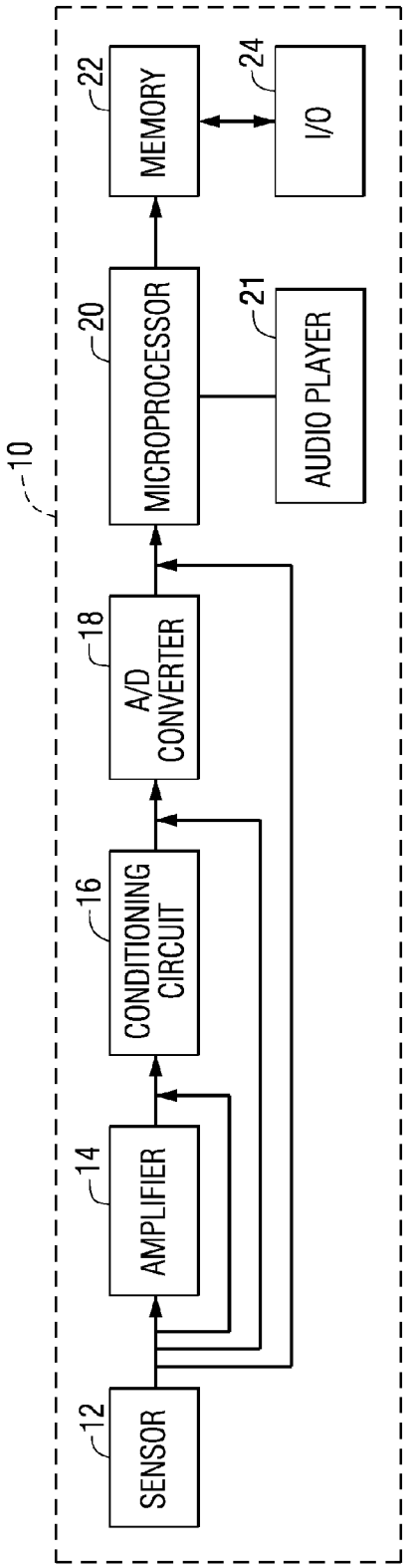
10
12
SENSOR
14
AMPLIFIER
16
CONDITIONING CIRCUIT
18
A/D CONVERTER
20
MICROPROCESSOR
21
AUDIO PLAYER
22
MEMORY
24
I/O

FIG. 2

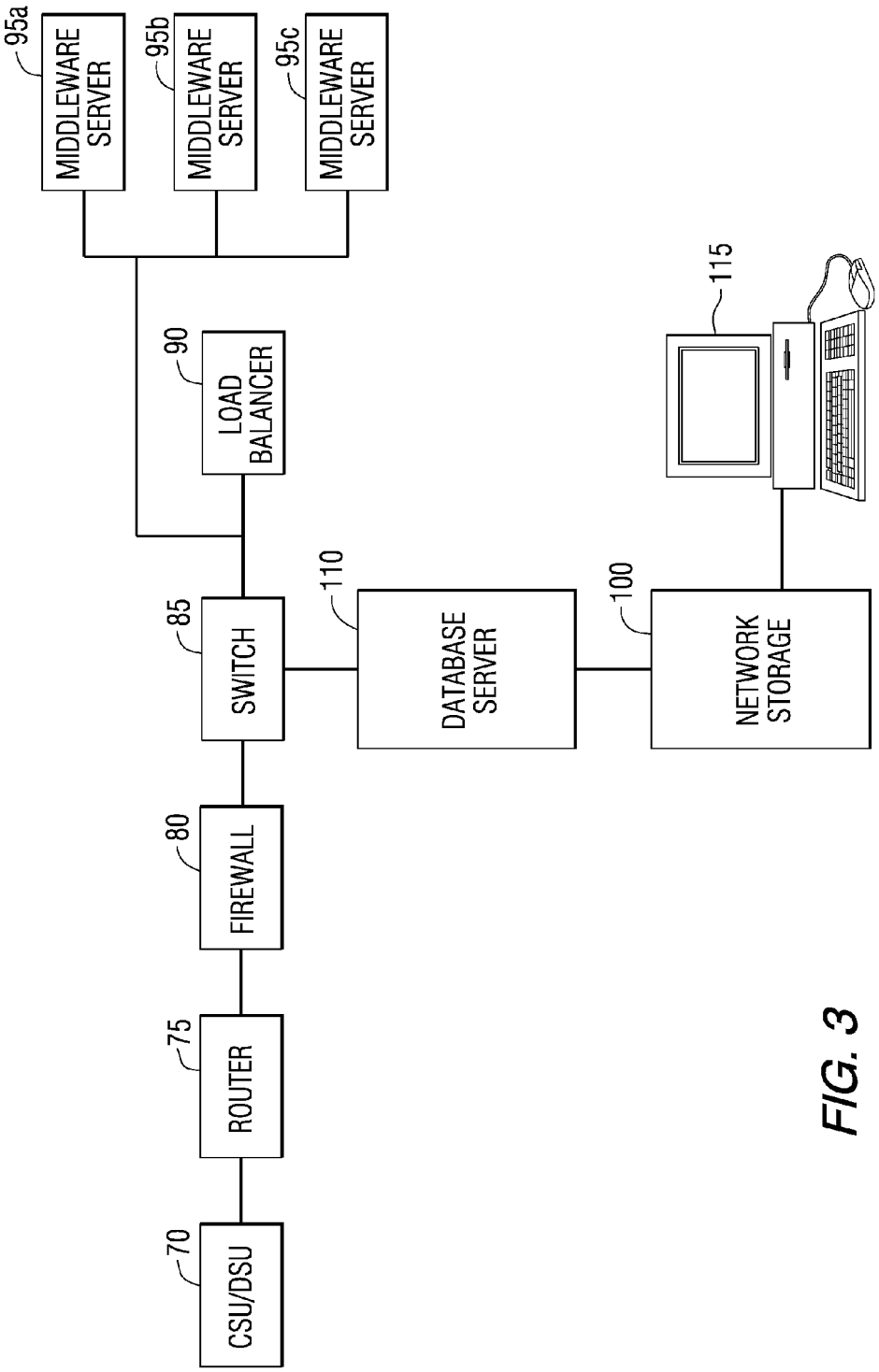
95a
MIDDLEWARE SERVER
95b
MIDDLEWARE SERVER
95c
MIDDLEWARE SERVER
90
LOAD BALANCER
115
85
SWITCH
110
DATABASE SERVER
100
NETWORK STORAGE
80
FIREWALL
75
ROUTER
70
CSU/DSU

FIG. 3

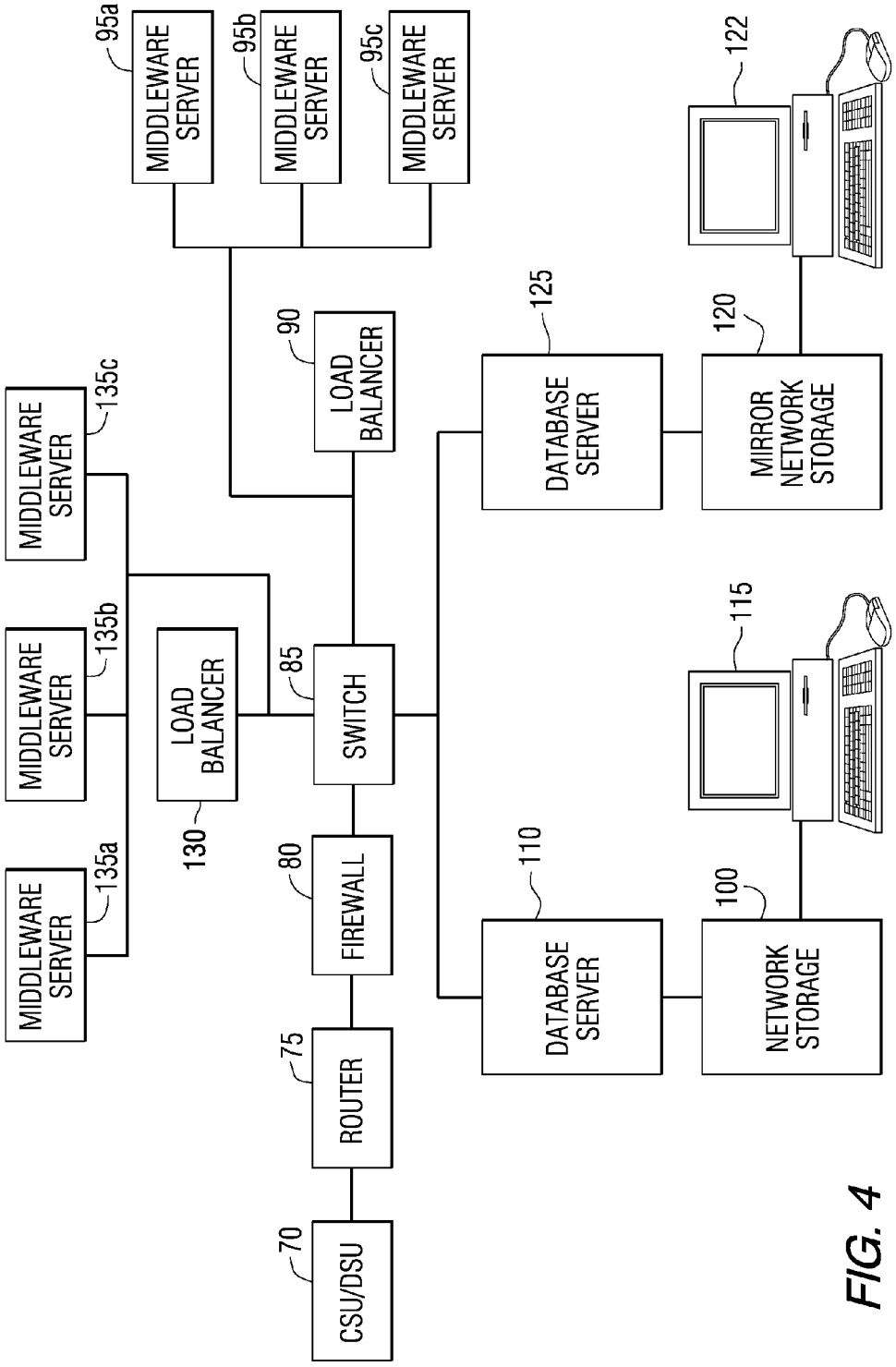
95a
MIDDLEWARE SERVER
95b
MIDDLEWARE SERVER
95c
MIDDLEWARE SERVER
122
90
LOAD BALANCER
125
DATABASE SERVER
120
MIRROR NETWORK STORAGE
135c
MIDDLEWARE SERVER
135b
MIDDLEWARE SERVER
LOAD BALANCER
130
85
SWITCH
115
135a
MIDDLEWARE SERVER
80
FIREWALL
110
DATABASE SERVER
100
NETWORK STORAGE
75
ROUTER
70
CSU/DSU

FIG. 4

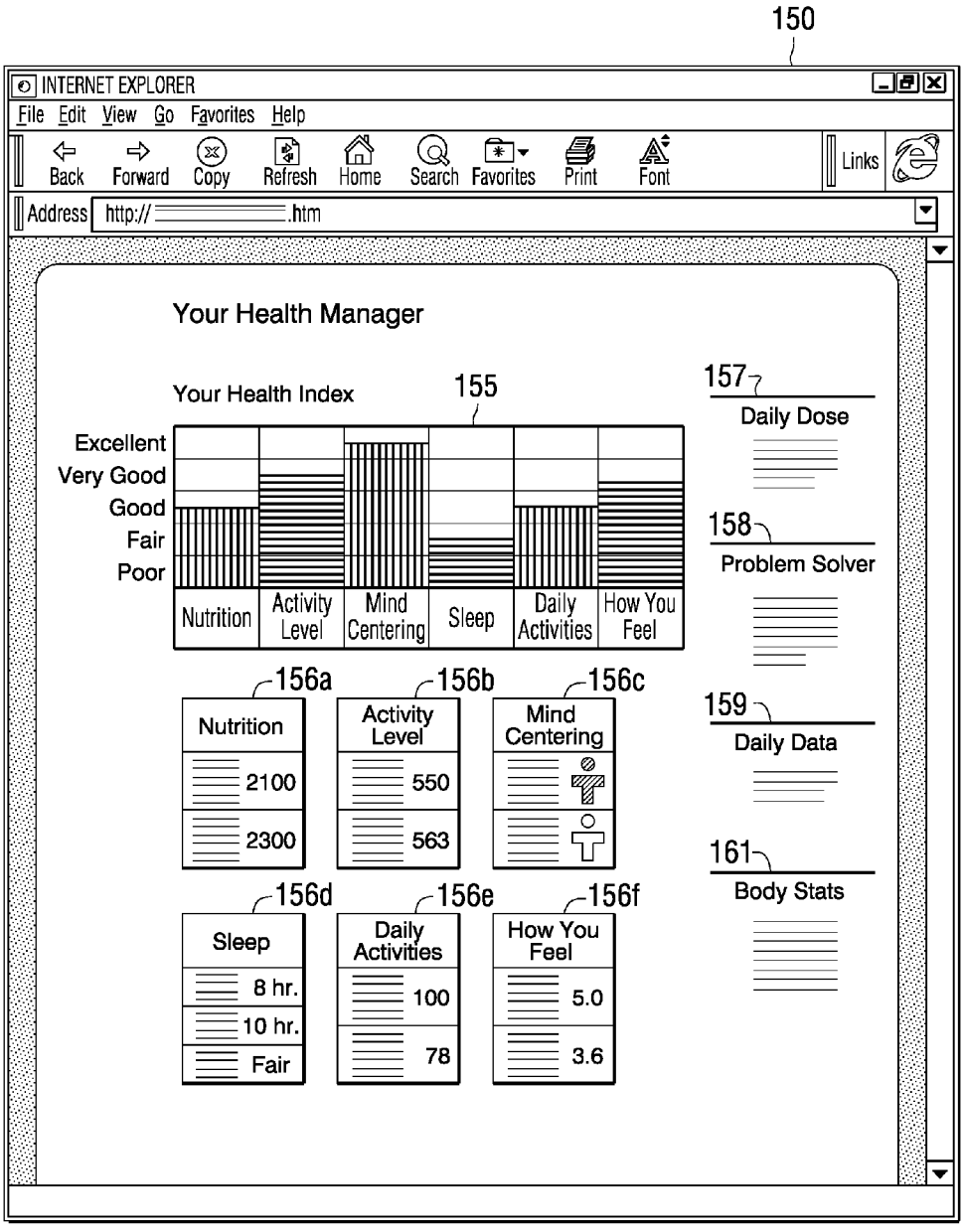
150
INTERNET EXPLORER
File Edit View Go Favorites Help
Back Forward Copy Refresh Home Search Favorites Print Font Links
Address http:// .htm
Your Health Manager
Your Health Index
155
Excellent
Very Good
Good
Fair
Poor
Nutrition
Activity Level
Mind Centering
Sleep
Daily Activities
How You Feel
157
Daily Dose
158
Problem Solver
159
Daily Data
161
Body Stats
156a
Nutrition
2100
2300
156b
Activity Level
550
563
156c
Mind Centering
156d
Sleep
8 hr.
10 hr.
Fair
156e
Daily Activities
100
78
156f
How You Feel
5.0
3.6

FIG. 5

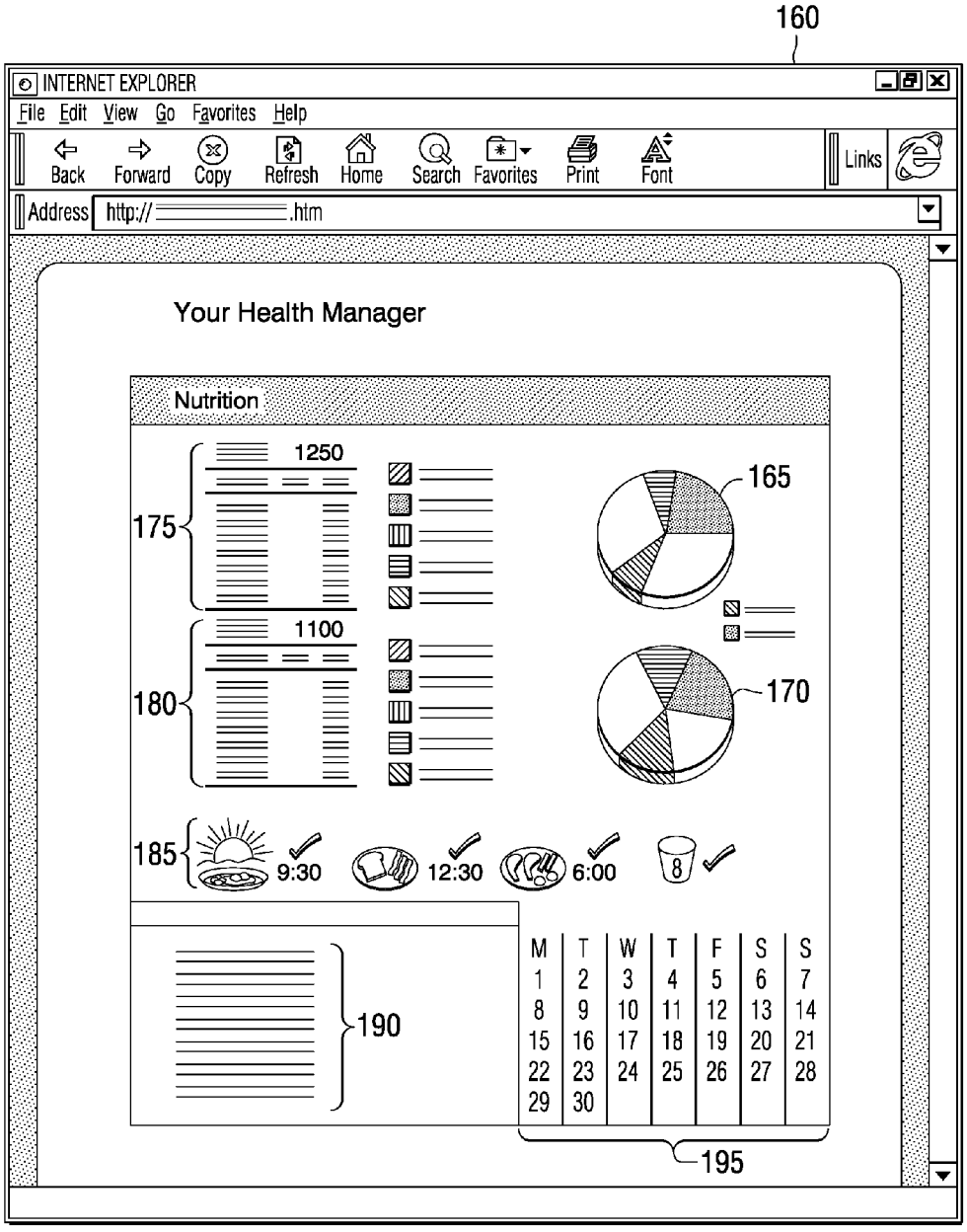
160
INTERNET EXPLORER
File Edit View Go Favorites Help
Back Forward Copy Refresh Home Search Favorites Print Font
Links
Address http://.htm
Your Health Manager
Nutrition
1250
175
1100
180
165
170
185
9:30
12:30
6:00
190
M T W T F S S
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
195

FIG. 6

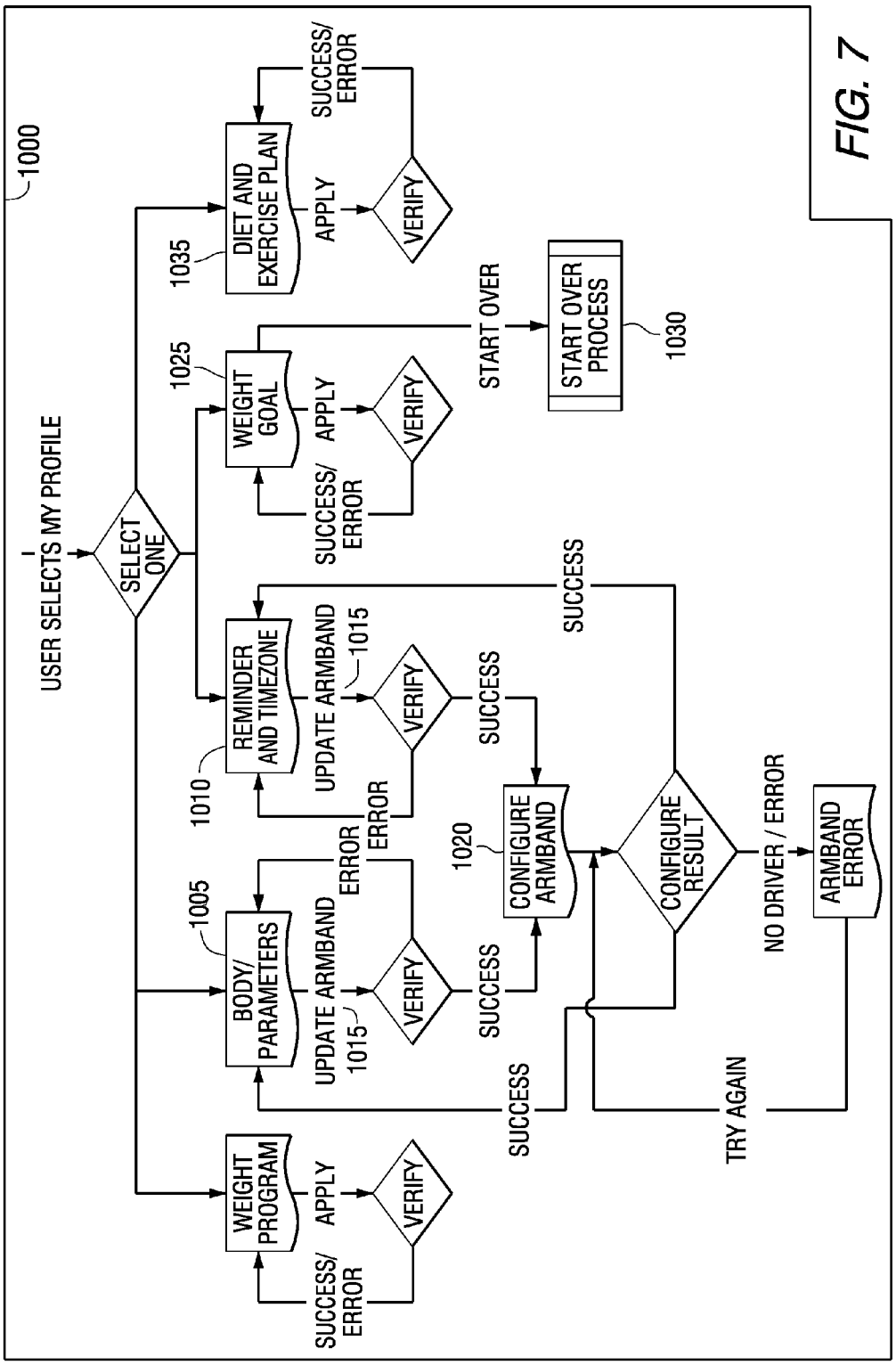
1000
USER SELECTS MY PROFILE
SELECT ONE
DIET AND EXERCISE PLAN
1035
APPLY
VERIFY
SUCCESS/ ERROR
WEIGHT GOAL
1025
APPLY
VERIFY
SUCCESS/ ERROR
START OVER
START OVER PROCESS
1030
REMINDER AND TIMEZONE
1010
UPDATE ARMBAND
1015
VERIFY
SUCCESS
ERROR
SUCCESS
BODY/ PARAMETERS
1005
UPDATE ARMBAND
1015
VERIFY
ERROR
SUCCESS
1020
CONFIGURE ARMBAND
CONFIGURE RESULT
NO DRIVER / ERROR
ARMBAND ERROR
TRY AGAIN
SUCCESS
WEIGHT PROGRAM
APPLY
VERIFY
SUCCESS/ ERROR

FIG. 7

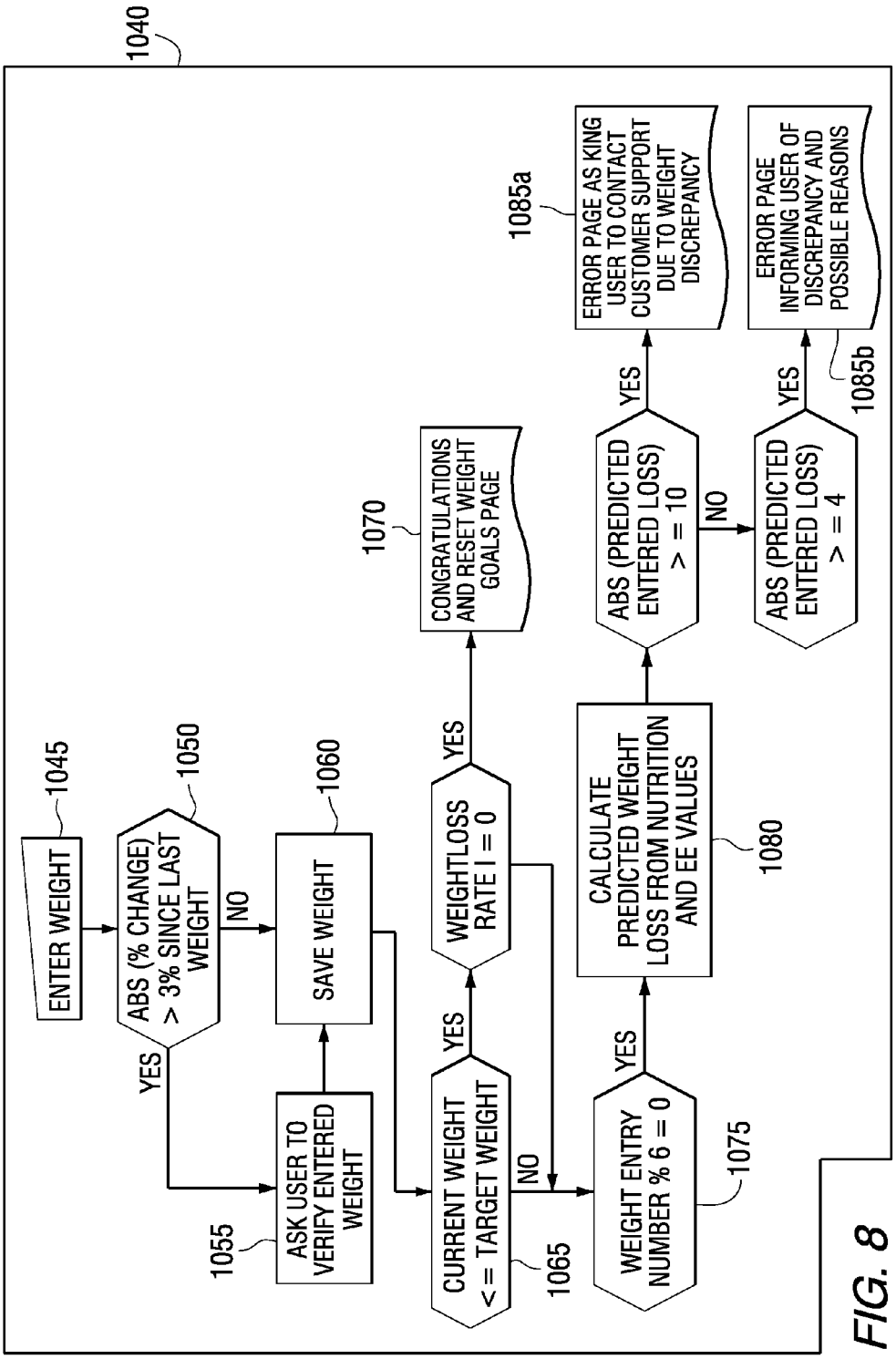
1040
ENTER WEIGHT
1045
ABS (% CHANGE) > 3% SINCE LAST WEIGHT
1050
YES
NO
ASK USER TO VERIFY ENTERED WEIGHT
1055
SAVE WEIGHT
1060
CURRENT WEIGHT <= TARGET WEIGHT
1065
YES
NO
WEIGHTLOSS RATE I = 0
YES
CONGRATULATIONS AND RESET WEIGHT GOALS PAGE
1070
WEIGHT ENTRY NUMBER % 6 = 0
1075
YES
CALCULATE PREDICTED WEIGHT LOSS FROM NUTRITION AND EE VALUES
1080
ABS (PREDICTED ENTERED LOSS) > = 10
YES
NO
ERROR PAGE AS KING USER TO CONTACT CUSTOMER SUPPORT DUE TO WEIGHT DISCREPANCY
1085a
ABS (PREDICTED ENTERED LOSS) > = 4
YES
ERROR PAGE INFORMING USER OF DISCREPANCY AND POSSIBLE REASONS
1085b

FIG. 8

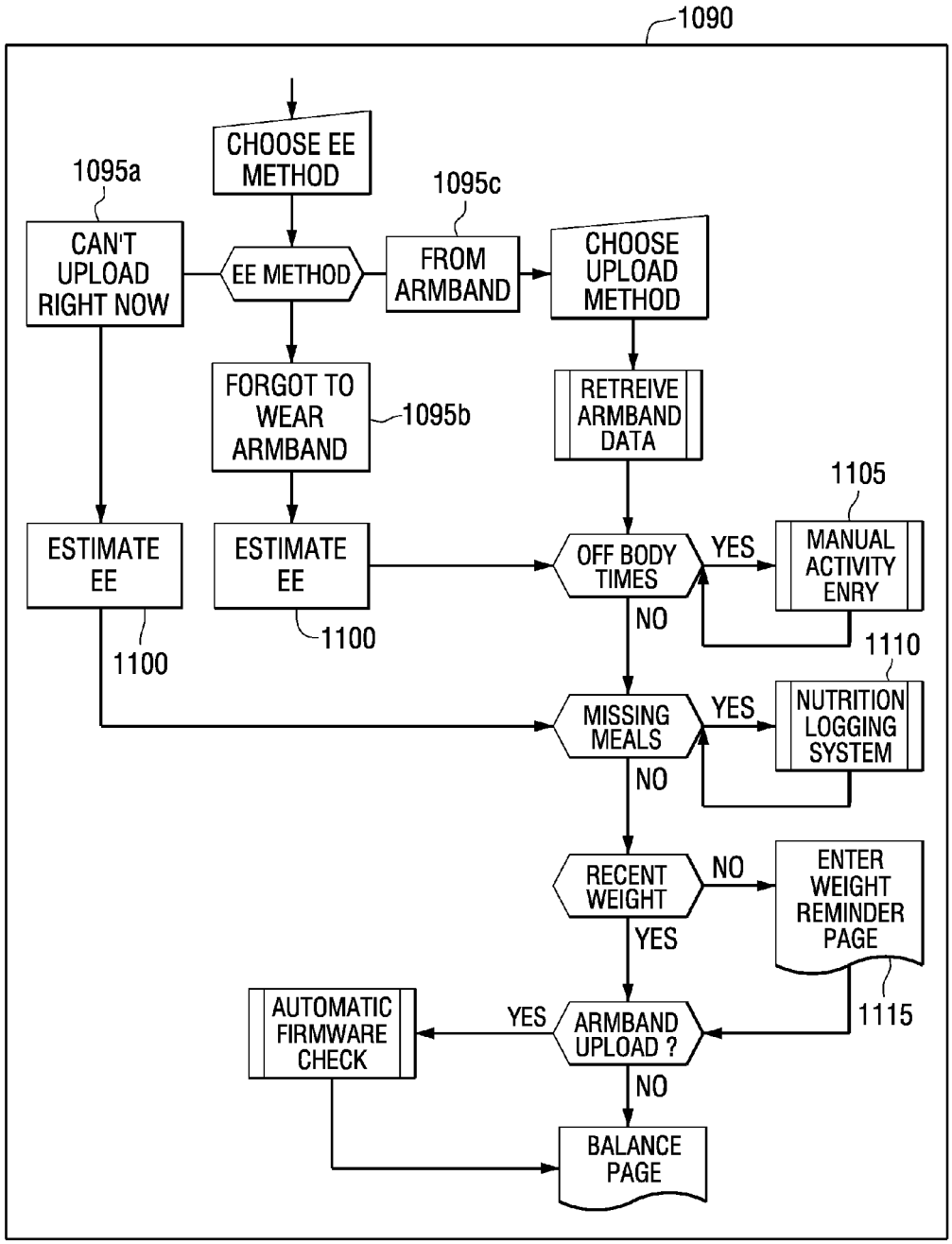
1090
CHOOSE EE METHOD
1095a
CAN'T UPLOAD RIGHT NOW
EE METHOD
1095c
FROM ARMBAND
CHOOSE UPLOAD METHOD
FORGOT TO WEAR ARMBAND
1095b
RETREIVE ARMBAND DATA
1105
ESTIMATE EE
ESTIMATE EE
OFF BODY TIMES
YES
MANUAL ACTIVITY ENRY
NO
1100
1100
1110
MISSING MEALS
YES
NUTRITION LOGGING SYSTEM
NO
RECENT WEIGHT
NO
ENTER WEIGHT REMINDER PAGE
YES
1115
AUTOMATIC FIRMWARE CHECK
YES
ARMBAND UPLOAD ?
NO
BALANCE PAGE

FIG. 9

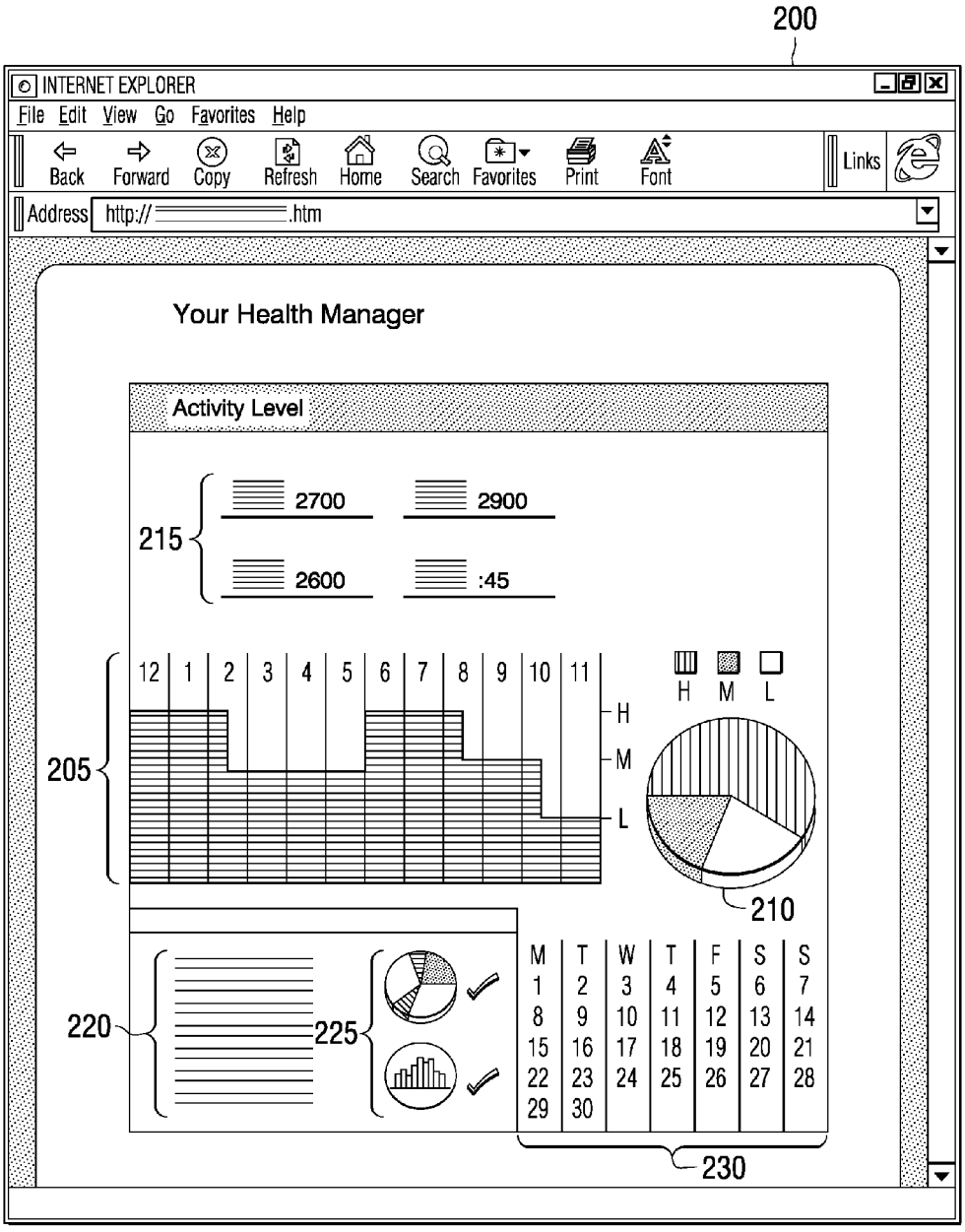
200
INTERNET EXPLORER
File Edit View Go Favorites Help
Back Forward Copy Refresh Home Search Favorites Print Font Links
Address http:// .htm
Your Health Manager
Activity Level
215
2700
2900
2600
:45
205
12 1 2 3 4 5 6 7 8 9 10 11
H
M
L
H M L
210
220
225
M T W T F S S
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
230

FIG. 10

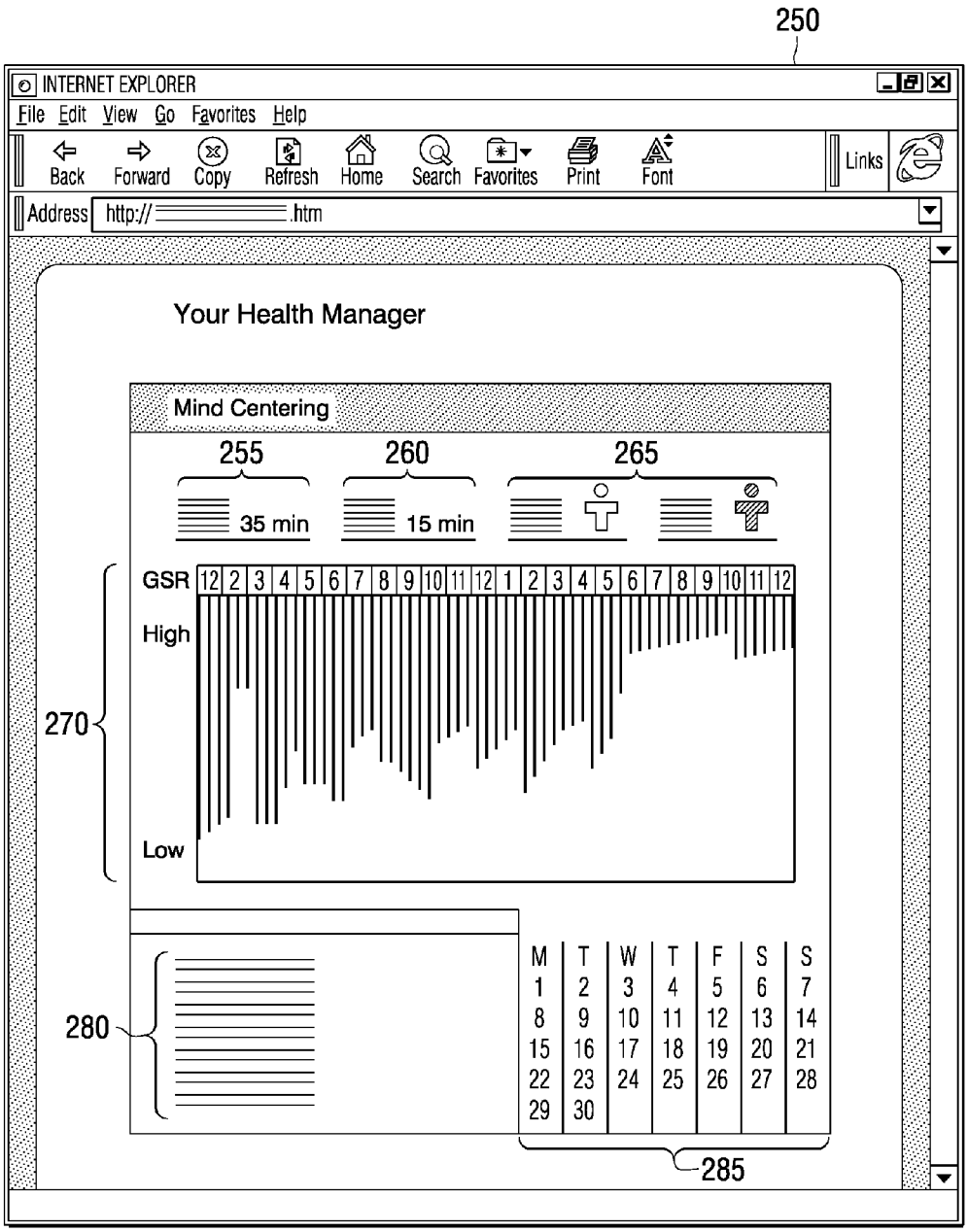
250
INTERNET EXPLORER
File Edit View Go Favorites Help
Back Forward Copy Refresh Home Search Favorites Print Font Links
Address http:// .htm
Your Health Manager
Mind Centering
255
260
265
35 min
15 min
GSR
12 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
High
Low
270
280
M T W T F S S
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
285

FIG. 11

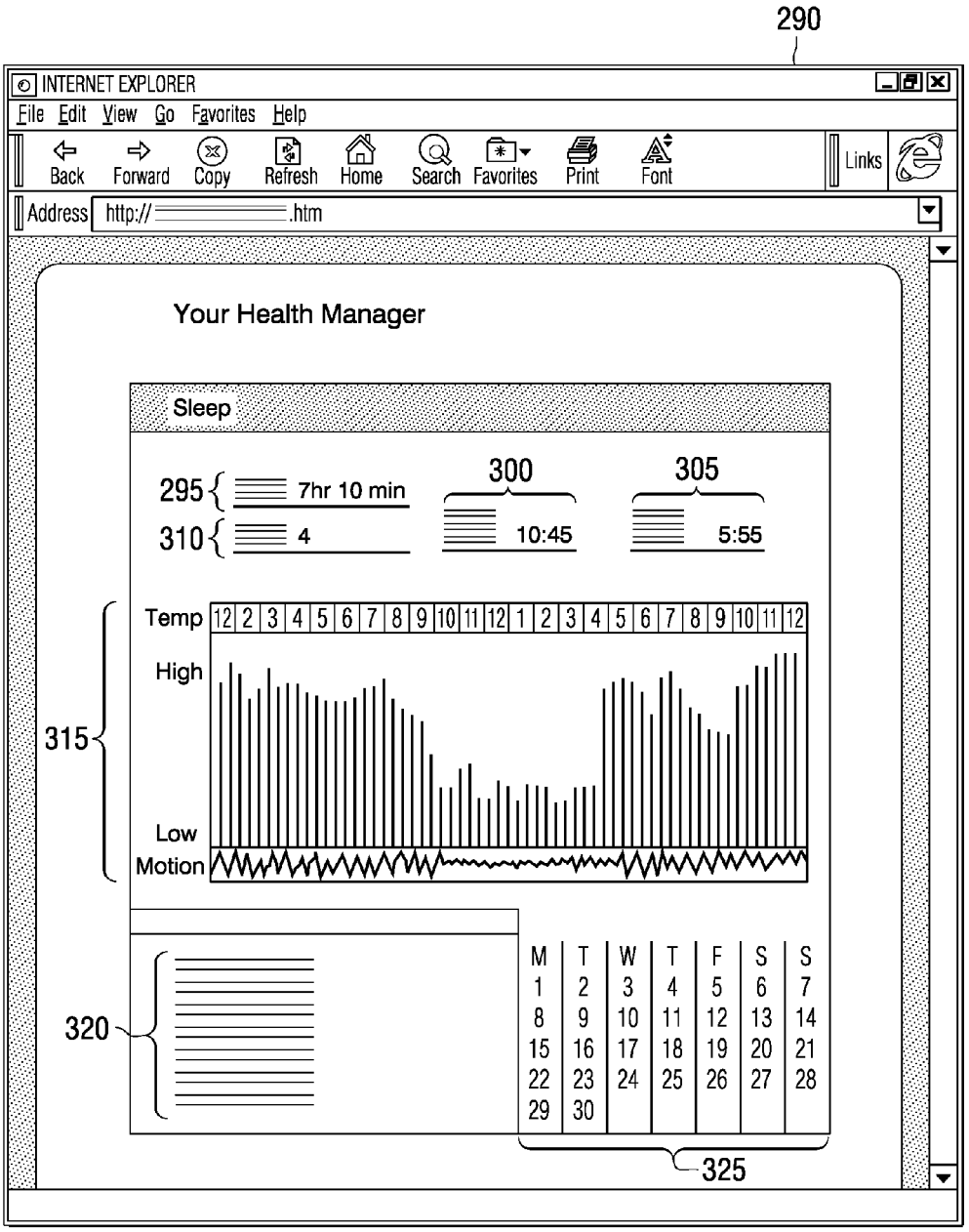
290
INTERNET EXPLORER
File Edit View Go Favorites Help
Back Forward Copy Refresh Home Search Favorites Print Font Links
Address http://.htm
Your Health Manager
Sleep
295
7hr 10 min
310
4
300
10:45
305
5:55
315
Temp
12 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
High
Low
Motion
320
M T W T F S S
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
325

FIG. 12

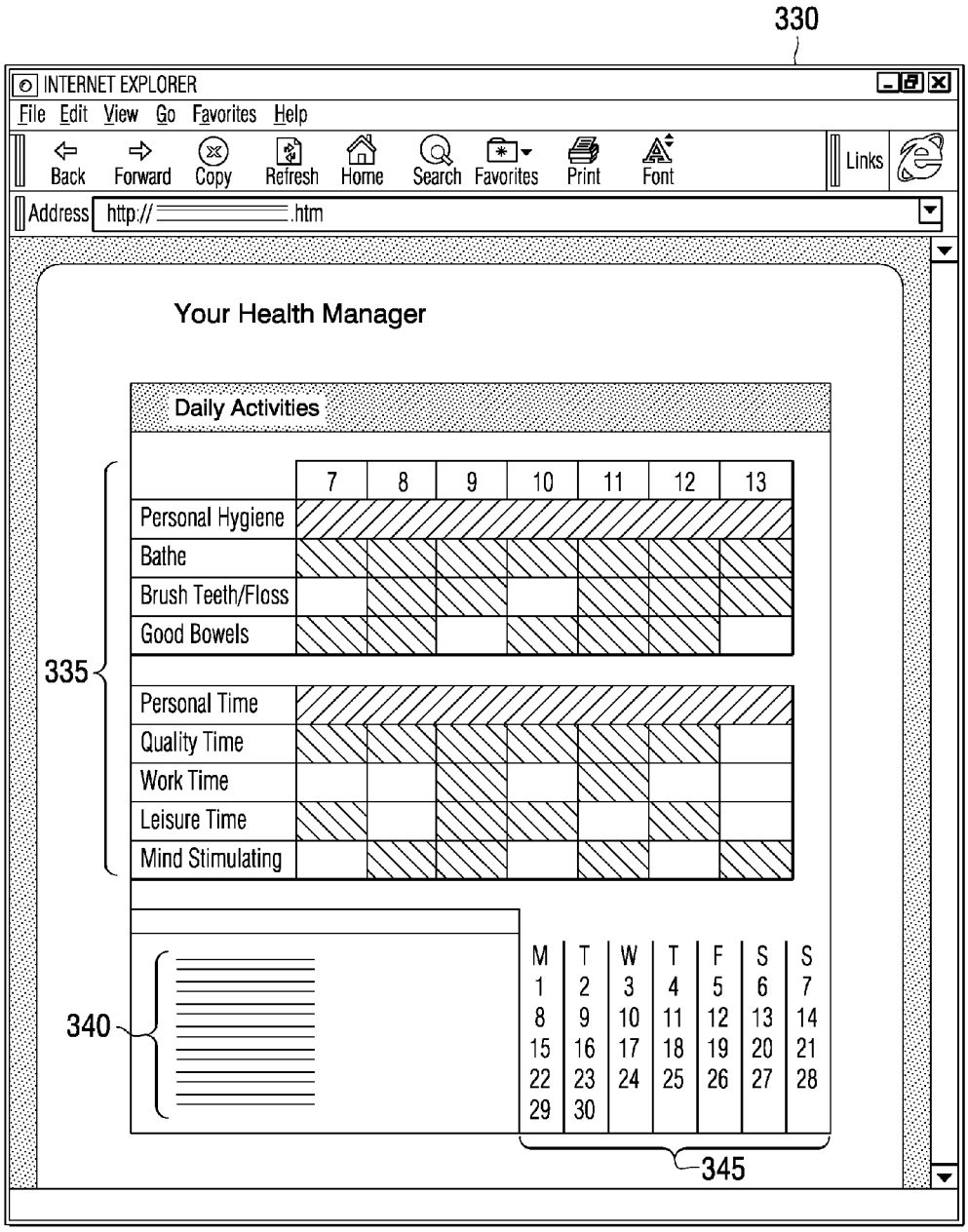
330
INTERNET EXPLORER
File Edit View Go Favorites Help
Back Forward Copy Refresh Home Search Favorites Print Font Links
Address http:// .htm
Your Health Manager
Daily Activities
7 8 9 10 11 12 13
Personal Hygiene
Bathe
Brush Teeth/Floss
Good Bowels
335
Personal Time
Quality Time
Work Time
Leisure Time
Mind Stimulating
340
M T W T F S S
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30
345

FIG. 13

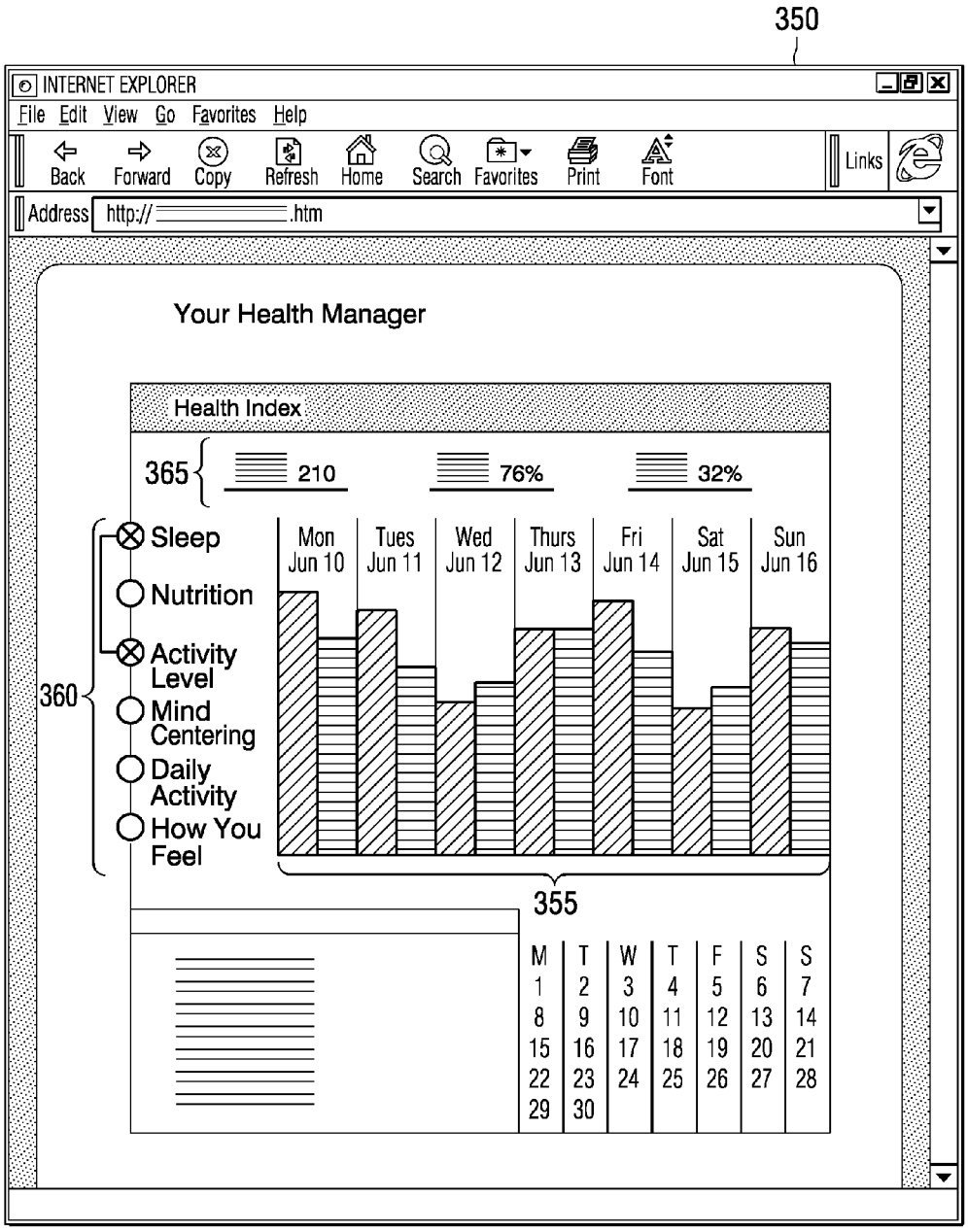
350
INTERNET EXPLORER
File Edit View Go Favorites Help
Back Forward Copy Refresh Home Search Favorites Print Font
Links
Address http://.htm
Your Health Manager
Health Index
365
210
76%
32%
Sleep
Nutrition
Activity Level
Mind Centering
Daily Activity
How You Feel
360
Mon Jun 10
Tues Jun 11
Wed Jun 12
Thurs Jun 13
Fri Jun 14
Sat Jun 15
Sun Jun 16
355
M T W T F S S
1 2 3 4 5 6 7
8 9 10 11 12 13 14
15 16 17 18 19 20 21
22 23 24 25 26 27 28
29 30

FIG. 14

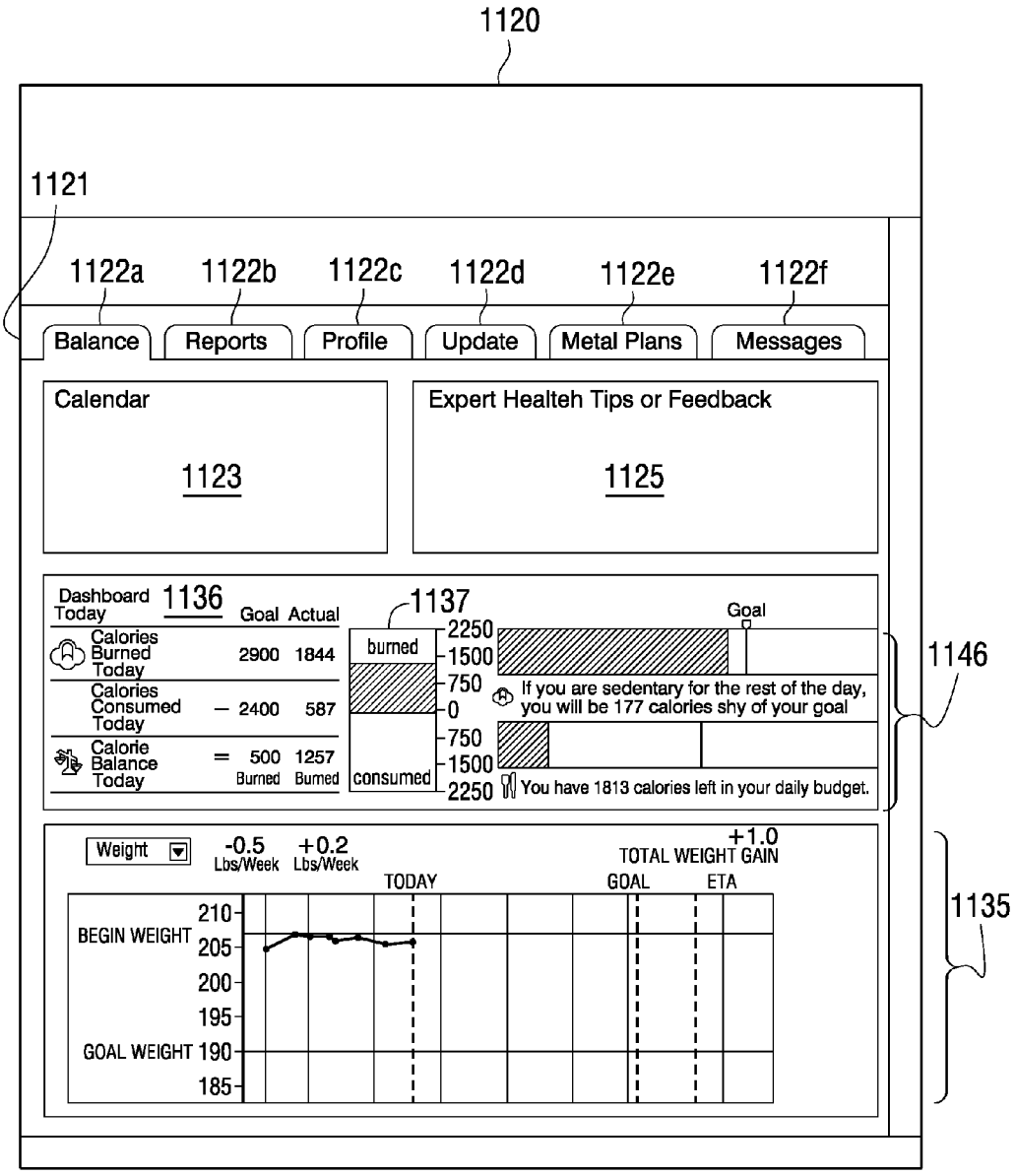
1120
1121
1122a
1122b
1122c
1122d
1122e
1122f
Balance
Reports
Profile
Update
Metal Plans
Messages
Calendar
1123
Expert Healteh Tips or Feedback
1125
Dashboard Today
1136
Goal Actual
Calories Burned Today 2900 1844
Calories Consumed Today — 2400 587
Calorie Balance Today = 500 1257
Burned Burned
1137
burned
consumed
2250
1500
750
0
750
1500
2250
Goal
If you are sedentary for the rest of the day, you will be 177 calories shy of your goal
You have 1813 calories left in your daily budget.
1146
Weight
-0.5 Lbs/Week
+0.2 Lbs/Week
+1.0 TOTAL WEIGHT GAIN
TODAY
GOAL
ETA
BEGIN WEIGHT
GOAL WEIGHT
210
205
200
195
190
185
1135

FIG. 15

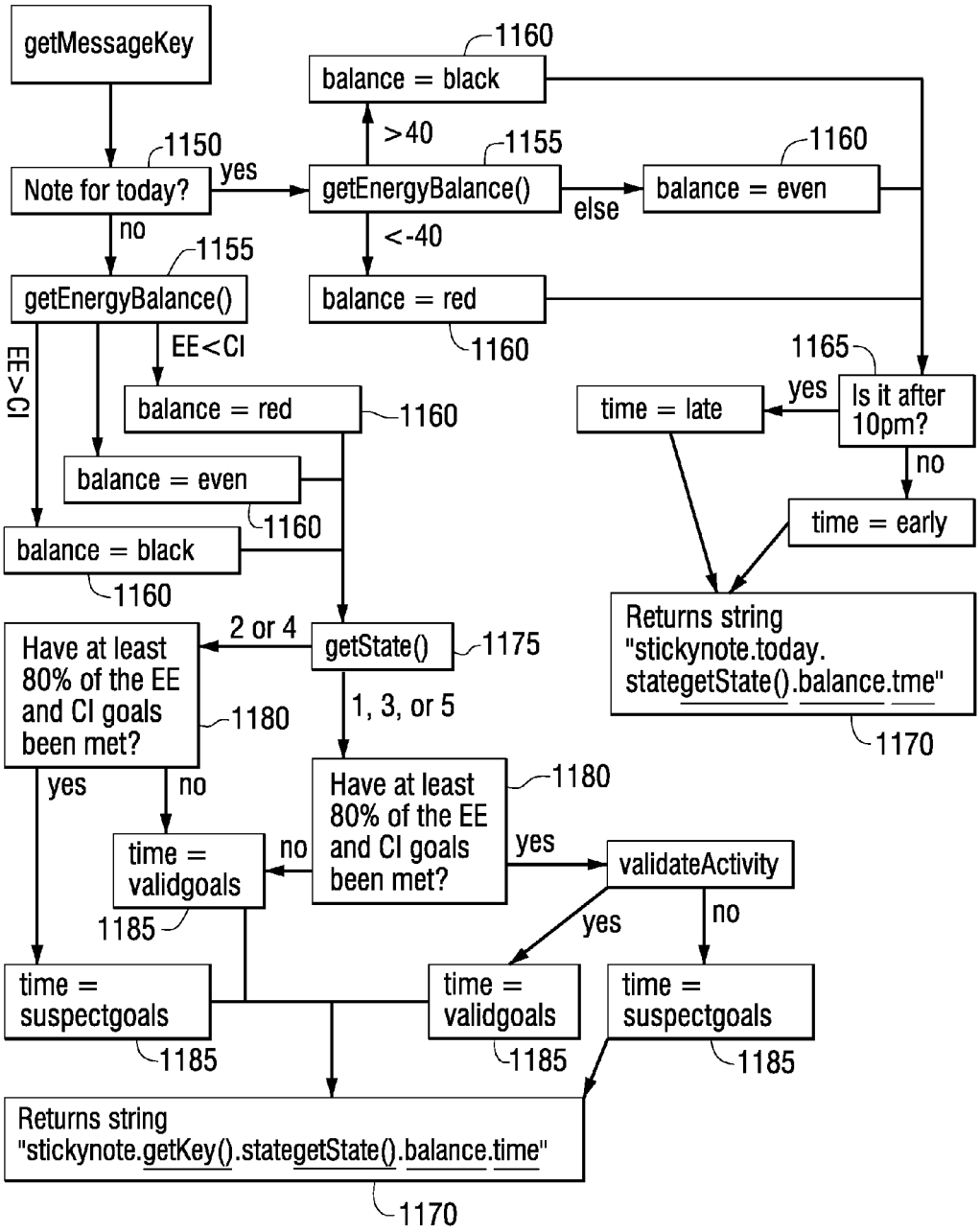
getMessageKey
Note for today?
1150
yes
no
getEnergyBalance()
1155
EE<CI
EE>CI
balance = red
1160
balance = even
1160
balance = black
1160
>40
<-40
balance = black
1160
getEnergyBalance()
1155
else
balance = even
1160
balance = red
1160
1165
Is it after 10pm?
yes
no
time = late
time = early
Returns string "stickynote.today. stategetState().balance.tme"
1170
2 or 4
getState()
1175
1, 3, or 5
Have at least 80% of the EE and CI goals been met?
1180
yes
no
time = validgoals
1185
Have at least 80% of the EE and CI goals been met?
1180
no
yes
validateActivity
yes
no
time = suspectgoals
1185
time = validgoals
1185
time = suspectgoals
1185
Returns string "stickynote.getKey().stategetState().balance.time"
1170

FIG. 16

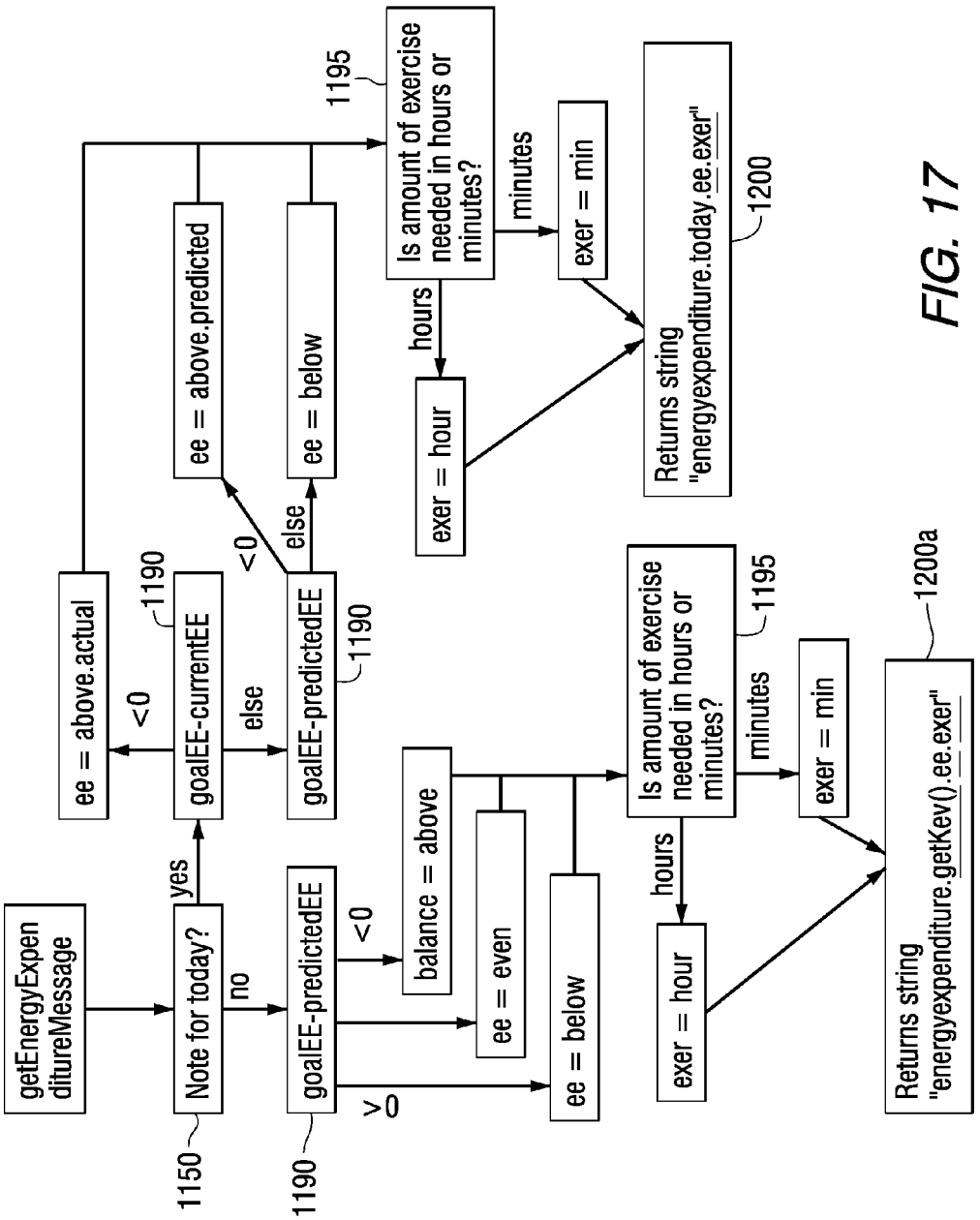
getEnergyExpen ditureMessage
Note for today?
yes
no
1150
goalEE-predictedEE
1190
<0
>0
balance = above
ee = even
ee = below
goalEE-currentEE
1190
<0
else
ee = above.actual
ee = above.predicted
ee = below
goalEE-predictedEE
1190
Is amount of exercise needed in hours or minutes?
1195
hours
minutes
exer = hour
exer = min
Returns string "energyexpenditure.today.ee.exer"
1200
Is amount of exercise needed in hours or minutes?
1195
hours
minutes
exer = hour
exer = min
Returns string "energyexpenditure.getKev().ee.exer"
1200a

FIG. 17

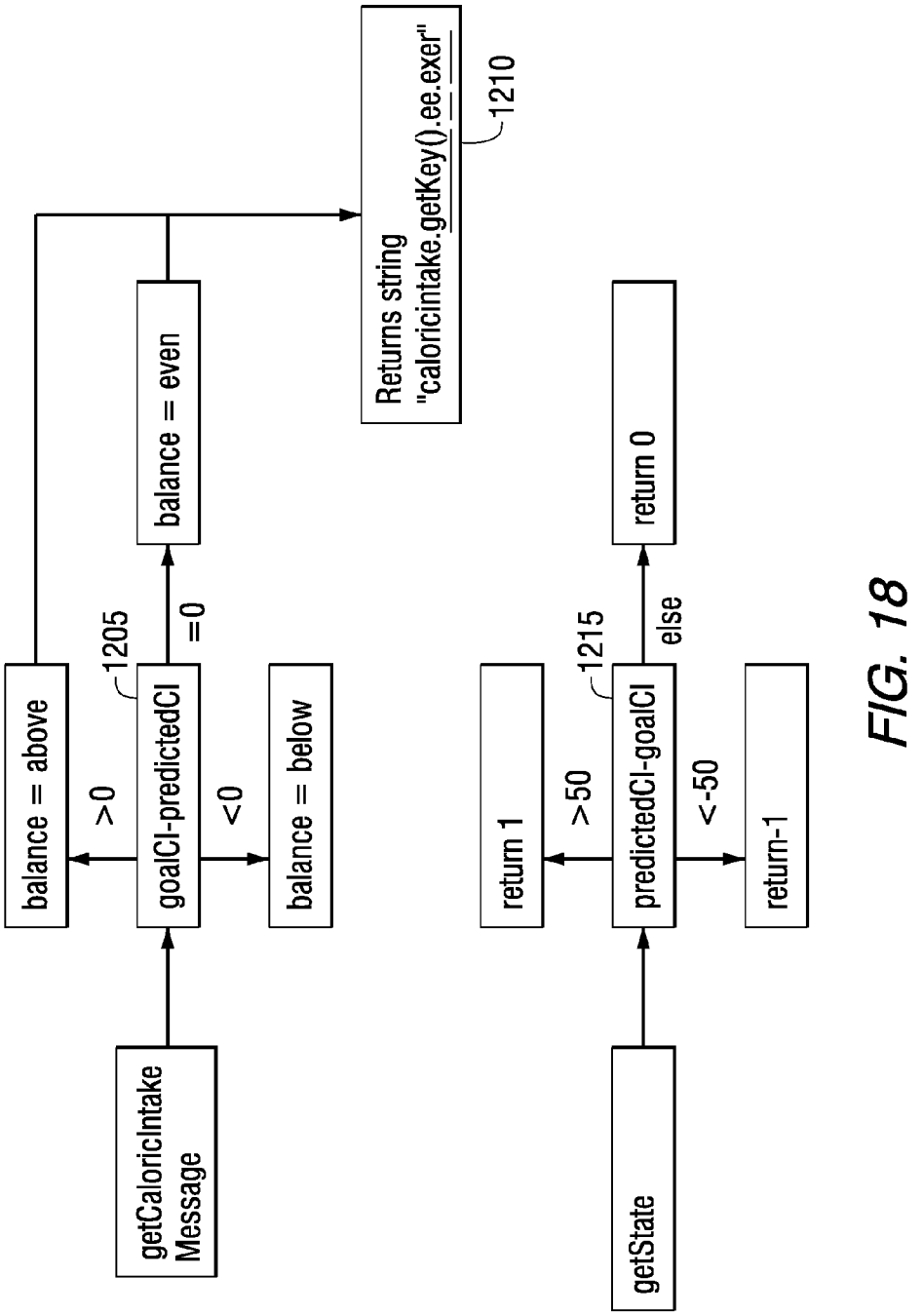
getCaloricIntake Message
goalCI-predictedCI
1205
>0
<0
=0
balance = above
balance = below
balance = even
Returns string "caloricintake.getKey().ee.exer"
1210
getState
predictedCI-goalCI
1215
>50
<-50
else
return 1
return-1
return 0

FIG. 18

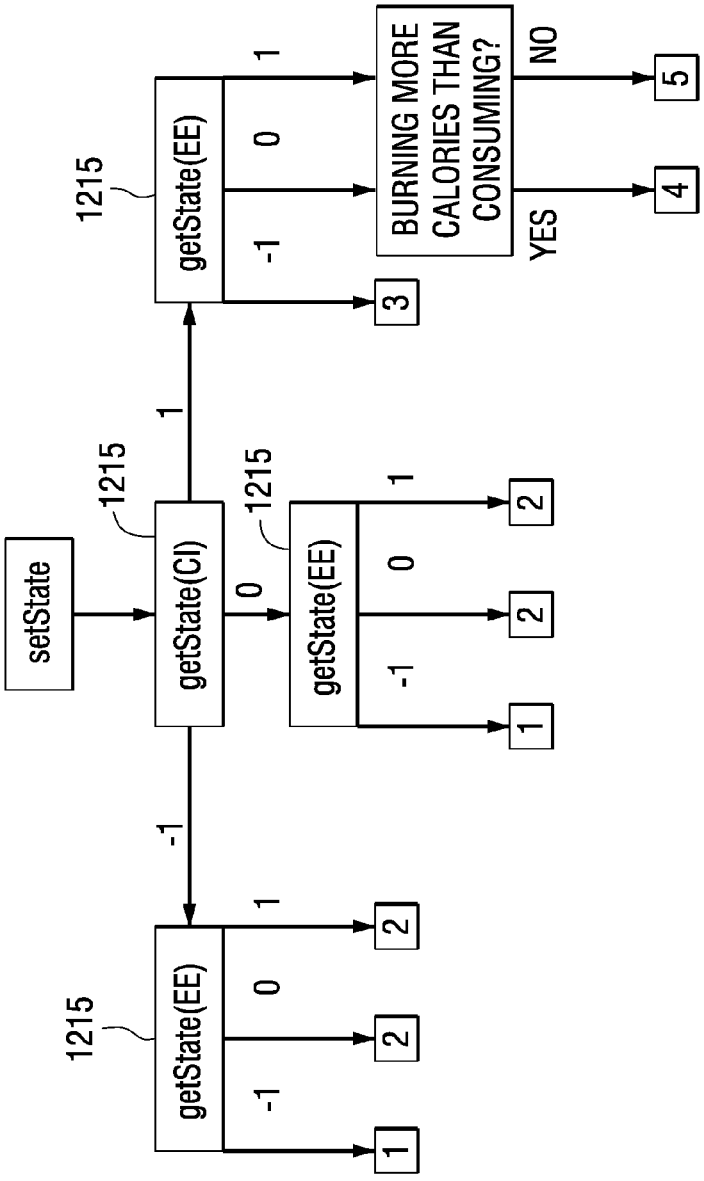
setState
getState(CI)
1215
getState(EE)
1215
getState(EE)
1215
getState(EE)
1215
BURNING MORE CALORIES THAN CONSUMING?
NO
YES
1
0
-1
1
2
3
4
5

FIG. 19

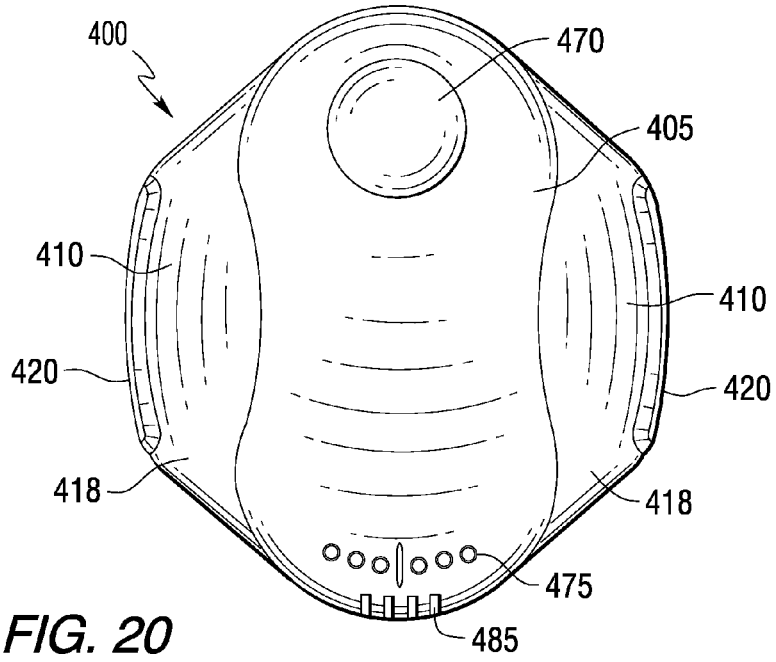
400
470
405
410
410
420
420
418
418
475
485

FIG. 20

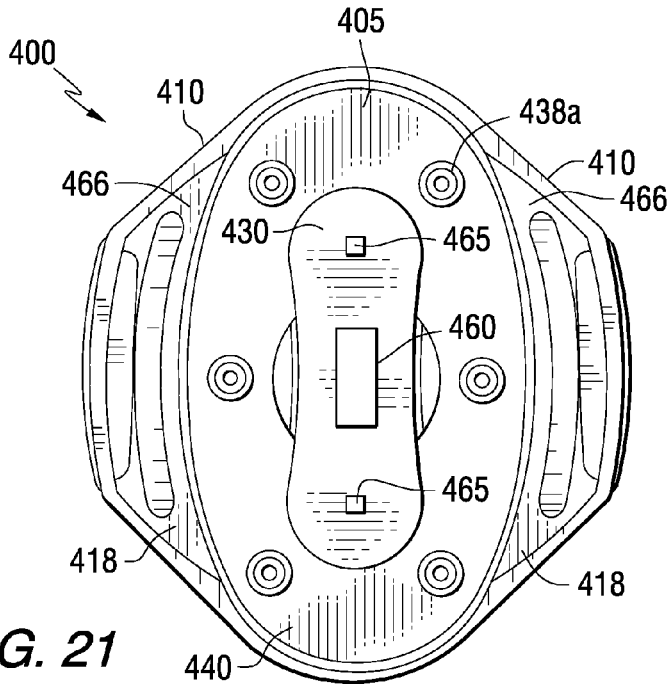
405
400
410
438a
410
466
466
430
465
460
465
418
418
440

FIG. 21

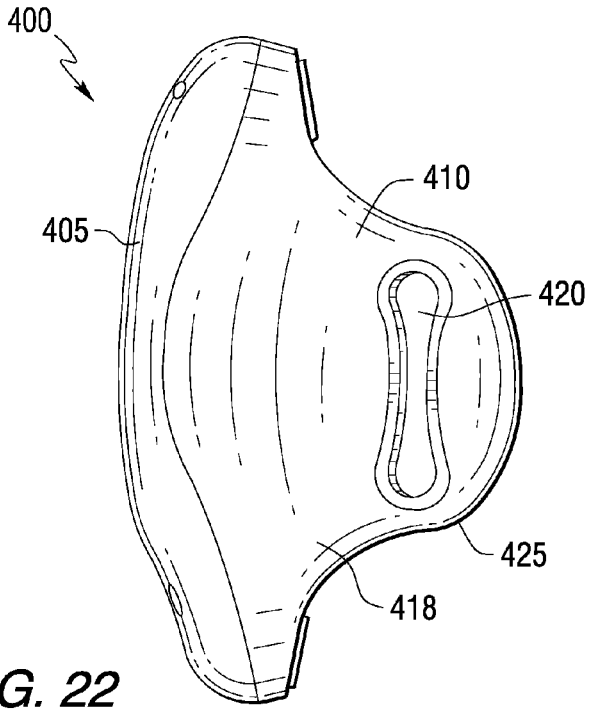
400
410
405
420
425
418

FIG. 22

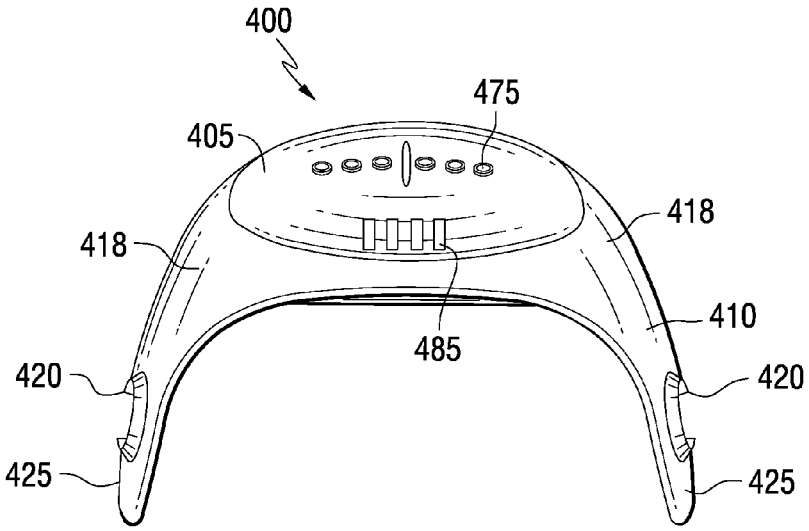
400
475
405
418
418
410
485
420
420
425
425

FIG. 23

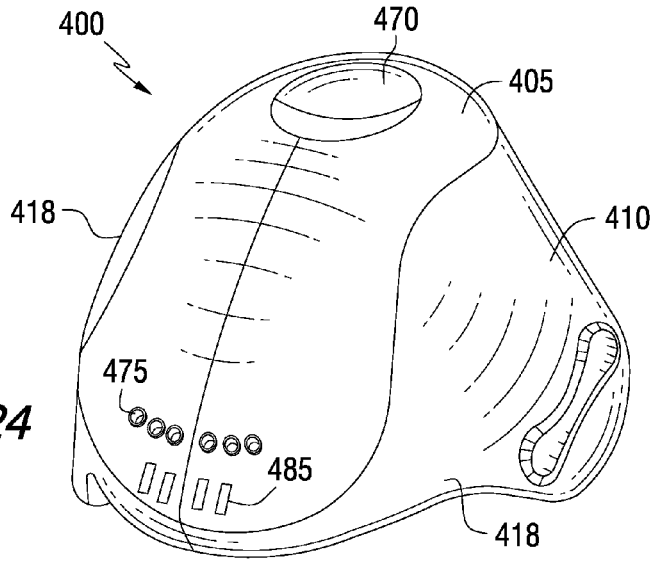
400
470
405
418
410
475
485
418

FIG. 24

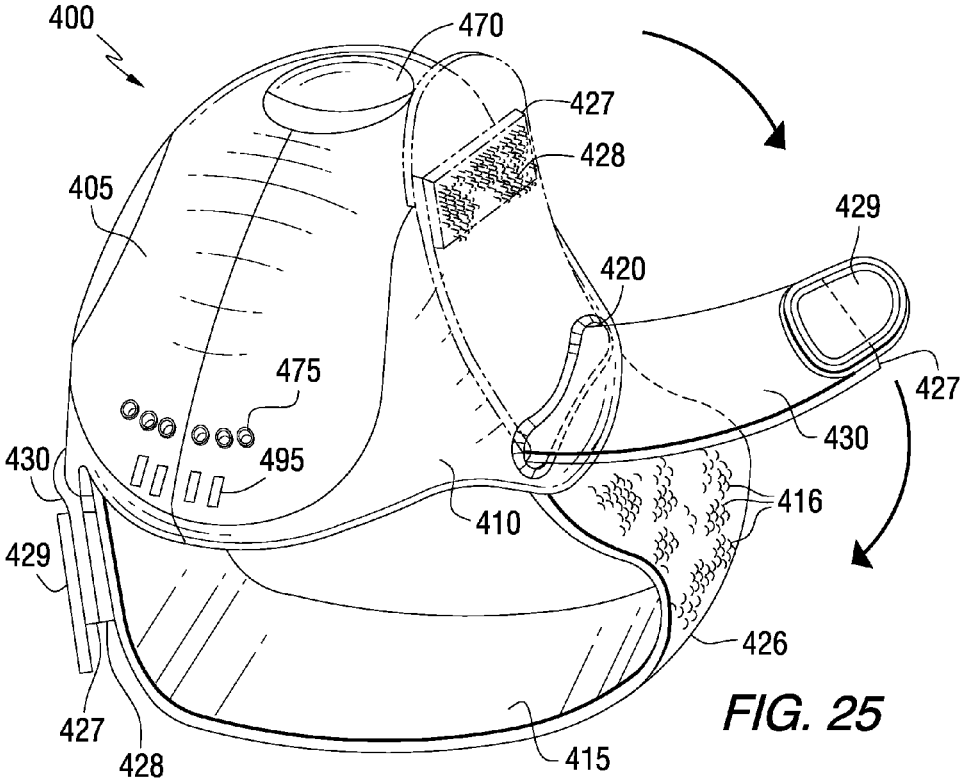
400
470
427
428
405
429
420
475
427
495
430
430
410
416
429
426
427
428
415

FIG. 25

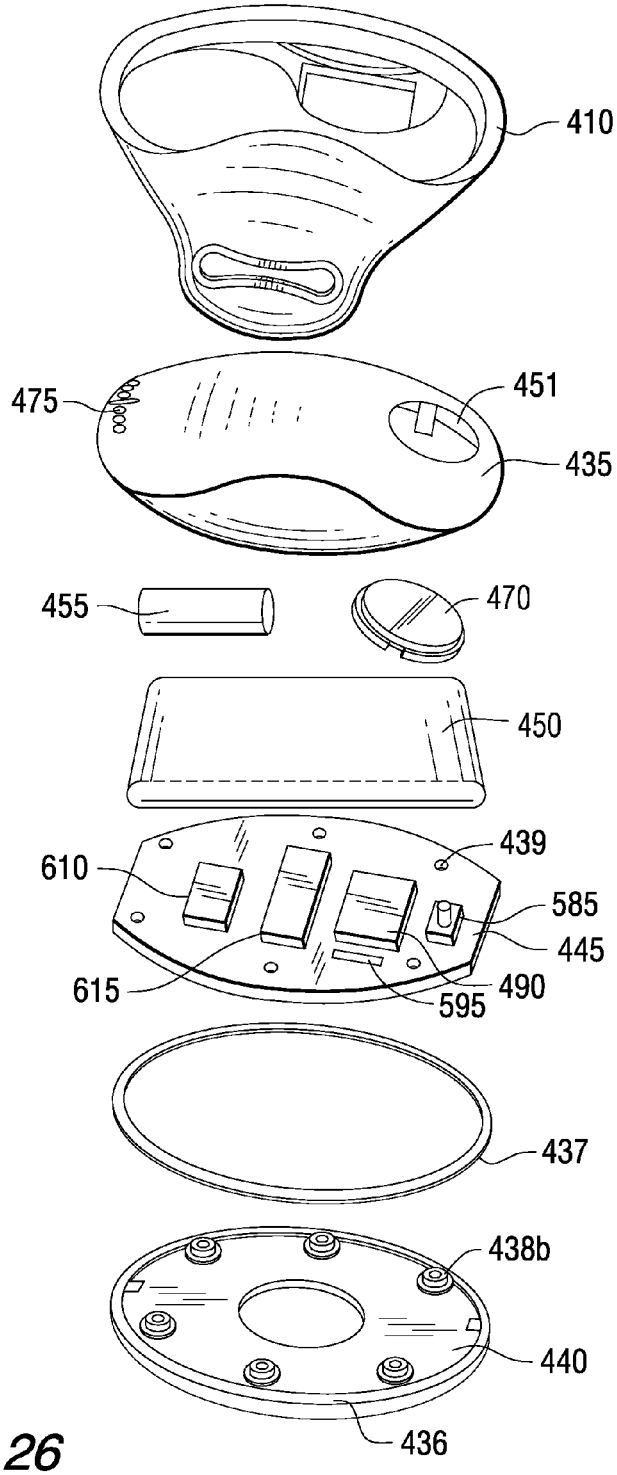
410
475
451
435
455
470
450
610
439
585
445
615
595
490
437
438b
440
436

FIG. 26

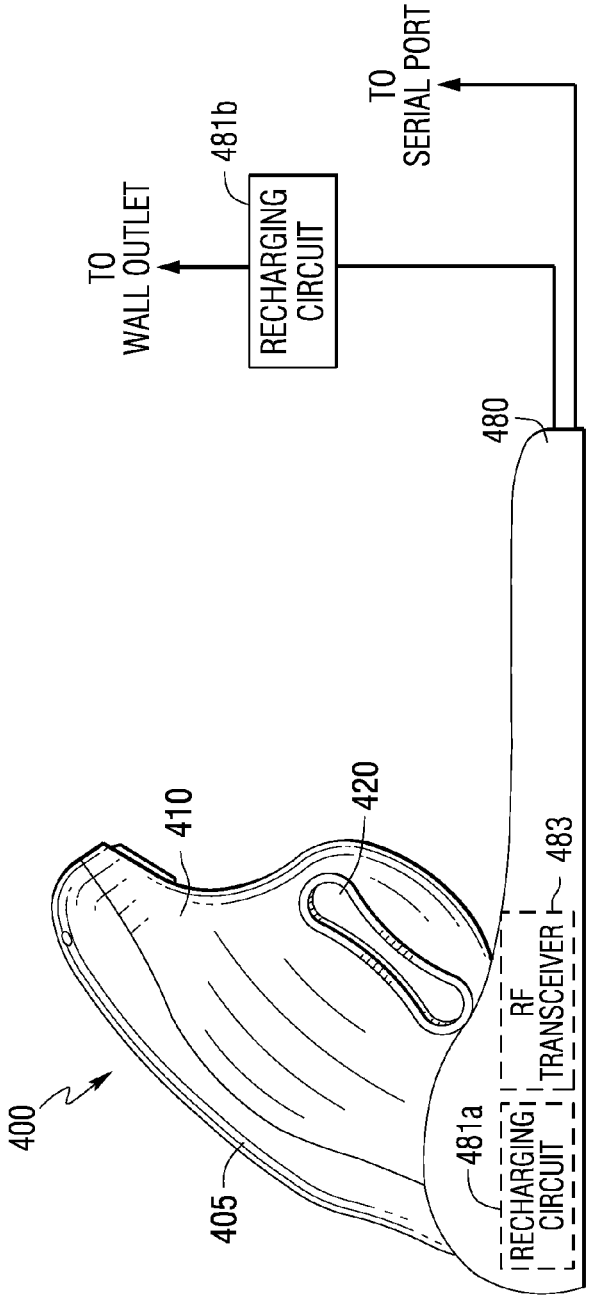
TO
SERIAL PORT
481b
TO
WALL OUTLET
RECHARGING
CIRCUIT
480
410
420
483
RF
TRANSCEIVER
400
481a
RECHARGING
CIRCUIT
405

FIG. 27

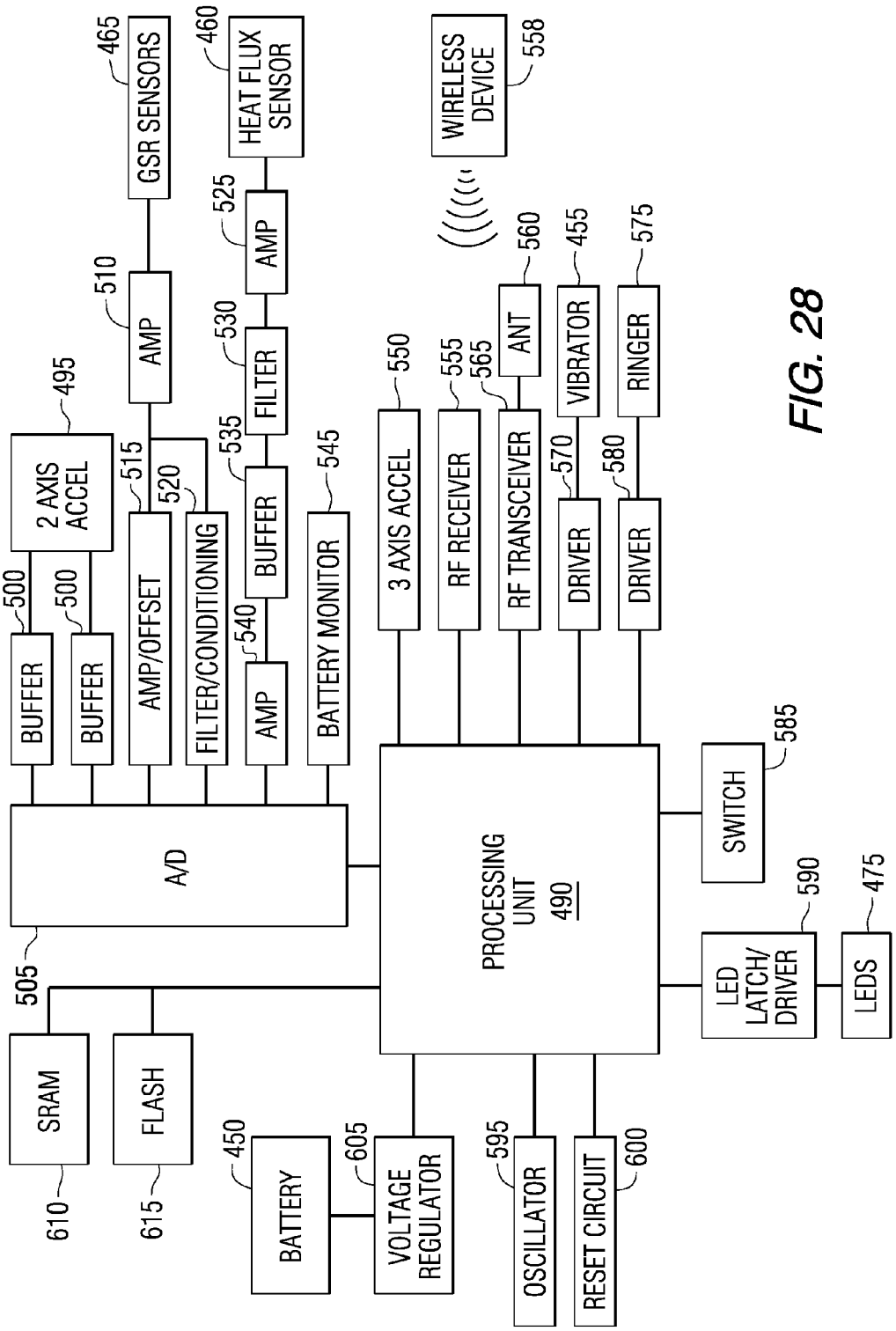
465
GSR SENSORS
460
HEAT FLUX SENSOR
WIRELESS DEVICE
558
525
AMP
510
AMP
530
FILTER
560
ANT
455
VIBRATOR
575
RINGER
495
2 AXIS ACCEL
515
520
535
BUFFER
545
BATTERY MONITOR
550
3 AXIS ACCEL
555
RF RECEIVER
565
RF TRANSCEIVER
570
DRIVER
580
DRIVER
500
BUFFER
500
BUFFER
AMP/OFFSET
FILTER/CONDITIONING
540
AMP
A/D
PROCESSING UNIT 490
585
SWITCH
590
LED LATCH/ DRIVER
475
LEDS
505
SRAM
FLASH
450
BATTERY
605
VOLTAGE REGULATOR
595
OSCILLATOR
600
RESET CIRCUIT
610
615

FIG. 28

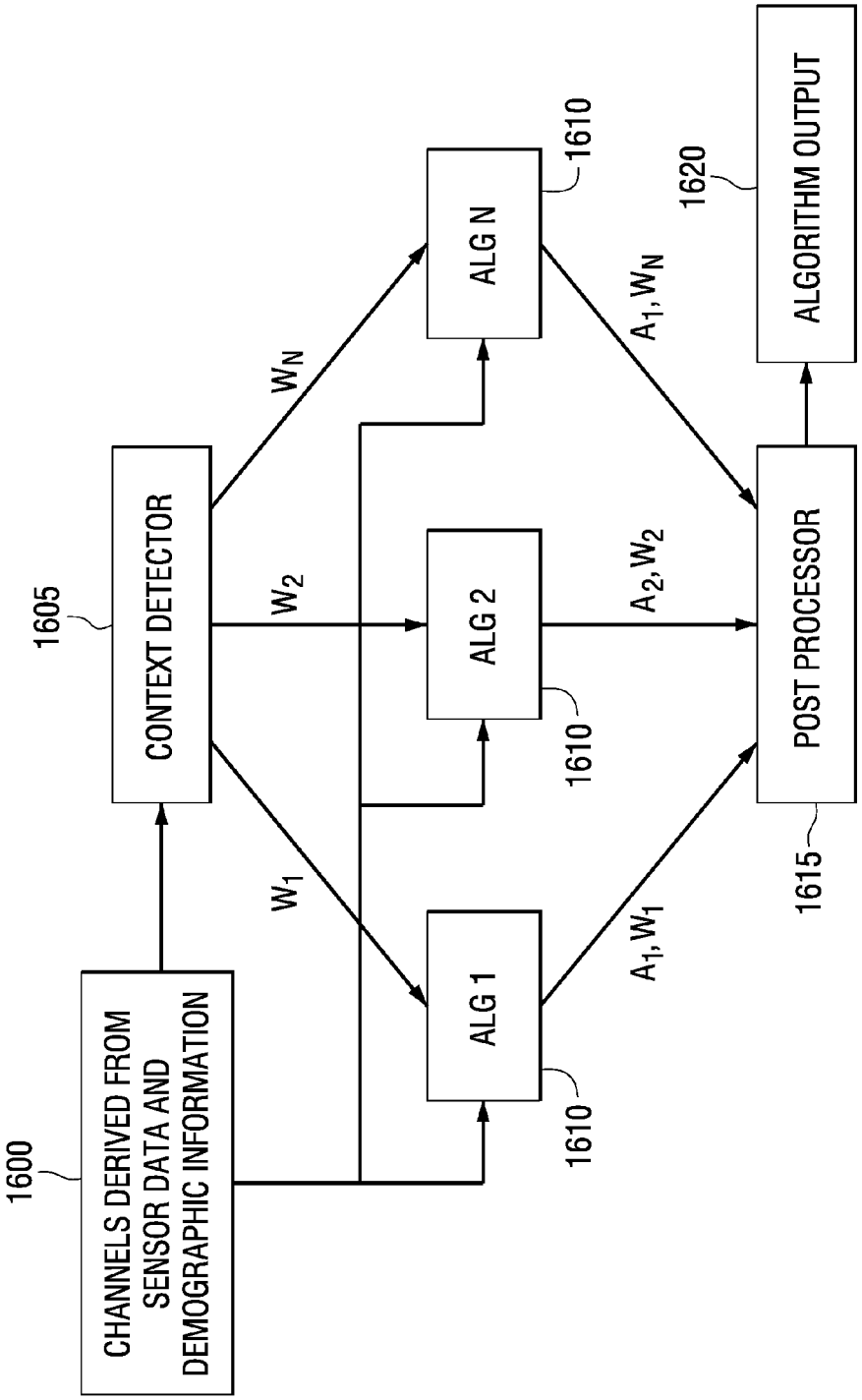
CHANNELS DERIVED FROM SENSOR DATA AND DEMOGRAPHIC INFORMATION
1600
CONTEXT DETECTOR
1605
ALG 1
ALG 2
ALG N
1610
1610
1610
W_1
W_2
W_N
A_1, W_1
A_2, W_2
A_1, W_N
POST PROCESSOR
1615
ALGORITHM OUTPUT
1620

FIG. 29

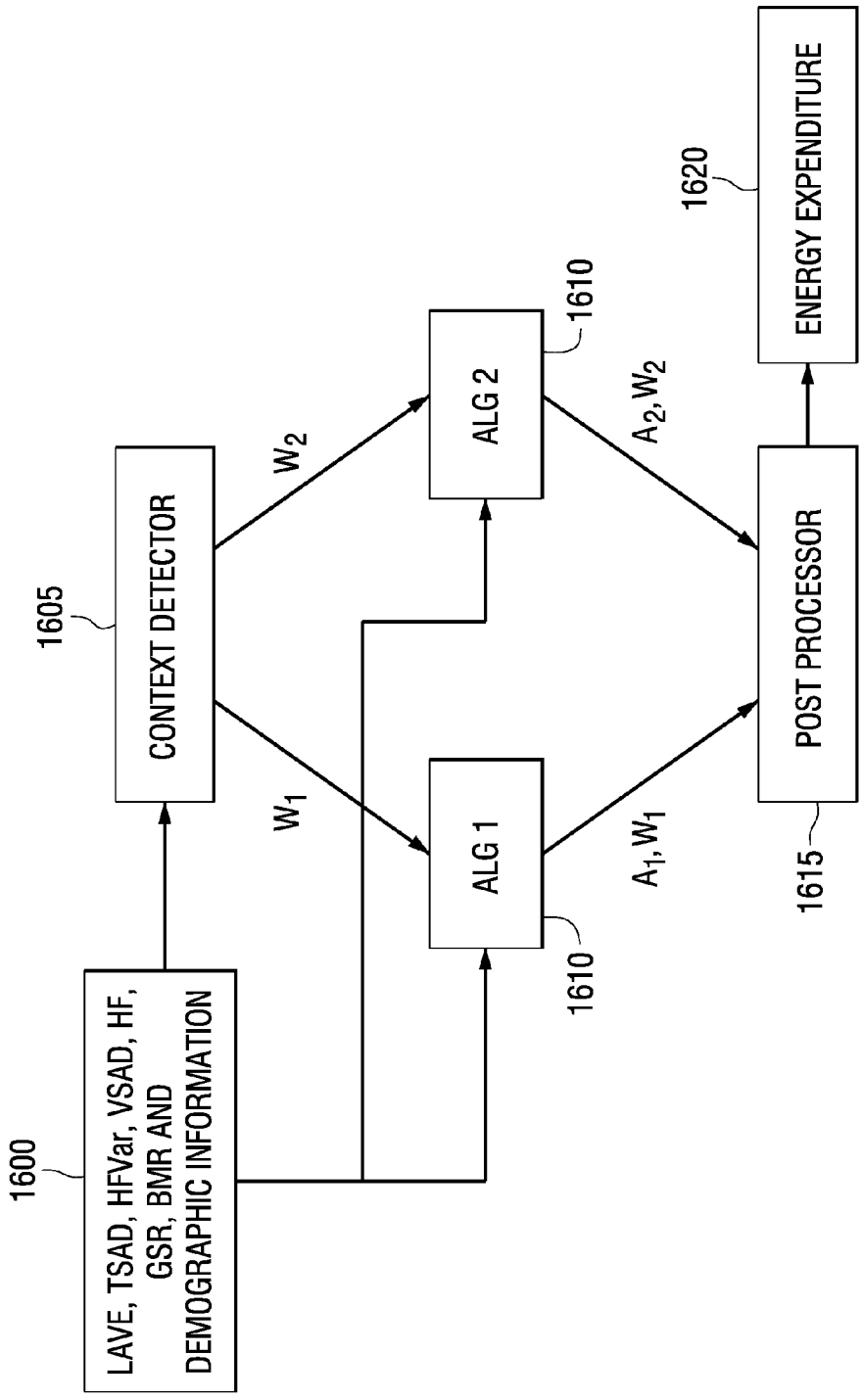
1600
LAVE, TSAD, HFVar, VSAD, HF, GSR, BMR AND DEMOGRAPHIC INFORMATION
1605
CONTEXT DETECTOR
W_1
W_2
ALG 1
ALG 2
1610
1610
A_1, W_1
A_2, W_2
POST PROCESSOR
1615
1620
ENERGY EXPENDITURE

FIG. 30

SYSTEM FOR MONITORING AND MANAGING BODY WEIGHT AND OTHER PHYSIOLOGICAL CONDITIONS INCLUDING ITERATIVE AND PERSONALIZED PLANNING, INTERVENTION AND REPORTING CAPABILITY

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation in part of U.S. application Ser. No. 10/638,588, filed Aug. 11, 2003, now U.S. Pat. No. 6,605,038 which is a continuation of U.S. application Ser. No. 09/602,537, filed Jun. 23, 2000, now U.S. Pat. No. 7,689,437 which is a continuation-in-part of U.S. application Ser. No. 09/595,660, filed Jun. 16, 2000. This application also claims the benefit of U.S. Provisional Application No. 60/502,764 filed on Sep. 13, 2003 and U.S. Provisional Application No. 50/555,280 filed on Mar. 22, 2004.

FIELD OF THE INVENTION

The present invention relates to a weight control system. More specifically, the system may be used as part of a behavioral modification program for calorie control, weight control or general fitness. In particular, the invention, according to one aspect, relates to an apparatus used in conjunction with a software platform for monitoring caloric consumption and/or caloric expenditure of an individual. Additionally, the invention relates to a method of tracking progress toward weight goals.

BACKGROUND OF THE INVENTION

Research has shown that a large number of the top health problems in society are either caused in whole or in part by an unhealthy lifestyle. More and more, our society requires people to lead fast-paced, achievement-oriented lifestyles that often result in poor eating habits, high stress levels, lack of exercise, poor sleep habits and the inability to find the time to center the mind and relax. Additionally, obesity and body weight have become epidemic problems facing a large segment of the population, notably including children and adolescents. Recognizing this fact, people are becoming increasingly interested in establishing a healthier lifestyle.

Traditional medicine, embodied in the form of an HMO or similar organization, does not have the time, the training, or the reimbursement mechanism to address the needs of those individuals interested in a healthier lifestyle. There have been several attempts to meet the needs of these individuals, including a perfusion of fitness programs and exercise equipment, dietary plans, self-help books, alternative therapies, and most recently, a plethora of health information web sites on the Internet. Each of these attempts is targeted to empower the individual to take charge and get healthy. Each of these attempts, however, addresses only part of the needs of individuals seeking a healthier lifestyle and ignores many of the real barriers that most individuals face when trying to adopt a healthier lifestyle. These barriers include the fact that the individual is often left to himself or herself to find motivation, to implement a plan for achieving a healthier lifestyle, to monitor progress, and to brainstorm solutions when problems arise; the fact that existing programs are directed to only certain aspects of a healthier lifestyle, and rarely come as a complete package; and the fact that recommendations are often not targeted to the unique characteristics of the individual or his life circumstances.

With respect to weight loss, specifically, many medical and other commercial methodologies have been developed to assist individuals in losing excess body weight and maintaining an appropriate weight level through various diet, exercise and behavioral modification techniques. Weight Watchers is an example of a weight loss behavior modification system in which an individual manages weight loss with a points system utilizing commercially available foods. All food items are assigned a certain number of points based on serving size and content of fat, fiber and calories. Foods that are high in fat are assigned a higher number of points. Foods that are high in fiber receive a lower number of points. Healthier foods are typically assigned a lower number of points, so the user is encouraged to eat these food items.

A user is assigned a daily points range which represents the total amount of food the user should consume within each day. Instead of directing the user away from a list of forbidden foods, a user is encouraged to enjoy all foods in moderation, as long as they fit within a user's points budget. The program is based on calorie reduction, portion control and modification of current eating habits. Exercise activities are also assigned points which are subtracted from the points accumulated by a user's daily caloric intake.

Weight Watchers attempts to make a user create a balance of exercise and healthy eating in their life. However, because only caloric value of food is specifically tracked, the program tends to fail in teaching the user about the nutritional changes they need to make to maintain weight loss. Calorie content is not the only measurement that a user should take into control when determining what food items to consume. Items that contain the same caloric content may not be nutritiously similar. So, instead of developing healthy eating habits, a user might become dependent on counting points. It is important to note that the Weight Watchers program deals essentially with caloric intake only and not caloric expenditure.

Similarly, Jenny Craig is also a weight loss program. Typically, an individual is assigned a personal consultant who monitors weight loss progress. In addition, the individual will receive pre-selected menus which are based on the Food Guide Pyramid for balanced nutrition. The menus contain Jenny Craig branded food items which are shipped to the individual's home or any other location chosen by the individual. The Jenny Craig program teaches portion control because the food items to be consumed are pre-portioned and supplied by Jenny Craig. However, such a close dietary supervision can be a problem once the diet ends because the diet plan does not teach new eating habits or the value of exercise. Instead it focuses mainly on short term weight loss goals.

The integration of computer and diet tracking systems has created several new and more automated approaches to weight loss. Available methodologies can be tailored to meet the individual's specific physiological characteristics and weight loss goals.

BalanceLog, developed by HealtheTech, Inc. and the subject of U.S. Published Application No. 20020133378 is a software program that provides a system for daily tracking and monitoring of caloric intake and expenditure. The user customizes the program based on metabolism in addition to weight and nutrition goals. The user is able to create both exercise and nutrition plans in addition to tracking progress. However, the BalanceLog system has several limitations.

First, a user must know their resting metabolic rate, which is the number of calories burned at rest. The user can measure their resting metabolic rate. However, a more accurate rate can be measured by appointment at a metabolism measurement location. A typical individual, especially an individual who is beginning a weight and nutrition management plan

may view this requirement as an inconvenience. The system can provide an estimated resting metabolic rate based on a broad population average if a more accurate measurement cannot be made. However, the resting metabolic rate can vary widely between individuals having similar physiological characteristics. Thus, an estimation may not be accurate and would affect future projections of an individual's progress.

Second, the system is limited by the interactivity and compliance of the user. Every aspect of the BalanceLog system is manual. Every item a user eats and every exercise a user does must be logged in the system. If a user fails to do this, the reported progress will not be accurate. This manual data entry required by BalanceLog assumes that the user will be in close proximity to a data entry device, such as a personal digital assistant or a personal computer, to enter daily activities and consumed meals. However, a user may not consistently or reliably be near their data entry device shortly thereafter engaging in an exercise or eating activity. They may be performing the exercise activity at a fitness center or otherwise away from such a device. Similarly, a user may not be eating a certain meal at home, so they may not be able to log the information immediately after consuming the meal. Therefore, a user must maintain a record of all food consumed and activities performed so that these items can be entered into the BalanceLog system at a later time.

Also, the BalanceLog system does not provide for the possibility of estimation. A user must select the food consumed and the corresponding portion size of the food item. If a time lapse has occurred between the meal and the time of entry and the user does not remember the meal, the data may not be entered accurately and the system would suffer from a lack of accuracy. Similarly, if a user does not remember the details of an exercise activity, the data may not be correct.

Finally, the BalanceLog system calculates energy expenditure based only upon the information entered by the user. A user may only log an exercise activity such as running on a treadmill for thirty minutes for a particular day. This logging process does not take into account the actual energy expenditure of the individual, but instead relies on averages or look-up tables based upon general population data, which may not be particularly accurate for any specific individual.

The program also ignores the daily activities of the user such as walking up stairs or running to catch the bus. These daily activities need to be taken into account for a user to accurately determine their total amount of energy expenditure.

Similarly FitDay, a software product developed by Cyser Software, is another system that allows a user to track both nutrition and exercise activity to plan weight loss and monitor progress.

The FitDay software aids a user in controlling diet through the input of food items consumed. This software also tracks the exercise activity and caloric expenditure through the manual data entry by the user. The FitDay software also enables the user to track and graph body measurements for additional motivation to engage in exercise activity. Also, FitDay also focuses on another aspect of weight loss. The system prompts a user for information regarding daily emotions for analysis of the triggers that may affect a user's weight loss progress.

FitDay suffers from the same limitations of Balance Log. FitDay is dependent upon user input for its calculations and weight loss progress analysis. As a result, the information may suffer from a lack of accuracy or compliance because the user might not enter a meal or an activity. Also, the analysis of energy expenditure is dependent on the input of the user and does not take the daily activities of the user into consideration.

Overall, if an individual consumes fewer calories than the number of calories burned, they user should experience a net weight loss. While the methods described above offer a plurality of ways to count consumed calories, they do not offer an efficient way to determine the caloric expenditure. Additionally, they are highly dependent upon compliance with rigorous data entry requirements. Therefore, what is lacking in the art is a management system that can accurately and automatically monitor daily activity and energy expenditure of the user to reduce the need for strict compliance with and the repetitive nature of manual data entry of information.

SUMMARY OF THE INVENTION

A nutrition and activity management system is disclosed that can help an individual meet weight loss goals and achieve an optimum energy balance of calories burned versus calories consumed. The system may be automated and is also adaptable or applicable to measuring a number of other physiological parameters and reporting the same and derivations of such parameters. The preferred embodiment, a weight management system, is directed to achieving an optimum energy balance, which is essential to progressing toward weight loss-specific goals. Most programs, such as the programs discussed above, offer methods of calorie and food consumption tracking, but that is only half of the equation. Without an accurate estimation of energy expenditure, the optimum energy balance cannot be reached. In other embodiments, the system may provide additional or substitute information regarding limits on physical activity, such as for a pregnant or rehabilitating user, or physiological data, such as blood sugar level, for a diabetic.

The management system that is disclosed provides a more accurate estimation of the total energy expenditure of the user. The other programs discussed above can only track energy expenditure through manual input of the user regarding specific physical activity of a certain duration. The management system utilizes an apparatus on the body that continuously monitors the heat given off by a user's body in addition to motion, skin temperature and conductivity. Because the apparatus is continuously worn, data is collected during any physical activity performed by the user, including exercise activity and daily life activity. The apparatus is further designed for comfort and convenience so that long term wear is not unreasonable within a wearer's lifestyle activities. It is to be specifically noted that the apparatus is designed for both continuous and long term wear. Continuous is intended to mean, however, nearly continuous, as the device may be removed for brief periods for hygienic purposes or other de minimus non-use. Long term wear is considered to be for a substantial portion of each day of wear, typically extending beyond a single day. The data collected by the apparatus is uploaded to the software platform for determining the number of calories burned, the number of steps taken and the duration of physical activity.

The management system that is disclosed also provides an easier process for the entry and tracking of caloric consumption. The tracking of caloric consumption provided by the management system is based on the recognition that current manual nutrition tracking methods are too time consuming and difficult to use, which ultimately leads to a low level of compliance, inaccuracy in data collection and a higher percentage of false caloric intake estimates. Most users are too busy to log everything they eat for each meal and tend to forget how much they ate. Therefore, in addition to manual input of consumed food items, the user may select one of several other methods of caloric input which may include an

estimation for a certain meal based upon an average for that meal, duplication of a previous meal and a quick caloric estimate tool. A user is guided through the complex task of recalling what they ate in order to increase compliance and reduce the discrepancy between self-reported and actual caloric intake.

The combination of the information collected from the apparatus and the information entered by the user is used to provide feedback information regarding the user's progress and recommendations for reaching dietary goals. Because of the accuracy of the information, the user can proactively make lifestyle changes to meet weight loss goals, such as adjusting diet or exercising to burn more calories. The system can also predict data indicative of human physiological parameters including energy expenditure and caloric intake for any given relevant time period as well as other detected and derived physiological or contextual information. The user may then be notified as to their actual or predicted progress with respect to the optimum energy balance or other goals for the day.

An apparatus is disclosed for monitoring certain identified human status parameters which includes at least one sensor adapted to be worn on an individual's body. A preferred embodiment utilizes a combination of sensors to provide more accurately sensed data, with the output of the multiple sensors being utilized in the derivation of additional data. The sensor or sensors utilized by the apparatus may include a physiological sensor selected from the group consisting of respiration sensors, temperature sensors, heat flux sensors, body conductance sensors, body resistance sensors, body potential sensors, brain activity sensors, blood pressure sensors, body impedance sensors, body motion sensors, oxygen consumption sensors, body chemistry sensors, body position sensors, body pressure sensors, light absorption sensors, body sound sensors, piezoelectric sensors, electrochemical sensors, strain gauges, and optical sensors. The sensor or sensors are adapted to generate data indicative of at least a first parameter of the individual and a second parameter of the individual, wherein the first parameter is a physiological parameter. The apparatus also includes a processor that receives at least a portion of the data indicative of the first parameter and the second parameter. The processor is adapted to generate derived data from at least a portion of the data indicative of a first parameter and a second parameter, wherein the derived data comprises a third parameter of the individual. The third parameter is an individual status parameter that cannot be directly detected by the at least one sensor.

In an alternate embodiment, the apparatus for monitoring human status parameters is disclosed that includes at least two sensors adapted to be worn on an individual's body selected from the group consisting of physiological sensors and contextual sensors, wherein at least one of the sensors is a physiological sensor. The sensors are adapted to generate data indicative of at least a first parameter of the individual and a second parameter of the individual, wherein the first parameter is physiological. The apparatus also includes a processor for receiving at least a portion of the data indicative of at least a first parameter and a second parameter, the processor being adapted to generate derived data from the data indicative of at least a first parameter and a second parameter. The derived data comprises a third parameter of the individual, for example one selected from the group consisting of ovulation state, sleep state, calories burned, basal metabolic rate, basal temperature, physical activity level, stress level, relaxation level, oxygen consumption rate, rise time, time in zone, recovery time, and nutrition activity. The third parameter is an individual status parameter that cannot be directly detected by any of the at least two sensors.

In either embodiment of the apparatus, the at least two sensors may be both physiological sensors, or may be one physiological sensor and one contextual sensor. The apparatus may further include a housing adapted to be worn on the individual's body, wherein the housing supports the sensors or wherein at least one of the sensors is separately located from the housing. The apparatus may further include a flexible body supporting the housing having first and second members that are adapted to wrap around a portion of the individual's body. The flexible body may support one or more of the sensors. The apparatus may further include wrapping means coupled to the housing for maintaining contact between the housing and the individual's body, and the wrapping means may support one or more of the sensors.

Either embodiment of the apparatus may further include a central monitoring unit remote from the at least two sensors that includes a data storage device. The data storage device receives the derived data from the processor and retrievably stores the derived data therein. The apparatus also includes means for transmitting information based on the derived data from the central monitoring unit to a recipient, which recipient may include the individual or a third party authorized by the individual. The processor may be supported by a housing adapted to be worn on the individual's body, or alternatively may be part of the central monitoring unit.

A weight-loss directed software program is disclosed that automates the tracking of the energy expenditure of the individual through the use of the apparatus and reduces the repetitive nature of data entry in the determination of caloric consumption in addition to providing relevant feedback regarding the user's weight loss goals. The software program is based on the energy balance equation which has two components: energy intake and energy expenditure. The difference between these two values is the energy balance. When this value is negative, a weight loss should be achieved because fewer calories were consumed than expended. A positive energy balance will most likely result in no loss of weight or a weight gain.

The weight-loss directed software program may include an energy intake tracking subsystem, an energy expenditure tracking subsystem, a weight tracking subsystem and an energy balance and feedback subsystem.

The energy intake tracking subsystem preferably incorporates a food database which includes an extensive list of commonly consumed foods, common branded foods available at regional and national food chains, and branded off the shelf entrees and the nutrient information for each item. The user also has the capability to enter custom preparations or recipes which then become a part of the food in the database.

The energy expenditure subsystem includes a data retrieval process to retrieve the data from the apparatus. The system uses the data collected by the apparatus to determine total energy expenditure. The user has the option of manually entering data for an activity engaged in during a time when the apparatus was not available. The system is further provided with the ability to track and recognize certain activity or nutritional intake parameters or patterns and automatically provide such identification to the user on a menu for selection, as disclosed in copending U.S. patent application Ser. No. 10/682,293, the disclosure of which is incorporated by reference. Additionally, the system may directly adopt such identified activities or nutritional information without input from the user, as appropriate.

The energy balance and feedback subsystem provides feedback on behavioral strategies to achieve energy balance

proactively. A feedback and coaching engine analyzes the data generated by the system to provide the user with a variety of choices depending on the progress of the user.

A management system is disclosed which includes an apparatus that continuously monitors a user's energy expenditure and a software platform for the manual input of information by the user regarding physical activity and calories consumed. This manual input may be achieved by the user entering their own food, by a second party entering the food for them such as an assistant in a assisted living situation, or through a second party receiving the information from the user via voice, phone, or other transmission mechanism. Alternatively, the food intake can be automatically gathered through either a monitoring system that captures what food is removed from an storage appliance such as a refrigerator or inserted into a food preparation appliance such as an oven or through a derived measure from one or more physiological parameters.

The system may be further adapted to obtain life activities data of the individual, wherein the information transmitted from the central monitoring unit is also based on the life activities data. The central monitoring unit may also be adapted to generate and provide feedback relating to the degree to which the individual has followed a suggested routine. The feedback may be generated from at least a portion of at least one of the data indicative of at least a first parameter and a second parameter, the derived data and the life activities data. The central monitoring unit may also be adapted to generate and provide feedback to a recipient relating to management of an aspect of at least one of the individual's health and lifestyle. This feedback may be generated from at least one of the data indicative of a first parameter, the data indicative of a second parameter and the derived data. The feedback may include suggestions for modifying the individual's behavior.

The system may be further adapted to include a weight and body fat composition tracking subsystem to interpret data received from: manual input, a second device such as a transceiver enabled weight measuring device, or data collected by the apparatus.

The system may also be further adapted to include a meal planning subsystem that allows a user to customize a meal plan based on individual fitness and weight loss goals. Appropriate foods are recommended to the user based on answers provided to general and medical questionnaires. These questionnaires are used as inputs to the meal plan generation system to ensure that foods are selected that take into consideration specific health conditions or preferences of the user. The system may be provided with functionality to recommend substitution choices based on the food category and exchange values of the food and will match the caloric content between substitutions. The system may be further adapted to generate a list of food or diet supplement intake recommendations based on answers provided by the user to a questionnaire.

The system may also provide the option for the user to save or print a report of summary data. The summary data could provide detailed information about the daily energy intake, daily energy expenditure, weight changes, body fat composition changes and nutrient information if the user has been consistently logging the foods consumed. Reports containing information for a certain time period, such as 7 days, 30 days, 90 days and from the beginning of the system usage may also be provided.

The system may also include an exercise planning subsystem that provides recommendations to the user for cardiovascular and resistance training. The recommendations could be based on the fitness goals submitted by the questionnaire to the system.

The system may also provide feedback to the user in the form of a periodic or intermittent status report. The status report may be an alert located in a box on a location of the screen and is typically set off to attract the user's attention. Status reports and images are generated by creating a key string based on the user's current view and state and may provide information to the user about their weight loss goal progress. This information may include suggestions to meet the user's calorie balance goal for the day.

Although this description addresses weight loss with specificity, it should be understood that this system may also be equally applicable to weight maintenance or weight gain.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the present invention will be apparent upon consideration of the following detailed description of the present invention, taken in conjunction with the following drawings, in which like reference characters refer to like parts, and in which:

FIG. **1** is a diagram of an embodiment of a system for monitoring physiological data and lifestyle over an electronic network according to the present invention;

FIG. **2** is a block diagram of an embodiment of the sensor device shown in FIG. **1**;

FIG. **3** is a block diagram of an embodiment of the central monitoring unit shown in FIG. **1**;

FIG. **4** is a block diagram of an alternate embodiment of the central monitoring unit shown in FIG. **1**;

FIG. **5** is a representation of a preferred embodiment of the Health Manager web page according to an aspect of the present invention;

FIG. **6** is a representation of a preferred embodiment of the nutrition web page according to an aspect of the present invention;

FIG. **7** is an block diagram representing the configuration of the management system for a specific user according to an aspect of the present invention.

FIG. **8** is a block diagram of a preferred embodiment of the weight tracking system according to an aspect of the present invention.

FIG. **9** is a block diagram of a preferred embodiment of the update information wizard interface according to one aspect of the present invention.

FIG. **10** is a representation of a preferred embodiment of the activity level web page according to an aspect of the present invention;

FIG. **11** is a representation of a preferred embodiment of the mind centering web page according to an aspect of the present invention;

FIG. **12** is a representation of a preferred embodiment of the sleep web page according to an aspect of the present invention;

FIG. **13** is a representation of a preferred embodiment of the daily activities web page according to an aspect of the present invention;

FIG. **14** is a representation of a preferred embodiment of the Health Index web page according to an aspect of the present invention;

FIG. **15** is a representation of a preferred embodiment of the Weight Manager interface according to an aspect of the present invention;

FIG. **16** is a logical diagram illustrating the generation of intermittent status reports according to an aspect of the present invention;

FIG. **17** is a logical diagram illustrating the generation of an intermittent status report based on energy expenditure values according to an aspect of the present invention;

FIG. **18** is a logical diagram illustrating the generation of an intermittent status report based on caloric intake in addition to state status determination according to an aspect of the present invention;

FIG. **19** is a logical diagram illustrating the calculation of state determination according to an aspect of the present invention;

FIG. **20** is a front view of a specific embodiment of the sensor device shown in FIG. **1**;

FIG. **21** is a back view of a specific embodiment of the sensor device shown in FIG. **1**;

FIG. **22** is a side view of a specific embodiment of the sensor device shown in FIG. **1**;

FIG. **23** is a bottom view of a specific embodiment of the sensor device shown in FIG. **1**;

FIGS. **24** and **25** are front perspective views of a specific embodiment of the sensor device shown in FIG. **1**;

FIG. **26** is an exploded side perspective view of a specific embodiment of the sensor device shown in FIG. **1**;

FIG. **27** is a side view of the sensor device shown in FIGS. **20** through **26** inserted into a battery recharger unit; and

FIG. **28** is a block diagram illustrating all of the components either mounted on or coupled to the printed circuit board forming a part of the sensor device shown in FIGS. **20** through **26**.

FIG. **29** is a block diagram showing the format of algorithms that are developed according to an aspect of the present invention; and

FIG. **30** is a block diagram illustrating an example algorithm for predicting energy expenditure according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In general, according to the present invention, data relating to the physiological state, the lifestyle and certain contextual parameters of an individual is collected and transmitted, either subsequently or in real-time, to a site, preferably remote from the individual, where it is stored for later manipulation and presentation to a recipient, preferably over an electronic network such as the Internet. Contextual parameters as used herein means parameters relating to activity state or to the environment, surroundings and location of the individual, including, but not limited to, air quality, sound quality, ambient temperature, global positioning and the like. Referring to FIG.**1**, located at user location **5** is sensor device **10** adapted to be placed in proximity with at least a portion of the human body. Sensor device **10** is preferably worn by an individual user on his or her body, for example as part of a garment such as a form fitting shirt, or as part of an arm band or the like. Sensor device **10**, includes one or more sensors, which are adapted to generate signals in response to physiological characteristics of an individual, and a microprocessor. Proximity as used herein means that the sensors of sensor device **10** are separated from the individual's body by a material or the like, or a distance such that the capabilities of the sensors are not impeded.

Sensor device **10** generates data indicative of various physiological parameters of an individual, such as the individual's heart rate, pulse rate, beat-to-beat heart variability, EKG or ECG, respiration rate, skin temperature, core body temperature, heat flow off the body, galvanic skin response or GSR, EMG, EEG, EOG, blood pressure, body fat, hydration level, activity level, oxygen consumption, glucose or blood sugar level, body position, pressure on muscles or bones, and UV radiation exposure and absorption. In certain cases, the data indicative of the various physiological parameters is the signal or signals themselves generated by the one or more sensors and in certain other cases the data is calculated by the microprocessor based on the signal or signals generated by the one or more sensors. Methods for generating data indicative of various physiological parameters and sensors to be used therefor are well known. Table 1 provides several examples of such well known methods and shows the parameter in question, an example method used, an example sensor device used, and the signal that is generated. Table 1 also provides an indication as to whether further processing based on the generated signal is required to generate the data.

TABLE 1

Parameter	Example Method	Example Sensor	Signal	Further Processing
Heart Rate	EKG	2 Electrodes	DC Voltage	Yes
Pulse Rate	BVP	LED Emitter and Optical Sensor	Change in Resistance	Yes
Beat-to-Beat Variability	Heart Beats	2 Electrodes	DC Voltage	Yes
EKG	Skin Surface Potentials	3–10 Electrodes	DC Voltage	No* (depending on location)
Respiration Rate	Chest Volume Change	Strain Gauge	Change in Resistance	Yes
Skin Temperature	Surface Temperature Probe	Thermistors	Change in Resistance	Yes
Core Temperature	Esophageal or Rectal Probe	Thermistors	Change in Resistance	Yes
Heat Flow	Heat Flux	Thermopile	DC Voltage	Yes
Galvanic Skin Response	Skin Conductance	2 Electrodes	Conductance	No
EMG	Skin Surface Potentials	3 Electrodes	DC Voltage	No
EEG	Skin Surface Potentials	Multiple Electrodes	DC Voltage	Yes

TABLE 1-continued

Parameter	Example Method	Example Sensor	Signal	Further Processing
EOG	Eye Movement	Thin Film Piezoelectric Sensors	DC Voltage	Yes
Blood Pressure	Non-Invasive Korotkuff Sounds	Electronic Sphygromarometer	Change in Resistance	Yes
Body Fat	Body Impedance	2 Active Electrodes	Change in Impedance	Yes
Activity	Body Movement	Accelerometer	DC Voltage, Capacitance Changes	Yes
Oxygen Consumption	Oxygen Uptake	Electro-chemical	DC Voltage Change	Yes
Glucose Level	Non-Invasive	Electro-chemical	DC Voltage Change	Yes
Body Position (e.g. supine, erect, sitting)	N/A	Mercury Switch Array	DC Voltage Change	Yes
Muscle Pressure	N/A	Thin Film Piezoelectric Sensors	DC Voltage Change	Yes
UV Radiation Absorption	N/A	UV Sensitive Photo Cells	DC Voltage Change	Yes

It is to be specifically noted that a number of other types and categories of sensors may be utilized alone or in conjunction with those given above, including but not limited to relative and global positioning sensors for determination of location of the user; torque & rotational acceleration for determination of orientation in space; blood chemistry sensors; interstitial fluid chemistry sensors; bio-impedance sensors; and several contextual sensors, such as: pollen, humidity, ozone, acoustic, body and ambient noise and sensors adapted to utilize the device in a biofingerprinting scheme.

The types of data listed in Table 1 are intended to be examples of the types of data that can be generated by sensor device **10**. It is to be understood that other types of data relating to other parameters can be generated by sensor device **10** without departing from the scope of the present invention.

The microprocessor of sensor device **10** may be programmed to summarize and analyze the data. For example, the microprocessor can be programmed to calculate an average, minimum or maximum heart rate or respiration rate over a defined period of time, such as ten minutes. Sensor device **10** may be able to derive information relating to an individual's physiological state based on the data indicative of one or more physiological parameters. The microprocessor of sensor device **10** is programmed to derive such information using known methods based on the data indicative of one or more physiological parameters. Table 2 provides examples of the type of information that can be derived, and indicates some of the types of data that can be used therefor.

TABLE 2

Derived Information	Example Input Data Signals
Ovulation	Skin temperature, core temperature, oxygen consumption
Sleep onset/wake	Beat-to-beat variability, heart rate, pulse rate, respiration rate, skin temperature, core temperature, heat flow, galvanic skin response, EMG, EEG, EOG, blood pressure, oxygen consumption
Calories burned	Heart rate, pulse rate, respiration rate, heat flow, activity, oxygen consumption
Basal metabolic rate	Heart rate, pulse rate, respiration rate, heat flow, activity, oxygen consumption
Basal temperature	Skin temperature, core temperature
Activity level	Heart rate, pulse rate, respiration rate, heat flow, activity, oxygen consumption
Stress level	EKG, beat-to-beat variability, heart rate, pulse rate, respiration rate, skin temperature, heat flow, galvanic skin response, EMG, EEG, blood pressure, activity, oxygen consumption
Relaxation level	EKG, beat-to-beat variability, heart rate, pulse rate, respiration rate, skin temperature, heat flow, galvanic skin response, EMG, EEG, blood pressure, activity, oxygen consumption
Maximum oxygen consumption rate	EKG, heart rate, pulse rate, respiration rate, heat flow, blood pressure, activity, oxygen consumption
Rise time or the time it takes to rise from a resting rate to 85% of a target maximum	Heart rate, pulse rate, heat flow, oxygen consumption
Time in zone or the time heart rate was above 85% of a target maximum	Heart rate, pulse rate, heat flow, oxygen consumption
Recovery time or the time it takes heart rate to return to a resting rate after heart rate was above 85% of a target maximum	Heart rate, pulse rate, heat flow, oxygen consumption

Additionally, sensor device **10** may also generate data indicative of various contextual parameters relating to activity state or the environment surrounding the individual. For example, sensor device **10** can generate data indicative of the air quality, sound level/quality, light quality or ambient temperature near the individual, or even the motion or global positioning of the individual. Sensor device **10** may include one or more sensors for generating signals in response to contextual characteristics relating to the environment surrounding the individual, the signals ultimately being used to generate the type of data described above. Such sensors are well known, as are methods for generating contextual parametric data such as air quality, sound level/quality, ambient temperature and global positioning.

FIG. **2** is a block diagram of an embodiment of sensor device **10**. Sensor device **10** includes at least one sensor **12** and microprocessor **20**. Depending upon the nature of the signal generated by sensor **12**, the signal can be sent through one or more of amplifier **14**, conditioning circuit **16**, and analog-to-digital converter **18**, before being sent to microprocessor **20**. For example, where sensor **12** generates an analog signal in need of amplification and filtering, that signal can be sent to amplifier **14**, and then on to conditioning circuit **16**, which may, for example, be a band pass filter. The amplified and conditioned analog signal can then be transferred to analog-to-digital converter **18**, where it is converted to a digital signal. The digital signal is then sent to microprocessor **20**. Alternatively, if sensor **12** generates a digital signal, that signal can be sent directly to microprocessor **20**.

A digital signal or signals representing certain physiological and/or contextual characteristics of the individual user may be used by microprocessor **20** to calculate or generate data indicative of physiological and/or contextual parameters of the individual user. Microprocessor **20** is programmed to derive information relating to at least one aspect of the individual's physiological state. It should be understood that microprocessor **20** may also comprise other forms of processors or processing devices, such as a microcontroller, or any other device that can be programmed to perform the functionality described herein.

Optionally, central processing unit may provide operational control or, at a minimum, selection of an audio player device **21**. As will be apparent to those skilled in the art, audio player **21** is of the type which either stores and plays or plays separately stored audio media. The device may control the output of audio player **21**, as described in more detail below, or may merely furnish a user interface to permit control of audio player **21** by the wearer.

The data indicative of physiological and/or contextual parameters can, according to one embodiment of the present invention, be sent to memory **22**, such as flash memory, where it is stored until uploaded in the manner to be described below. Although memory **22** is shown in FIG. **2** as a discrete element, it will be appreciated that it may also be part of microprocessor **20**. Sensor device **10** also includes input/output circuitry **24**, which is adapted to output and receive as input certain data signals in the manners to be described herein. Thus, memory **22** of the sensor device **10** will build up, over time, a store of data relating to the individual user's body and/or environment. That data is periodically uploaded from sensor device **10** and sent to remote central monitoring unit **30**, as shown in FIG. **1**, where it is stored in a database for subsequent processing and presentation to the user, preferably through a local or global electronic network such as the Internet. This uploading of data can be an automatic process that is initiated by sensor device **10** periodically or upon the happening of an event such as the detection by sensor device **10** of a heart rate below a certain level, or can be initiated by the individual user or some third party authorized by the user, preferably according to some periodic schedule, such as every day at 10:00 p.m. Alternatively, rather than storing data in memory **22**, sensor device **10** may continuously upload data in real time.

The uploading of data from sensor device **10** to central monitoring unit **30** for storage can be accomplished in various ways. In one embodiment, the data collected by sensor device **10** is uploaded by first transferring the data to personal computer **35** shown in FIG. **1** by means of physical connection **40**, which, for example, may be a serial connection such as an RS232 or USB port. This physical connection may also be accomplished by using a cradle, not shown, that is electronically coupled to personal computer **35** into which sensor device **10** can be inserted, as is common with many commercially available personal digital assistants. The uploading of data could be initiated by then pressing a button on the cradle or could be initiated automatically upon insertion of sensor device **10** or upon proximity to a wireless receiver. The data collected by sensor device **10** may be uploaded by first transferring the data to personal computer **35** by means of short-range wireless transmission, such as infrared or RF transmission, as indicated at **45**.

Once the data is received by personal computer **35**, it is optionally compressed and encrypted by any one of a variety of well known methods and then sent out over a local or global electronic network, preferably the Internet, to central monitoring unit **30**. It should be noted that personal computer **35** can be replaced by any computing device that has access to and that can transmit and receive data through the electronic network, such as, for example, a personal digital assistant such as the Palm VII sold by Palm, Inc., or the Blackberry 2-way pager sold by Research in Motion, Inc.

Alternatively, the data collected by sensor device **10**, after being encrypted and, optionally, compressed by microprocessor **20**, may be transferred to wireless device **50**, such as a 2-way pager or cellular phone, for subsequent long distance wireless transmission to local telco site **55** using a wireless protocol such as e-mail or as ASCII or binary data. Local telco site **55** includes tower **60** that receives the wireless transmission from wireless device **50** and computer **65** connected to tower **60**. According to the preferred embodiment, computer **65** has access to the relevant electronic network, such as the Internet, and is used to transmit the data received in the form of the wireless transmission to the central monitoring unit **30** over the Internet. Although wireless device **50** is shown in FIG. **1** as a discrete device coupled to sensor device **10**, it or a device having the same or similar functionality may be embedded as part of sensor device **10**.

Sensor device **10** may be provided with a button to be used to time stamp events such as time to bed, wake time, and time of meals. These time stamps are stored in sensor device **10** and are uploaded to central monitoring unit **30** with the rest of the data as described above. The time stamps may include a digitally recorded voice message that, after being uploaded to central monitoring unit **30**, are translated using voice recognition technology into text or some other information format that can be used by central monitoring unit **30**. Note that in an alternate embodiment, these time-stamped events can be automatically detected.

In addition to using sensor device **10** to automatically collect physiological data relating to an individual user, a kiosk could be adapted to collect such data by, for example, weighing the individual, providing a sensing device similar to sensor device **10** on which an individual places his or her hand or another part of his or her body, or by scanning the indi-

vidual's body using, for example, laser technology or an iStat blood analyzer. The kiosk would be provided with processing capability as described herein and access to the relevant electronic network, and would thus be adapted to send the collected data to the central monitoring unit **30** through the electronic network. A desktop sensing device, again similar to sensor device **10**, on which an individual places his or her hand or another part of his or her body may also be provided. For example, such a desktop sensing device could be a blood pressure monitor in which an individual places his or her arm. An individual might also wear a ring having a sensor device **10** incorporated therein. A base, not shown, could then be provided which is adapted to be coupled to the ring. The desktop sensing device or the base just described may then be coupled to a computer such as personal computer **35** by means of a physical or short range wireless connection so that the collected data could be uploaded to central monitoring unit **30** over the relative electronic network in the manner described above. A mobile device such as, for example, a personal digital assistant, might also be provided with a sensor device **10** incorporated therein. Such a sensor device **10** would be adapted to collect data when mobile device is placed in proximity with the individual's body, such as by holding the device in the palm of one's hand, and upload the collected data to central monitoring unit **30** in any of the ways described herein.

An alternative embodiment includes the incorporation of third party devices, not necessary worn on the body, collect additional data pertaining to physiological conditions. Examples include portable blood analyzers, glucose monitors, weight scales, blood pressure cuffs, pulse oximeters, CPAP machines, portable oxygen machines, home thermostats, treadmills, cell phones and GPS locators. The system could collect from, or in the case of a treadmill or CPAP, control these devices, and collect data to be integrated into the streams for real time or future derivations of new parameters. An example of this is a pulse oximeter on the user's finger could help measure pulse and therefore serve a surrogate reading for blood pressure. Additionally, a user could utilize one of these other devices to establish baseline readings in order to calibrate the device.

Furthermore, in addition to collecting data by automatically sensing such data in the manners described above, individuals can also manually provide data relating to various life activities that is ultimately transferred to and stored at central monitoring unit **30**. An individual user can access a web site maintained by central monitoring unit **30** and can directly input information relating to life activities by entering text freely, by responding to questions posed by the web site, or by clicking through dialog boxes provided by the web site. Central monitoring unit **30** can also be adapted to periodically send electronic mail messages containing questions designed to elicit information relating to life activities to personal computer **35** or to some other device that can receive electronic mail, such as a personal digital assistant, a pager, or a cellular phone. The individual would then provide data relating to life activities to central monitoring unit **30** by responding to the appropriate electronic mail message with the relevant data. Central monitoring unit **30** may also be adapted to place a telephone call to an individual user in which certain questions would be posed to the individual user. The user could respond to the questions by entering information using a telephone keypad, or by voice, in which case conventional voice recognition technology would be used by central monitoring unit **30** to receive and process the response. The telephone call may also be initiated by the user, in which case the user could speak to a person directly or enter information using the keypad or by voice/voice recognition technology. Central monitoring unit **30** may also be given access to a source of information controlled by the user, for example the user's electronic calendar such as that provided with the Outlook product sold by Microsoft Corporation of Redmond, Wash., from which it could automatically collect information. The data relating to life activities may relate to the eating, sleep, exercise, mind centering or relaxation, and/or daily living habits, patterns and/or activities of the individual. Thus, sample questions may include: What did you have for lunch today? What time did you go to sleep last night? What time did you wake up this morning? How long did you run on the treadmill today?

Feedback may also be provided to a user directly through sensor device **10** in a visual form, for example through an LED or LCD or by constructing sensor device **10**, at least in part, of a thermochromatic plastic, in the form of an acoustic signal or in the form of tactile feedback such as vibration. Such feedback may be a reminder or an alert to eat a meal or take medication or a supplement such as a vitamin, to engage in an activity such as exercise or meditation, or to drink water when a state of dehydration is detected. Additionally, a reminder or alert can be issued in the event that a particular physiological parameter such as ovulation has been detected, a level of calories burned during a workout has been achieved or a high heart rate or respiration rate has been encountered.

As will be apparent to those of skill in the art, it may be possible to download data from central monitoring unit **30** to sensor device **10**. The flow of data in such a download process would be substantially the reverse of that described above with respect to the upload of data from sensor device **10**. Thus, it is possible that the firmware of microprocessor **20** of sensor device **10** can be updated or altered remotely, i.e., the microprocessor can be reprogrammed, by downloading new firmware to sensor device **10** from central monitoring unit **30** for such parameters as timing and sample rates of sensor device **10**. Also, the reminders/alerts provided by sensor device **10** may be set by the user using the web site maintained by central monitoring unit **30** and subsequently downloaded to the sensor device **10**.

Referring to FIG. **3**, a block diagram of an embodiment of central monitoring unit **30** is shown. Central monitoring unit **30** includes CSU/DSU **70** which is connected to router **75**, the main function of which is to take data requests or traffic, both incoming and outgoing, and direct such requests and traffic for processing or viewing on the web site maintained by central monitoring unit **30**. Connected to router **75** is firewall **80**. The main purpose of firewall **80** is to protect the remainder of central monitoring unit **30** from unauthorized or malicious intrusions. Switch **85**, connected to firewall **80**, is used to direct data flow between middleware servers **95***a* through **95***c* and database server **110**. Load balancer **90** is provided to spread the workload of incoming requests among the identically configured middleware servers **95***a* through **95***c*. Load balancer **90**, a suitable example of which is the F5 ServerIron product sold by Foundry Networks, Inc. of San Jose, Calif., analyzes the availability of each middleware server **95***a* through **95***c*, and the amount of system resources being used in each middleware server **95***a* through **95***c*, in order to spread tasks among them appropriately.

Central monitoring unit **30** includes network storage device **100**, such as a storage area network or SAN, which acts as the central repository for data. In particular, network storage device **100** comprises a database that stores all data gathered for each individual user in the manners described above. An example of a suitable network storage device **100** is the Symmetrix product sold by EMC Corporation of Hopkinton,

Mass. Although only one network storage device **100** is shown in FIG. **3**, it will be understood that multiple network storage devices of various capacities could be used depending on the data storage needs of central monitoring unit **30**. Central monitoring unit **30** also includes database server **110** which is coupled to network storage device **100**. Database server **110** is made up of two main components: a large scale multiprocessor server and an enterprise type software server component such as the 8/8i component sold by Oracle Corporation of Redwood City, Calif., or the 506 7 component sold by Microsoft Corporation of Redmond, Wash. The primary functions of database server **110** are that of providing access upon request to the data stored in network storage device **100**, and populating network storage device **100** with new data. Coupled to network storage device **100** is controller **115**, which typically comprises a desktop personal computer, for managing the data stored in network storage device **100**.

Middleware servers **95***a* through **95***c*, a suitable example of which is the 22OR Dual Processor sold by Sun Microsystems, Inc. of Palo Alto, Calif., each contain software for generating and maintaining the corporate or home web page or pages of the web site maintained by central monitoring unit **30**. As is known in the art, a web page refers to a block or blocks of data available on the World-Wide Web comprising a file or files written in Hypertext Markup Language or HTML, and a web site commonly refers to any computer on the Internet running a World-Wide Web server process. The corporate or home web page or pages are the opening or landing web page or pages that are accessible by all members of the general public that visit the site by using the appropriate uniform resource locator or URL. As is known in the art, URLs are the form of address used on the World-Wide Web and provide a standard way of specifying the location of an object, typically a web page, on the Internet. Middleware servers **95***a* through **95***c* also each contain software for generating and maintaining the web pages of the web site of central monitoring unit **30** that can only be accessed by individuals that register and become members of central monitoring unit **30**. The member users will be those individuals who wish to have their data stored at central monitoring unit **30**. Access by such member users is controlled using passwords for security purposes. Preferred embodiments of those web pages are described in detail below and are generated using collected data that is stored in the database of network storage device **100**.

Middleware servers **95***a* through **95***c* also contain software for requesting data from and writing data to network storage device **100** through database server **110**. When an individual user desires to initiate a session with the central monitoring unit **30** for the purpose of entering data into the database of network storage device **100**, viewing his or her data stored in the database of network storage device **100**, or both, the user visits the home web page of central monitoring unit **30** using a browser program such as Internet Explorer distributed by Microsoft Corporation of Redmond, Wash., and logs in as a registered user. Load balancer **90** assigns the user to one of the middleware servers **95***a* through **95***c*, identified as the chosen middleware server. A user will preferably be assigned to a chosen middleware server for each entire session. The chosen middleware server authenticates the user using any one of many well known methods, to ensure that only the true user is permitted to access the information in the database. A member user may also grant access to his or her data to a third party such as a health care provider or a personal trainer. Each authorized third party may be given a separate password and may view the member user's data using a conventional browser. It is therefore possible for both the user and the third party to be the recipient of the data.

When the user is authenticated, the chosen middleware server requests, through database server **110**, the individual user's data from network storage device **100** for a predetermined time period. The predetermined time period is preferably thirty days. The requested data, once received from network storage device **100**, is temporarily stored by the chosen middleware server in cache memory. The cached data is used by the chosen middleware server as the basis for presenting information, in the form of web pages, to the user again through the user's browser. Each middleware server **95***a* through **95***c* is provided with appropriate software for generating such web pages, including software for manipulating and performing calculations utilizing the data to put the data in appropriate format for presentation to the user. Once the user ends his or her session, the data is discarded from cache. When the user initiates a new session, the process for obtaining and caching data for that user as described above is repeated. This caching system thus ideally requires that only one call to the network storage device **100** be made per session, thereby reducing the traffic that database server **110** must handle. Should a request from a user during a particular session require data that is outside of a predetermined time period of cached data already retrieved, a separate call to network storage device **100** may be performed by the chosen middleware server. The predetermined time period should be chosen, however, such that such additional calls are minimized. Cached data may also be saved in cache memory so that it can be reused when a user starts a new session, thus eliminating the need to initiate a new call to network storage device **100**.

As described in connection with Table 2, the microprocessor of sensor device **10** may be programmed to derive information relating to an individual's physiological state based on the data indicative of one or more physiological parameters. Central monitoring unit **30**, and preferably middleware servers **95***a* through **95***c*, may also be similarly programmed to derive such information based on the data indicative of one or more physiological parameters.

It is also contemplated that a user will input additional data during a session, for example, information relating to the user's eating or sleeping habits. This additional data is preferably stored by the chosen middleware server in a cache during the duration of the user's session. When the user ends the session, this additional new data stored in a cache is transferred by the chosen middleware server to database server **110** for population in network storage device **100**. Alternatively, in addition to being stored in a cache for potential use during a session, the input data may also be immediately transferred to database server **110** for population in network storage device **100**, as part of a write-through cache system which is well known in the art.

Data collected by sensor device **10** shown in FIG. **1** is periodically uploaded to central monitoring unit **30**. Either by long distance wireless transmission or through personal computer **35**, a connection to central monitoring unit **30** is made through an electronic network, preferably the Internet. In particular, connection is made to load balancer **90** through CSU/DSU **70**, router **75**, firewall **80** and switch **85**. Load balancer **90** then chooses one of the middleware servers **95***a* through **95***c* to handle the upload of data, hereafter called the chosen middleware server. The chosen middleware server authenticates the user using any one of many well known methods. If authentication is successful, the data is uploaded to the chosen middleware server as described above, and is ultimately transferred to database server **110** for population in the network storage device **100**.

Referring to FIG. **4**, an alternate embodiment of central monitoring unit **30** is shown. In addition to the elements shown and described with respect to FIG. **3**, the embodiment of the central monitoring unit **30** shown in FIG. **4** includes a mirror network storage device **120** which is a redundant backup of network storage device **100**. Coupled to mirror network storage device **120** is controller **122**. Data from network storage device **100** is periodically copied to mirror network storage device **120** for data redundancy purposes.

Third parties such as insurance companies or research institutions may be given access, possibly for a fee, to certain of the information stored in mirror network storage device **120**. Preferably, in order to maintain the confidentiality of the individual users who supply data to central monitoring unit **30**, these third parties are not given access to such user's individual database records, but rather are only given access to the data stored in mirror network storage device **120** in aggregate form. Such third parties may be able to access the information stored in mirror network storage device **120** through the Internet using a conventional browser program. Requests from third parties may come in through CSU/DSU **70**, router **75**, firewall **80** and switch **85**. In the embodiment shown in FIG. **4**, a separate load balancer **130** is provided for spreading tasks relating to the accessing and presentation of data from mirror drive array **120** among identically configured middleware servers **135***a* through **135***c*. Middleware servers **135***a* through **135***c* each contain software for enabling the third parties to, using a browser, formulate queries for information from mirror network storage device **120** through separate database server **125**. Middleware servers **135***a* through **135***c* also contain software for presenting the information obtained from mirror network storage device **120** to the third parties over the Internet in the form of web pages. In addition, the third parties can choose from a series of prepared reports that have information packaged along subject matter lines, such as various demographic categories.

As will be apparent to one of skill in the art, instead of giving these third parties access to the backup data stored in mirror network storage device **120**, the third parties may be given access to the data stored in network storage device **100**. Also, instead of providing load balancer **130** and middleware servers **135***a* through **135***c*, the same functionality, although at a sacrificed level of performance, could be provided by load balancer **90** and middleware servers **95***a* through **95***c*.

When an individual user first becomes a registered user or member, that user completes a detailed survey. The purposes of the survey are to: identify unique characteristics/circumstances for each user that they might need to address in order to maximize the likelihood that they will implement and maintain a healthy lifestyle as suggested by central monitoring unit **30**; gather baseline data which will be used to set initial goals for the individual user and facilitate the calculation and display of certain graphical data output such as the Health Index pistons; identify unique user characteristics and circumstances that will help central monitoring unit **30** customize the type of content provided to the user in the Health Manager's Daily Dose; and identify unique user characteristics and circumstances that the Health Manager can guide the user to address as possible barriers to a healthy lifestyle through the problem-solving function of the Health Manager.

In an alternative embodiment specifically directed to a weight loss or management application, as more fully described herein, a user may elect to wear the sensor device **10** long term or continuously in order to observe changes in certain health or weight related parameters. Alternatively, the user may elect to only wear the sensor device **10** for a brief, initial period of time in order to establish a baseline or initial evaluation of their typical daily caloric intake and energy expenditure. This information may form the basis for diet and/or exercise plans, menu selections, meal plans and the like, and progress may be checked periodically by returning to use of the sensor device **10** for brief periods within the time frame established for the completion of any relevant weight loss or change goal.

The specific information to be surveyed may include: key individual temperamental characteristics, including activity level, regularity of eating, sleeping, and bowel habits, initial response to situations, adaptability, persistence, threshold of responsiveness, intensity of reaction, and quality of mood; the user's level of independent functioning, i.e., self-organization and management, socialization, memory, and academic achievement skills; the user's ability to focus and sustain attention, including the user's level of arousal, cognitive tempo, ability to filter distractions, vigilance, and self-monitoring; the user's current health status including current weight, height, and blood pressure, most recent general physician visit, gynecological exam, and other applicable physician/healthcare contacts, current medications and supplements, allergies, and a review of current symptoms and/or health-related behaviors; the user's past health history, i.e., illnesses/surgeries, family history, and social stress events, such as divorce or loss of a job, that have required adjustment by the individual; the user's beliefs, values and opinions about health priorities, their ability to alter their behavior and, what might contribute to stress in their life, and how they manage it; the user's degree of self-awareness, empathy, empowerment, and self-esteem, and the user's current daily routines for eating, sleeping, exercise, relaxation and completing activities of daily living; and the user's perception of the temperamental characteristics of two key persons in their life, for example, their spouse, a friend, a co-worker, or their boss, and whether there are clashes present in their relationships that might interfere with a healthy lifestyle or contribute to stress.

In the weight loss or management application, an individual user first becomes a registered user or member of a software platform and is issued a body monitoring apparatus that collects data from the user. The user may further personalize the apparatus by input of specific information into the software platform. This information may include: name, birth date, height, weight, gender, waistline measurements, body type, smoker/nonsmoker, lifestyle, typical activities, usual bed time and usual wake time. After the user connects the apparatus to a personal computer or other similar device by any of the means of the connectivity described above, the apparatus configuration is updated with this information. The user may also have the option to set a reminder which may be a reminder to take a vitamin at a certain time, to engage in physical activity, or to upload data. After the configuration process is complete, the program displays how the device should be worn on the body, and the user removes the apparatus from the personal computer for placement of the apparatus in the appropriate location on the body for the collection of data. Alternatively, some of this personalization can happen through an initial trial wearing period.

In the more generally directed embodiments, each member user will have access, through the home web page of central monitoring unit **30**, to a series of web pages customized for that user, referred to as the Health Manager. The opening Health Manager web page **150** is shown in FIG. **5**. The Health Manager web pages are the main workspace area for the member user. The Health Manager web pages comprise a utility through which central monitoring unit **30** provides various types and forms of data, commonly referred to as

analytical status data, to the user that is generated from the data it collects or generates, namely one or more of: the data indicative of various physiological parameters generated by sensor device **10**; the data derived from the data indicative of various physiological parameters; the data indicative of various contextual parameters generated by sensor device **10**; and the data input by the user. Analytical status data is characterized by the application of certain utilities or algorithms to convert one or more of the data indicative of various physiological parameters generated by sensor device **10**, the data derived from the data indicative of various physiological parameters, the data indicative of various contextual parameters generated by sensor device **10**, and the data input by the user into calculated health, wellness and lifestyle indicators. For example, based on data input by the user relating to the foods he or she has eaten, things such as calories and amounts of proteins, fats, carbohydrates, and certain vitamins can be calculated. As another example, skin temperature, heart rate, respiration rate, heat flow and/or GSR can be used to provide an indicator to the user of his or her stress level over a desired time period. As still another example, skin temperature, heat flow, beat-to-beat heart variability, heart rate, pulse rate, respiration rate, core temperature, galvanic skin response, EMG, EEG, EOG, blood pressure, oxygen consumption, ambient sound and body movement or motion as detected by a device such as an accelerometer can be used to provide indicators to the user of his or her sleep patterns over a desired time period.

Located on the opening Health Manager web page **150** is Health Index **155**. Health Index **155** is a graphical utility used to measure and provide feedback to member users regarding their performance and the degree to which they have succeeded in reaching a healthy daily routine suggested by central monitoring unit **30**. Health Index **155** thus provides an indication for the member user to track his or her progress. Health Index **155** includes six categories relating to the user's health and lifestyle: Nutrition, Activity Level, Mind Centering, Sleep, Daily Activities and How You Feel. The Nutrition category relates to what, when and how much a person eats and drinks. The Activity Level category relates to how much a person moves around. The Mind Centering category relates to the quality and quantity of time a person spends engaging in some activity that allows the body to achieve a state of profound relaxation while the mind becomes highly alert and focused. The Sleep category relates to the quality and quantity of a person's sleep. The Daily Activities category relates to the daily responsibilities and health risks people encounter. Finally, the How You Feel category relates to the general perception that a person has about how they feel on a particular day. Each category has an associated level indicator or piston that indicates, preferably on a scale ranging from poor to excellent, how the user is performing with respect to that category.

When each member user completes the initial survey described above, a profile is generated that provides the user with a summary of his or her relevant characteristics and life circumstances. A plan and/or set of goals is provided in the form of a suggested healthy daily routine. The suggested healthy daily routine may include any combination of specific suggestions for incorporating proper nutrition, exercise, mind centering, sleep, and selected activities of daily living in the user's life. Prototype schedules may be offered as guides for how these suggested activities can be incorporated into the user's life. The user may periodically retake the survey, and based on the results, the items discussed above will be adjusted accordingly.

The Nutrition category is calculated from both data input by the user and sensed by sensor device **10**. The data input by the user comprises the time and duration of breakfast, lunch, dinner and any snacks, and the foods eaten, the supplements such as vitamins that are taken, and the water and other liquids consumed during a relevant, pre-selected time period. Based upon this data and on stored data relating to known properties of various foods, central monitoring unit **30** calculates well known nutritional food values such as calories and amounts of proteins, fats, carbohydrates, vitamins, etc., consumed.

The Nutrition Health Index piston level is preferably determined with respect to the following suggested healthy daily routine: eat at least three meals; eat a varied diet consisting of 6-11 servings of bread, pasta, cereal, and rice, 2-4 servings fruit, 3-5 servings of vegetables, 2-3 servings of fish, meat, poultry, dry beans, eggs, and nuts, and 2-3 servings of milk, yogurt and cheese; and drink 8 or more 8 ounce glasses of water. This routine may be adjusted based on information about the user, such as sex, age, height and/or weight. Certain nutritional targets may also be set by the user or for the user, relating to daily calories, protein, fiber, fat, carbohydrates, and/or water consumption and percentages of total consumption. Parameters utilized in the calculation of the relevant piston level include the number of meals per day, the number of glasses of water, and the types and amounts of food eaten each day as input by the user.

Nutritional information is presented to the user through nutrition web page **160** as shown in FIG. **6**. The preferred nutritional web page **160** includes nutritional fact charts **165** and **170** which illustrate actual and target nutritional facts, respectively as pie charts, and nutritional intake charts **175** and **180** which show total actual nutritional intake and target nutritional intake, respectively as pie charts. Nutritional fact charts **165** and **170** preferably show a percentage breakdown of items such as carbohydrates, protein and fat, and nutritional intake charts **175** and **180** are preferably broken down to show components such as total and target calories, fat, carbohydrates, protein, and vitamins. Web page **160** also includes meal and water consumption tracking **185** with time entries, hyperlinks **190** which allow the user to directly access nutrition-related news items and articles, suggestions for refining or improving daily routine with respect to nutrition and affiliate advertising elsewhere on the network, and calendar **195** for choosing between views having variable and selectable time periods. The items shown at **190** may be selected and customized based on information learned about the individual in the survey and on their performance as measured by the Health Index.

In the weight management embodiment, a user may also have access through central monitoring unit **30** to a software platform referred to as the Weight Manager which may be included in the Health Manager module or independent. It is also contemplated that Weight Manager may be a web-based application.

When the Weight Manager software platform is initialized, a registered user may login to the Weight Manager. If a user is not registered, they must complete the registration process before using another part of the software platform. The user begins the registration process by selecting a user name and password and entering the serial number of the apparatus.

FIG. **7** is a block diagram illustrating the steps used to configure the personalized Weight Manager. During the initial configuration of the Weight Manager, the user may personalize the system with specific information in the user profile **1000** of the Weight Manager. The user may also return to the user profile **1000** at any time during the use of the system to modify the information. On the body parameters screen **1005** the user may enter specific information including: name, birth date, height, weight, sex, waistline measure-

ment, right or left handedness, body frame size, smoker/nonsmoker, physical activity level, bed time and wake time. On the reminders screen **1010** the user may select a time zone from a pull-down menu in addition to setting a reminder. If any information on the body parameter screen **1005** or the reminders screen **1010** is modified, an armband update button **1015** allows the user to start the upload process for armband configuration **1020**.

On the weight goals screen **1025**, the user is given the option of setting weight loss goals. If the user selects this option, the user will be asked to enter the following information to establish these goals: current weight, goal weight, goal date to reach the goal weight, the target daily caloric intake and the target daily caloric burn rate. The system will then calculate the following: body mass index at the user's current weight, the body mass index at the goal weight, weight loss per week required to reach goal weight by the target date, and the daily caloric balance at the entered daily intake and burn rates. The screen may also display risk factor bars that show the risk of certain conditions such as diabetes, heart disease, hypertension, stroke and premature death at the user's current weight in comparison to the risk at the goal weight. The current and goal risk factors of each disease state may be displayed side-by-side for the user. The user is given a start over option **1030** if they have not entered any information for more than 5 days.

The user may also establish a diet and exercise plan on the diet and exercise plan screen **1035** from a selection of plans which may include a low carb, high protein diet plan or a more health condition related diet and exercise plan such as that prescribed by the American Heart Association or the American Diabetes Association. It is to be specifically noted that all such diets, including many not listed herein, are interchangeable for the purposes of this application. The user's diet plan is selected from a pull-down menu. The user also enters their expected intake of fat, carbohydrates and protein as percentages of their overall caloric intake. The user also selects appropriate exercises from a pull down menu or these exercises can be manually entered.

According to one aspect of the present invention, the system generates individualized daily meal plans to help the user attain their health and fitness goals. The system uses a database of food and meals (combinations of foods) to create daily menus. The database of food and meals is used in conjunction with user preferences, health and fitness goals, lifestyle, body type and dietary restrictions which constrain the types of meals included in the menu. These individual constraints determine a personalized calorie range and nutritional breakdown for the user's meal plan. Meals are assigned to menus in a best-first strategy to fall within a desired tolerance of the optimal daily caloric and nutritional balance.

According to another aspect of the present invention, the system may utilize the information regarding the user's daily energy expenditure to produce menus with calories that may compensate for the user's actual energy expenditure throughout the day. For example, if a user typically exercises right before lunch, the lunch can be made slightly larger. The feedback between the information gathered from the armband and the menus can help the user achieve fitness and health goals more quickly.

The user logs meals on a daily basis by selecting individual food items from the food database. The food database provides an extensive list of commonly consumed foods, e.g., milk, bread, common foods available at certain regional or national restaurant chains, e.g., McDonald's and Burger King, as well as brand name entrees, e.g., Weight Watchers or Mrs. T's, available in grocery stores. The name of the food, caloric content of the food and the nutrient information is stored in the database. Equivalent foods can be found in the case of simple preparations. If the user elects to not provide detailed nutritional information, a summary meal entry, such as large, medium or small meal, may be substituted. This will provide a baseline nutritional input for the energy balance features described herein. Over time, as described more fully below, the accuracy of these estimations can be improved through feedback of the system which monitors and estimates the amount of calories actually consumed and correlates the same to the large, medium and small categories.

For greater accuracy, the capability to add custom preparations is an option. There are two ways a user can add a custom food. The first is by creating a custom food or meal by adding either the ingredients or dishes of a larger composite dish or meal. The second way is by entering the data found on the back of processed or packaged foods. Either way constitutes an addition to the user's food database for later retrieval. If the user wants to add their own custom food, the food database provides the capability to the user to name their own preparation, enter the ingredients and also the caloric and nutrient contents. When entering a custom preparation, the user must specify a name and at least one ingredient. Once the preparation is added as a custom food to the database, it is available to be selected as the rest of the foods in the database for that user. The custom food data may include calories, total fat, sodium content, total carbohydrate content, total protein content, fiber and cholesterol in each serving. These values may be estimated based on the ingredients entered.

Another aspect of the current invention is to utilize adaptive and inferential methods to further simplify the food entry process. These methods include helping the user correctly choose the portion sizes of meals or ingredients and by automatically simplifying the system for the user over time. One example of the first method is to query the user when certain foods are entered. For example, when lasagna is entered, the user is queried about details of the lasagna dish to help narrow down the caloric content of the food. Furthermore, the user's portion sizes can be compared to the typical portion sizes entered for the given meal, and the user is queried when their entry is out of range. Finally, the user can be queried about commonly related foods when certain foods are entered. For example, when a turkey sandwich is entered, the user can be prompted about condiments, since it is highly likely that some condiments were consumed. In general, these suggestions are driven based on conditional probabilities. Given that the user had beer, for example, the system might suggest pizza. These suggestions can be hard-coded or derived from picking out common patterns in the population database or a regional, familial, seasonal or individual subset.

In a similar vein, the user's patterns and their relationship to the rest of the population can also be used to drive other aspects of the food entry interaction. For example, if the user has a particular combination of foods regularly, the system suggests that the user make that combination a custom meal.

Another aspect of this invention is that the order of foods in the frequent food list or in the database lookup can be designed to maximize the probability that the user will select foods with the fewest clicks possible. Instead of launching the page with a blank meal, the system can also guess at the meal using the historical meal entry information, the physiological data, the user's body parameters, general population food entry data, or in light of relationships with specific other users. For example, if the system has noticed that two or more users often have nearly identical meals on a regular pattern, the system can use one user's entry to prompt the second user. For example, if a wife had a cheeseburger, the system can

prompt the husband with the same meal. For a group of six individuals that seems to all have a particular brand of sandwiches for lunch on Tuesdays, the system can use the input from one to drive the promptings for the other users. Additionally, in institutional settings, such as a hospital or lo assisted living center, where large numbers of the same meal or meals are being distributed, a single entry for each meal component could be utilized for all of the wearer/patients. Another aspect is to use the physiology directly to drive suggestions, for example, if the system detects a large amount of activity, sports drinks can be prompted.

The food input screen is the front end to the food database. The user interface provides the capability to search the food database. The search is both interactive and capable of letter and phrase matching to speed input. The user begins a search by entering at least three characters in the input box. The search should be case insensitive and order independent of the words entered into the input box. The results of the food search may be grouped in categories such as My Foods, Popular Foods or Miscellaneous Foods. Within each group in the search results, the foods should be listed first with foods that start with the search string and then alphabetically. After selecting a food item, the user selects the portion size of the selected food. The portion size and the measure depend upon the food selected, e.g., item, serving, gram, ounce. Meal information can also be edited after it is entered. The user may enter as many different meals per day as they choose including breakfast, after breakfast snack, lunch, after lunch snack, dinner and after dinner snack. The system may also automatically populate the user's database of custom foods with the entries from their selected meal plan. This will provide a simple method for the user to track what they have consumed and also a self reported way of tracking compliance with the program.

FIG. **8** is a block diagram illustrating a weight tracking subsystem **1040** which allows a user to record weight changes over time and receive feedback. A user enters an initial weight entry **1045** into the weight tracking subsystem **1040**. The weight tracking subsystem **1040** calculates the percent weight change **1050** since the last time the user has made a weight entry. If a newly entered weight is more than 3% above or below the last weight, a weight verification page **1055** is displayed for the user to confirm that the entered weight is correct. If the entered weight is not more than 3% above or below the last weight, the weight tracking subsystem **1040** saves the entry as the current weight **1060**. It is to be specifically noted that the weight tracking subsystem **1040** may utilize body fat measurements and calculations in addition to, or in substitution for, the weight entry **1045**.

The current weight **1060** is compared to the target weight selected by the user through a weight loss comparison **1065**. If a weight is entered which is equal to or below the goal weight, a congratulatory page **1070** displays which has fields for resetting the goal weight. In the preferred embodiment, a comparison is made every six entries between the current weight x and the $(x\text{-}6)^{th}$ weight to determine an interval weight loss **1075**. Based on the information provided by the user in the registration process regarding weight loss goals, in addition to the input of the user through use of the system, an expected weight loss **1080** is calculated based on these nutritional and energy expenditure values. If interval weight loss **1075** between the two weights is greater than 10 or more pounds from the preprogrammed expected weight loss **1080**, the user may be directed to a weight discrepancy error page **1085***a* directing the user to contact technical support. If the difference between the two weights if four pounds or more, the user may be directed a second weight discrepancy error page **1085***b* displaying a list of potential reasons for the discrepancy.

Another aspect of the weight tracking subsystem is the estimation of the date at which the user's weight should equal the defined goal value input by the user during the registration or as updated at a later time. An algorithm calculates a rate of weight change based on the sequence of the user's recorded weight entries. A Kalman smoother is applied to the sequence to eliminate the effects of noise due to scale imprecision and day to day weight variability. The date at which the user will reach their weight goal is predicted based on the rate of weight change.

The total energy expenditure of the user can be estimated either by using the apparatus or by manually entering the duration and type of activities. The apparatus automates the estimation process to speed up and simplify data entry, but it is not required for the use of the system. It is known that total body metabolism is measured as total energy expenditure (TEE) according to the following equation:

$$TEE=BMR+AE+TEF+AT,$$

wherein BMR is basal metabolic rate, which is the energy expended by the body during rest such as sleep; AE is activity energy expenditure, which is the energy expended during physical activity; TEF is thermic effect of food, which is the energy expended while digesting and processing the food that is eaten; and AT is adaptive thermogenesis, which is a mechanism by which the body modifies its metabolism to extreme temperatures. It is estimated that it costs humans about 10% of the value of food that is eaten to process the food. TEF is therefore estimated to be 10% of the total calories consumed. Thus, a reliable and practical method of measuring TEF would enable caloric consumption to be measured without the need to manually track or record food related information. Specifically, once TEF is measured, caloric consumption can be accurately estimated by dividing TEF by 0.1 (TEF=0.1*Calories Consumed; Calories Consumed=TEF/0.1).

FIG. **9** is a block diagram of the update information wizard interface **1090** illustrating the process of data retrieval from the apparatus to update energy expenditure. The user is given at least three options for updating energy expenditure including: an unable to upload armband data option **1095***a*, a forgot to wear armband data option **1095***b*, and an upload armband data option **1095***c*.

When data is retrieved from the apparatus, the system may provide a semi-automated interface. The system is provided with the capability to communicate with the apparatus both wirelessly and with a wired USB connection. The system prompts the user to select the mode of communication before the retrieval of data. It is contemplated that the most common usage model may be wireless retrieval. If wireless retrieval is used, a wired connection could be used primarily for field upgrades of the firmware in the armband. Each apparatus is associated with a particular user and the apparatus is personalized so that it cannot be interchanged between different users.

The system will use the data collected by the armband for estimating the total energy expenditure. This value is calculated using an algorithm contained within the software. The database stores the minute-by-minute estimates of the energy expenditure values, the number of steps, the amount of time the apparatus was worn, the active energy expenditure values, the user's habits, which, in the preferred embodiment are stored as typical hourly non-physically active energy expen-

diture, their reported exercise while not wearing the apparatus, and the time spent actively.

Referring again to FIG. **9**, if the user selects the unable to upload armband data option **1095***a* or the forgot to wear armband option **1095***b*, the user may elect the estimate energy expenditure option **1100**, If the user selects the upload armband data option **1095***c*, the user may begin retrieving the data from the apparatus. If the apparatus was worn intermittently or not worn for a period of time, the system can provide the user with a manual activity entry option **1105** to manually enter the type of activity they have engaged in during this period. The options available include a sedentary option, a list of activities from the American College of Sports Medicine Metabolic Equivalent Table and a list of activities previously entered during the use of the device. Over time, the options may be presented in order of highest to lowest incidence, speeding the data input by placing the most frequent options at the top of the list. Additionally, the system may observe patterns of activity based upon time of day, day of the week and the like and suggest an activity with high probability for the particular missing time period. If nothing was entered for activities, the system will estimate the user's energy expenditure using their previously stored data. In the preferred embodiment, this is done using a histogram estimation and analysis incorporating a set of hourly data sets, each of which includes a running average of the non-exercise energy expenditure recorded by the apparatus.

Additionally, the user may select a exercise calculator to estimate the calories burned during any particular activity in the database. The user selects the appropriate activity from a list and a time period for the activity. The system calculates the approximate calories that would be burned by the user during that time period, based upon either or both of (i) a lookup table of average estimate data or (ii) prior measurements for that user during those specific activities.

According to an aspect of the present invention, the armband may detect when the user is physically active and sedentary. During the physically active times, the usage patterns are not updated. Instead the user is asked to report on their highly active periods. During the non-physically active times, the usage pattern is updated and the information gathered is then used during reported sedentary time when the user did not wear the armband.

The system, either through the software platform, the body monitor, or both, can improve its performance in making accurate statements about the wearer by gathering and analyzing data, finding patterns, finding relations, or correlating data about the person over time. For example, if the user gives explicit feedback, such as time stamping a particular activity to the system, the system can this to directly improve the system's ability to identify that activity. As another example, the system can build a characterization of an individual's habits over time to further improve the quality of the derived measures. For example, knowing the times a user tends to exercise, for how long they tend to exercise, or the days they tend not to exercise can all be valuable inputs to the prediction of when physical activity is occurring.

It will be obvious to one skilled in the art that the characterizations of habits and detected patterns are themselves possible derived parameters. Furthermore, these characterizations of habits and patterns can allow the system to be intuitive when the sensors are not working or the apparatus is not attached to the user's body. For example, if the user does not wear the apparatus and measured energy expenditure is not available, or neglects to input a meal, the data can be estimated from the characterizations of habits and prior observed meals and activities, as stated more fully herein.

For the more general embodiment, the Activity Level category of Health Index **155** is designed to help users monitor how and when they move around during the day and utilizes both data input by the user and data sensed by sensor device **10**. The data input by the user may include details regarding the user's daily activities, for example the fact that the user worked at a desk from 8 a.m. to 5 p.m. and then took an aerobics class from 6 p.m. to 7 p.m. Relevant data sensed by sensor device **10** may include heart rate, movement as sensed by a device such as an accelerometer, heat flow, respiration rate, calories burned, GSR and hydration level, which may be derived by sensor device **60** or central monitoring unit **30**. Calories burned may be calculated in a variety of manners, including: the multiplication of the type of exercise input by the user by the duration of exercise input by the user; sensed motion multiplied by time of motion multiplied by a filter or constant; or sensed heat flux multiplied by time multiplied by a filter or constant.

The Activity Level Health Index piston level is preferably determined with respect to a suggested healthy daily routine that includes: exercising aerobically for a pre-set time period, preferably 20 minutes, or engaging in a vigorous lifestyle activity for a pre-set time period, preferably one hour, and burning at least a minimum target number of calories, preferably **205** calories, through the aerobic exercise and/or lifestyle activity. The minimum target number of calories may be set according to information about the user, such as sex, age, height and/or weight. Parameters utilized in the calculation of the relevant piston level include the amount of time spent exercising aerobically or engaging in a vigorous lifestyle activity as input by the user and/or sensed by sensor device **10**, and the number of calories burned above pre-calculated energy expenditure parameters.

Information regarding the individual user's movement is presented to the user through activity level web page **200** shown in FIG. **10**, which may include activity graph **205** in the form of a bar graph, for monitoring the individual user's activities in one of three categories: high, medium and low intensity with respect to a pre-selected unit of time. Activity percentage chart **210**, in the form or a pie chart, may also be provided for showing the percentage of a pre-selected time period, such as one day, that the user spent in each category. Activity level web page **200** may also include calorie section **215** for displaying items such as total calories burned, daily target calories burned, total caloric intake, and duration of aerobic activity. Finally, activity level web page **200** may include at least one hyperlink **220** to allow a user to directly access relevant news items and articles, suggestions for refining or improving daily routine with respect to activity level and affiliate advertising elsewhere on the network. Activity level web page **200** may be viewed in a variety of formats, and may include user-selectable graphs and charts such as a bar graph, pie chart, or both, as selectable by Activity level check boxes **225**. Activity level calendar **230** is provided for selecting among views having variable and selectable time periods. The items shown at **220** may be selected and customized based on information learned about the individual in the survey and on their performance as measured by the Health Index.

The Mind Centering category of Health Index **155** is designed to help users monitor the parameters relating to time spent engaging in certain activities which allow the body to achieve a state of profound relaxation while the mind becomes focused, and is based upon both data input by the user and data sensed by the sensor device **10**. In particular, a user may input the beginning and end times of relaxation activities such as yoga or meditation. The quality of those

activities as determined by the depth of a mind centering event can be measured by monitoring parameters including skin temperature, heart rate, respiration rate, and heat flow as sensed by sensor device **10**. Percent change in GSR as derived either by sensor device **10** or central monitoring unit **30** may also be utilized.

The Mind Centering Health Index piston level is preferably calculated with respect to a suggested healthy daily routine that includes participating each day in an activity that allows the body to achieve profound relaxation while the mind stays highly focused for at least fifteen minutes. Parameters utilized in the calculation of the relevant piston level include the amount of time spent in a mind centering activity, and the percent change in skin temperature, heart rate, respiration rate, heat flow or GSR as sensed by sensor device **10** compared to a baseline which is an indication of the depth or quality of the mind centering activity.

Information regarding the time spent on self-reflection and relaxation is presented to the user through mind centering web page **250** shown in FIG. **1***l*. For each mind centering activity, referred to as a session, the preferred mind centering web page **250** includes the time spent during the session, shown at **255**, the target time, shown at **260**, comparison section **265** showing target and actual depth of mind centering, or focus, and a histogram **270** that shows the overall level of stress derived from such things as skin temperature, heart rate, respiration rate, heat flow and/or GSR. In comparison section **265**, the human figure outline showing target focus is solid, and the human figure outline showing actual focus ranges from fuzzy to solid depending on the level of focus. The preferred mind centering web page may also include an indication of the total time spent on mind centering activities, shown at **275**, hyperlinks **280** which allow the user to directly access relevant news items and articles, suggestions for refining or improving daily routine with respect to mind centering and affiliate advertising, and a calendar **285** for choosing among views having variable and selectable time periods. The items shown at **280** may be selected and customized based on information learned about the individual in the survey and on their performance as measured by the Health Index.

The Sleep category of Health Index **155** is designed to help users monitor their sleep patterns and the quality of their sleep. It is intended to help users learn about the importance of sleep in their healthy lifestyle and the relationship of sleep to circadian rhythms, being the normal daily variations in body functions. The Sleep category is based upon both data input by the user and data sensed by sensor device **10**. The data input by the user for each relevant time interval includes the times the user went to sleep and woke up and a rating of the quality of sleep. As noted in Table 2, the data from sensor device **10** that is relevant includes skin temperature, heat flow, beat-to-beat heart variability, heart rate, pulse rate, respiration rate, core temperature, galvanic skin response, EMG, EEG, EOG, blood pressure, and oxygen consumption. Also relevant is ambient sound and body movement or motion as detected by a device such as an accelerometer. This data can then be used to calculate or derive sleep onset and wake time, sleep interruptions, and the quality and depth of sleep.

The Sleep Health Index piston level is determined with respect to a healthy daily routine including getting a minimum amount, preferably eight hours, of sleep each night and having a predictable bed time and wake time. The specific parameters which determine the piston level calculation include the number of hours of sleep per night and the bed time and wake time as sensed by sensor device **10** or as input by the user, and the quality of the sleep as rated by the user or derived from other data.

Information regarding sleep is presented to the user through sleep web page **290** shown in FIG. **12**. Sleep web page **290** includes a sleep duration indicator **295**, based on either data from sensor device **10** or on data input by the user, together with user sleep time indicator **300** and wake time indicator **305**. A quality of sleep rating **310** input by the user may also be utilized and displayed. If more than a one day time interval is being displayed on sleep web page **290**, then sleep duration indicator **295** is calculated and displayed as a cumulative value, and sleep time indicator **300**, wake time indicator **305** and quality of sleep rating **310** are calculated and illustrated as averages. Sleep web page **290** also includes a user-selectable sleep graph **315** which calculates and displays one sleep related parameter over a pre-selected time interval. For illustrative purposes, FIG. **12** shows heat flow over a one-day period, which tends to be lower during sleeping hours and higher during waking hours. From this information, a person's bio-rhythms can be derived. Sleep graph **315** may also include a graphical representation of data from an accelerometer incorporated in sensor device **10** which monitors the movement of the body. The sleep web page **290** may also include hyperlinks **320** which allow the user to directly access sleep related news items and articles, suggestions for refining or improving daily routine with respect to sleep and affiliate advertising available elsewhere on the network, and a sleep calendar **325** for choosing a relevant time interval. The items shown at **320** may be selected and customized based on information learned about the individual in the survey and on their performance as measured by the Health Index.

The Activities of Daily Living category of Health Index **155** is designed to help users monitor certain health and safety related activities and risks and is based in part on data input by the user. Other data which is utilized by the Activities of Daily Living category is derived from the sensor data, in the form of detected activities which are recognized based on physiological and/or contextual data, as described more fully in this application. The Activities of Daily Living category is divided into four sub-categories: personal hygiene, which allows the user to monitor activities such as brushing and flossing his or her teeth and showering; health maintenance, that tracks whether the user is taking prescribed medication or supplements and allows the user to monitor tobacco and alcohol consumption and automobile safety such as seat belt use; personal time, that allows the user to monitor time spent socially with family and friends, leisure, and mind centering activities; and responsibilities, that allows the user to monitor certain work and financial activities such as paying bills and household chores.

The Activities of Daily Living Health Index piston level is preferably determined with respect to the healthy daily routine described below. With respect to personal hygiene, the routine requires that the users shower or bathe each day, brush and floss teeth each day, and maintain regular bowel habits. With respect to health maintenance, the routine requires that the user take medications and vitamins and/or supplements, use a seat belt, refrain from smoking, drink moderately, and monitor health each day with the Health Manager. With respect to personal time, the routine requires the users to spend at least one hour of quality time each day with family and/or friends, restrict work time to a maximum of nine hours a day, spend some time on a leisure or play activity each day, and engage in a mind stimulating activity. With respect to responsibilities, the routine requires the users to do household

chores, pay bills, be on time for work, and keep appointments. The piston level is calculated based on the degree to which the user completes a list of daily activities as determined by information input by the user.

Information relating to these activities is presented to the user through daily activities web page **330** shown in FIG. **13**. In preferred daily activities web page **330**, activities chart **335**, selectable for one or more of the sub-categories, shows whether the user has done what is required by the daily routine. A colored or shaded box indicates that the user has done the required activity, and an empty, non-colored or shaded box indicates that the user has not done the activity. Activities chart **335** can be created and viewed in selectable time intervals. For illustrative purposes, FIG. **13** shows the personal hygiene and personal time sub-categories for a particular week. In addition, daily activities web page **330** may include daily activity hyperlinks **340** which allow the user to directly access relevant news items and articles, suggestions for improving or refining daily routine with respect to activities of daily living and affiliate advertising, and a daily activities calendar **345** for selecting a relevant time interval. The items shown at **340** may be selected and customized based on information learned about the individual in the survey and on their performance as measured by the Health Index.

The How You Feel category of Health Index **155** is designed to allow users to monitor their perception of how they felt on a particular day, and is based on information, essentially a subjective rating, that is input directly by the user. A user provides a rating, preferably on a scale of 1 to 5, with respect to the following nine subject areas: mental sharpness; emotional and psychological well being; energy level; ability to cope with life stresses; appearance; physical well being; self-control; motivation; and comfort in relating to others. Those ratings are averaged and used to calculate the relevant piston level.

Referring to FIG. **14**, Health Index web page **350** is shown. Health Index web page **350** enables users to view the performance of their Health Index over a user selectable time interval including any number of consecutive or non-consecutive days. Using Health Index selector buttons **360**, the user can select to view the Health Index piston levels for one category, or can view a side-by-side comparison of the Health Index piston levels for two or more categories. For example, a user might want to just turn on Sleep to see if their overall sleep rating improved over the previous month, much in the same way they view the performance of their favorite stock. Alternatively, Sleep and Activity Level might be simultaneously displayed in order to compare and evaluate Sleep ratings with corresponding Activity Level ratings to determine if any day-to-day correlations exist. Nutrition ratings might be displayed with How You Feel for a pre-selected time interval to determine if any correlation exists between daily eating habits and how they felt during that interval. For illustrative purposes, FIG. **14** illustrates a comparison of Sleep and Activity Level piston levels for the week of June 10 through June 16. Health Index web page **350** also includes tracking calculator **365** that displays access information and statistics such as the total number of days the user has logged in and used the Health Manager, the percentage of days the user has used the Health Manager since becoming a subscriber, and percentage of time the user has used the sensor device **10** to gather data.

Referring again to FIG. **5**, opening Health Manager web page **150** may include a plurality of user selectable category summaries **156***a* through **156***f*, one corresponding to each of the Health Index **155** categories. Each category summary **156***a* through **156**f presents a pre-selected filtered subset of the data associated with the corresponding category. Nutrition category summary **156***a* displays daily target and actual caloric intake. Activity Level category summary **156***b* displays daily target and actual calories burned. Mind Centering category summary **156***c* displays target and actual depth of mind centering or focus. Sleep category summary **156***d* displays target sleep, actual sleep, and a sleep quality rating. Daily Activities category summary **156***e* displays a target and actual score based on the percentage of suggested daily activities that are completed. The How You Feel category summary **156***f* shows a target and actual rating for the day.

Opening Health Manager web page **150** also may include Daily Dose section **157** which provides, on a daily time interval basis, information to the user, including, but not limited to, hyperlinks to news items and articles, commentary and reminders to the user based on tendencies, such as poor nutritional habits, determined from the initial survey. The commentary for Daily Dose **157** may, for example, be a factual statement that drinking 8 glasses of water a day can reduce the risk of colon cancer by as much as 32%, accompanied by a suggestion to keep a cup of water by your computer or on your desk at work and refill often. Opening Health Manager web page **150** also may include a Problem Solver section **158** that actively evaluates the user's performance in each of the categories of Health Index **155** and presents suggestions for improvement. For example, if the system detects that a user's Sleep levels have been low, which suggest that the user has been having trouble sleeping, Problem Solver **158** can provide suggestions for way to improve sleep. Problem Solver **158** also may include the capability of user questions regarding improvements in performance. Opening Health Manager web page **150** may also include a Daily Data section **159** that launches an input dialog box. The input dialog box facilitates input by the user of the various data required by the Health Manager. As is known in the art, data entry may be in the form of selection from pre-defined lists or general free form text input. Finally, opening Health Manager web page **150** may include Body Stats section **161** which may provide information regarding the user's height, weight, body measurements, body mass index or BMI, and vital signs such as heart rate, blood pressure or any of the identified physiological parameters.

Referring again to the weight management embodiment, energy balance is utilized to track and predict weight loss and progress. The energy balance equation has two components, energy intake and energy expenditure, and the difference between these two values is the energy balance. Daily caloric intake equals the number of calories that a user consumes within a day. Total energy expenditure is the amount of calories expended by a user whether at rest or engaging in any type of activity. The goal of the system is to provide a way to track daily caloric intake and automatically monitor total energy expenditure accurately so users can track their status and progress with respect to these two parameters. The user is also provided with feedback regarding additional activities necessary to achieve their energy balance. To achieve weight loss the energy balance should be negative which means that fewer calories were consumed than expended. A positive energy balance has the potential to result in weight gain or no loss of weight. The management system automates the ability of the user to track energy balance through the energy intake tracking subsystem, the energy expenditure tracking subsystem and the energy balance and feedback subsystem.

Referring again to FIG. **9**, if the user has not entered any meals or food items consumed since the last update, the user will be prompted to initiate the energy intake subsystem **1110** to log caloric intake for the appropriate meals. The energy intake subsystem may estimate the average daily caloric

intake of the user using the total energy expenditure estimate and the change in the user's weight and/or body fat composition. The inputs to this system include the user's body fat composition or weight, at regular intervals related to the relevant time period, and the energy expenditure estimation. If the user has not updated their weight within the last 7 days, they will be directed to a weight reminder page **1115**. The energy expenditure estimation is based on the basic equivalence of 3500 kcal equal to a 1 lb change in weight. The software program will also attempt to smooth the estimation by accounting for fluctuations in water retained by the body and for differences in the way the user has collected weight readings, e.g. different times of the day or different weight scales.

It is to be specifically noted that the system may also be utilized to derive the caloric intake from the energy expenditure of the user and the changes in weight which are input by the user or otherwise detected by the system. This is accomplished by utilizing the same basic calculations described herein, however the net weight gain or loss is utilized as the reference input. In the equation A+B=C, A is equal to caloric intake, B equal to energy expenditure and C equal to the net weight gain or loss. The system may not be able to determine the specific information regarding the type of food items consumed by the user, but it can calculate what the caloric intake for the user would be, given the known physiological parameters and the energy expenditure measured during the relevant time period. Changes in body fat and water weight may also be incorporated into this calculation for greater accuracy.

This calculation of daily caloric intake may also be performed even when the user is entering nutritional information as a check against the accuracy of the data input, or to tune the correlation between the small, medium and large size meal options described above, in the more simplified method of caloric input, and the actual calorie consumption of the user, as is disclosed in co-pending U.S. patent application Ser. No. 10/682,759, the specification of which is incorporated herein by reference. Lastly, this reverse calculation can be utilized in the institutional setting to determine whether or to what degree the patients are consuming the meals provided and entered into the system.

Logging of the foods consumed is completely optional for the user. By using this feature the user can get feedback about how much food they think they consumed compared to what they actually consumed, as measured by the energy intake estimation subsystem described above. If the user chooses to log food intake, a semi automated interface guides the user through the breakfast, after breakfast snack, lunch, after lunch snack, dinner, and after dinner snack progression. If the user does not have the need to enter any data, e.g., the user did not have a snack after breakfast, options may be provided to skip the entry. Immediate feedback about the caloric content of the selected foods also may be provided.

For any of the 6 meal events, the software assumes one of the following scenarios to be true: a user has eaten the meal and wants to log in what they ate food by food; a user has eaten the meal but has eaten the same thing as a previous day; a user has eaten the meal but can not recall what they ate; a user has eaten the meal, can recall what they ate, but does not want to enter in what they ate food by food; a user has skipped the meal; a user has not eaten the meal yet. The software forces the user to apply these scenarios for each meal chronologically since the last meal event was entered into the system. This ensures there are no gaps in the data. Gaps in the data lead to misleading calculations of calorie balance.

If the user wants to log food items, the software responds by prompting the user to type in the first few letters of a food into the dynamic search box which automatically pulls the closest matches from the food database into a scrollable drop down list just below the entry. Upon selection of an entry, the food appears in a consumed foods list to the right of the drop down, where addition of information such as unit of measure and serving size can be edited, or the food can be deleted from the consumed foods list. The total number of calories per meal is automatically calculated at the bottom of the consumed foods list. This method is repeated until the meal has been recounted. In the event that a food does not exist in the database, a message appears in the drop down box suggesting that the user can add a custom food to their personal database.

If a user has eaten the same thing as a previous day, the user selects the appropriate day and the meal chosen appears to the right. The user hits the next button to enter it into the system. This specifically capitalizes on the tendency of people to have repetitive eating patterns such as the same foods for the same meals over increments of time.

If a user cannot recall a meal, the software responds by bringing up a screen that calculates an average of the total number of calories consumed for that meal over a certain number of days and presents that number to the user.

If the user has eaten a meal, but does not want to enter the consumed food items, the software may bring up a screen that enables the user to quickly estimate caloric intake by either entering a number of calories consumed or selecting a word amount such as normal, less than normal, more than normal, a lot or very little. Depending on the selection, estimated caloric intake increases or decreases from the average, or what is typical based on an average range. For example, if on average the user consumes between 850 and 1000 kcal for dinner, and specifies that for the relevant meal that he ate more than usual, the estimate may be higher than 1000 kcal.

If a user specifies that they did not eat a certain meal yet, they may choose to proceed to the weight management center. This accounts for the fact that users eat meals at different points of the day, but never one before the other.

To keep the amount of time a user has to spend entering the meal information to a minimum, the system may also offer the option to select from a list of frequently consumed foods. The user can select food items from the frequent foods list and minimize the need to search the database for commonly consumed foods. The frequent foods tool is designed to further expedite the task of accurately recalling and entering food consumption. It is based on the observation that people tend to eat only 35-50 unique foods seasonally. People tend to eat a core set of favorite breakfast foods, snacks, side dishes, lunches, and fast food based on personal preference, and issues concerning convenience, like places they can walk or drive to from work for lunch. The frequent foods tool works by tallying the number of times specific food entries are selected from the database by the user for each of the six daily meal events. The total number of selections of a specific food entry is recorded, and the top foods with the most selections appears in a frequent foods list in order of popularity. Additionally, the system is also aware of other meal related parameters of the user, such as meal plan or diet type, and speeds data entry by limiting choices or placing more relevant foods at the top of the lists.

FIG. **15** is a representation of a preferred embodiment of the Weight Manager interface **1120**. Weight Manager interface **1120** is provided with a multi section screen having a navigation bar **1121** which comprises a series of subject matter tabs **1122**. The tabs are customizable with the program but typically include sections for report writing and selection

1122*b*, a navigation tab to the user's profile **1122***c*, a navigation tab to the armband sensor device update section **1122***d*, a navigation tab to the meal entry section **1122***e* and a message section **1122***f*. The interface **1120** is further provided, as shown in FIG. **15**, with an operational section **1122***a* entitled balance which comprises the primary user functions of the Weight Manager interface **1120**. A calendar section **1123** provides the user with the ability to select and view data from or for any particular date. A feedback section **1125** provide commentary as described herein, and a dashboard section **1126** provides graphical output regarding the selected days energy intake and expenditure. Finally, a weight loss progress section **1135** provides a graphical output of weight versus time for any given date selected in calendar section **1123**.

A feedback and coaching engine analyzes the data generated by the total energy expenditure and daily caloric intake calculations, as previously discussed, to provide the user with feedback in the feedback section **1125**. The feedback may present a variety of choices depending on the current state of the progress of the user. If the user is both losing weight and achieving the target daily caloric intake and total energy expenditure goals, they are encouraged to continue the program without making any adjustments. If the user is not losing weight according to the preset goals, the user may be presented with an option to increase the total energy expenditure, decrease the daily caloric intake, combination of increase in total energy expenditure and decrease in daily caloric intake to reach energy balance goals or reset goals to be more achievable. The feedback may further include suggestions as to meal and vitamin supplements. This feedback and coaching may also be incorporated in the intermittent status reports described below, as both present similar information.

If the user chooses to decrease daily caloric intake the user may be presented with an option to generate a new meal plan to suit their new daily caloric goal. If the user chooses to increase total expenditure energy goal, the user may be presented with an exercise plan to guide them to the preset goals. A total energy expenditure estimation calculator utility may also be available to the users. The calculator utility may enable the user to select from multiple exercise options. If the user chooses to increase total energy expenditure and decrease daily caloric intake to reach the preset goals, the meal plan and exercise choices may be adjusted accordingly. Safety limitations may be placed on both the daily caloric intake and total energy expenditure recommendations. For example, a meal plan with fewer than 1200 kcal a day and exercise recommendations for more than an hour a day may not be recommended based on the imposed safety limitations.

Additionally, the user may be provided with suggestions for achieving a preset goal. These suggestions may include simple hints, such as to wear their armband more often, visit the gym more, park farther from the office, or log food items more regularly, as well as specific hints about why the user might not be seeing the expected results.

In an alternative embodiment, the recommendations given by the coaching engine are based on a wider set of inputs, including the past history of recommendations and the user's physiological data. The feedback engine can optionally engage the user in a serious of questions to elicit the underlying source for their failure to achieve a preset goal. For example, the system can ask questions including whether the user had visitors, was the user out of town over the weekend, was the user too busy to have time to exercise, or if the user dine out a lot during the week. Asking these questions gives the user encouragement and helps the user understand the reasons that a preset goal has not been achieved.

Another aspect of this alternative embodiment of the feedback system is that the system can evaluate the results of giving the feedback to the user. This is accomplished through the tracking of the parameters which are the subject of the feedback, such as context and estimated daily caloric intake or logged intake. This feature enables the system to be observational and not just result based, because it can monitor the nature of compliance and modify the feedback accordingly. For example, if the system suggests eating less, the system can measure how much less the user eats in the next week and use this successful response as feedback to tune the system's effectiveness with respect to the user's compliance with the original feedback or suggestions.

Other examples of such delayed feedback for the system are whether the user exercises more when the system suggests it, whether the user undertakes more cardiovascular exercise when prompted to, and whether the user wears the armband more when it is suggested. This type of delayed feedback signal, and the system's subsequent adaptation thereto is identified as reinforcement learning, as is well known in the art. This learning system tunes the behavior of a system or agent based on delayed feedback signals.

In this alternate embodiment, the system is tuned at three levels of specificity through the reinforcement learning framework. First, the feedback is adapted for the entire population for a given situation, e.g. what is the right feedback to give when the user is in a plateau. Second, the feedback is adapted for groups of people, e.g. what is the right feedback in situation X for people like person Y or what is the right feedback for women when the person hasn't been achieving intake goals for three weeks, which may be different from the nature or character or tone of the feedback given to men under the same conditions. Finally, the system can also adapt itself directly based on the individual, e.g. i.e., what is the best feedback for this particular user who has not exercised enough in a given week.

In another aspect of the invention, the feedback provided to the user might be predictive in nature. At times, an individual may experience non-goal or negatively oriented situations, such as weight gain, during a weight loss regimen. The situations may also be positive or neutral. Because of the continuous monitoring of data through the use of the system, the events surrounding, that is, immediately prior and subsequent to, the situation can be analyzed to determine and classify the type of event. The sequence of events, readings or parameters can be recorded as a pattern, which the system can store and review. The system can compare current data regarding this situation to prior data or patterns to determine if a similar situation has occurred previously and further to predict if a past episode is going to occur in the near term. The system may then provide feedback regarding the situation, and, with each occurrence, the system can tailor the feedback provided to the user, based on the responses provided by or detected from the user. The system can further tailor the feedback based on the effectiveness of the feedback. As the system is further customized for the user, the system may also proactively make suggestions based on the user's detected responses to the feedback. For example, in the situation where a user has reached a plateau in weight management, the system may formulate new suggestions to enable a user to return to a state of progress.

Furthermore, the system modifies the reinforcement learning framework with regard to detected or nondetected responses to the provided feedback. For example, if the system suggests that the user should increase their energy expenditure, but the individual responds by wearing the armband more often, the system can modify the framework based on

the user's sensitivities to the feedback. The reinforcement is not only from the direct interaction of the user with the system, but also any difference in behavior, even if the connection is not immediately obvious.

It should be specifically noted that the predictive analysis of the data regarding negatively positively or neutrally oriented situations may be based on the user's personal history or patterns or based on aggregate data of similar data from other users in the population. The population data may be based on the data gathered from users of any of the embodiments of the system, including but not limited to weight management.

Moreover, as the user experiences multiple occasions of similar situations, the system may begin to understand how the individual arrived at this stage and how the person attempted to correct the situation, successfully or unsuccessfully. The system reinforces its learning and adaptation through pattern matching to further modify future feedback the next time this situation may occur. For example, it is not uncommon in weight management for a user to experience a plateau, which is the slowing of the user's metabolism to slow in order to conserve calories and also a period during which a user may not realize any progress toward preset goals. Also, occasions may occur which cause the user to deviate from a preset goal either temporarily or long-term such as long weekends, vacations, business trips or periods of consistent weather conditions, the system may provide reminders prior to the plateau or the event, warning of an impending problem and providing suggestions for avoidance.

In an alternate embodiment, when the user experiences a negative, positive or neutral situation that is likely to affect achieved progress, the system may display the risk factors discussed above as they are affected by the situation. For example, if the user has experienced a negative situation that has caused an increase in weight, the system may determine that the user's risk for heart disease is now elevated. This current elevated risk is displayed accordingly in the risk factor bar for that condition and compared to the risk at the user's goal level.

It will be clear to one skilled in the art that the description just given for guiding a person through an automated process of behavior modification with reinforcement with respect to a series of physiologic and/or contextual states of the individual's body and their previous behavior responses, while described for the specific behavior modification goal of weight management, need not be limited to that particular behavior modification goal. The process could also be adapted and applied without limitation to sleep management, pregnancy wellness management, diabetes disease management, cardiovascular disease management, fitness management, infant wellness management, and stress management, with the same or other additional inputs or outputs to the system.

Equally appreciable is a system in which a user is a diabetic using the tool for weight management and, therefore, insulin level and has had a serious or series of symptoms or sudden changes in blood glucose level recorded in the data. In this embodiment, the inputs would be the same as the weight embodiment, calories ingested, types of calories, activity and energy expenditure and weight. With respect to the insulin level, management where the feedback of this system was specifically tuned for predicted body insulin levels, calorie intake, calorie burn, activity classifications and weight measurement could be utilized. User input would include glucometer readings analogous to the weight scale of the weight loss embodiment. It should be noted that insulin level is indirectly related to energy balance and therefore weight management. Even for a non-diabetic, a low insulin level reflects a limitation on energy expenditure, since the body is unable to obtain its maximum potential.

In addition to monitoring of physiological and contextual parameters, environmental parameters may also be monitored to determine the effect on the user. These parameters may include ozone, pollen count, and humidity and may be useful for, but not limited to, a system of asthma management.

There are many aspects to the feedback that can be adapted in different embodiments of this system. For example, the medium of the feedback can be modified. Based on performance, the system can choose to contact the user through phone, email, fax, or the web site. The tone or format of the message itself can be modified, for example by choosing a strong message delivered as a pop-up message. A message such as "You've been too lazy! I'm ordering you to get out there and exercise more this week" or a more softly toned message delivered in the feedback section of the site, such as "You've been doing pretty well,. but if you can find more time to exercise this week, you'll stay closer to your targets".

The system may also include a reporting feature to provide a summary of the energy expenditure, daily caloric intake, energy balance or nutritional information for a period of time. The user may be provided with an interface to visualize graphically and analyze the numbers of their energy balance. The input values for the energy balance calculation are the daily caloric intake that was estimated using the total energy expenditure and weight or body fat changes and total energy expenditure estimates based on the usage of the energy expenditure tracking system. The user may be provided with this information both in an equation form and visually. Shortcuts are provided for commonly used summary time periods, such as daily, yesterday, last 7 days, last 30 days and since beginning.

The report can also be customized in various ways including what the user has asked to see in the past or what the user actually has done. The reports may be customized by third party specifications or by user selection. If the user has not exercised, the exercise tab can be left out. The user may ask to see a diary of past feedback to see the type of feedback previously received. If the feedback has all been about controlling daily caloric intake, the reports can be more about nutrition. One skilled in the art will recognize that the reports can be enhanced in all the ways that the feedback engine can be enhanced and can be viewed as an extension of the feedback engine.

Referring again to FIG. **15**, the balance tab **1122***a* presents a summary of the user's weight loss progress in a variety of formats. For the balance section **1122***a*, a weight loss progress graph **1135** illustrates the user's weight loss progress from day the user began using the total weight loss system to the present date. Energy balance section **1136** provides details regarding the user's actual and goal energy balance including the actual and goal calories consumed and actual and goal calories burned. Energy balance graph **1137** is a graphical representation of this same information. Dashboard section **1126** also has a performance indicator section **1146** which lets the user know the state of their energy balance in relation to their goal. The information contained within the performance indicator section **1146** may be a graphical representation of the information in the feedback section **1125**. Optionally, the system may display a list of the particular foods consumed during the relevant time period and the nutritional aspects of the food, such as calories, carbohydrate and fat content in chart form. Similarly, the display may include a charted list of all activities conducted during the relevant time period together with relevant data such as the duration of the

activity and the calories burned. The system may further be utilized to log such activities at a user-selected level of detail, including individual exercises, calisthenics and the like.

In an alternative embodiment, the system may also provide intermittent feedback to the user in the feedback section **1125**, alone or in conjunction with the feedback and coaching engine. The feedback and coaching engine is a more specific or alternative embodiment of the Problem Solver, as described above. The feedback may also be presented in an additional display box or window, as appropriate, in the form of a periodic or intermittent status report **1140**. The intermittent status report **1140** may also be requested by the user at any time. The status report may be an alert located in a box on a location of the screen and is typically set off to attract the user's attention. Status reports and images are generated by creating a key string, or parameter set, based on the user's current view and state and may provide information to the user about their weight loss goal progress. This information typically includes suggestions to meet the user's calorie balance goal for the day.

Intermittent status reports **1140** are generated on the balance tab **1122***a* of the Weight Manager Interface **1120**. The purpose of the intermittent status report **1140** is to provide immediate instructional feedback to the user for the selected view. A properties file containing key value pairs is searched to match message and images which establishes certain selection criteria to the corresponding key.

In the preferred embodiment, there are four possible views for intermittent status reports **1140**: Today, Specific Day, Average (Last 7 or 30 Day) and Since Beginning.

A user state is incorporated as part of the selection criteria for intermittent status report **1140**. The user state is based on the actual and goal values of energy expenditure and daily caloric intake as previously described. The goal and predicted energy balance based, on the respective energy expenditure and daily caloric intake values, is also utilized as an additional comparison factor in user states 4 and 5. The possible user states are shown in Table 3:

TABLE 3

State	Description	Calculation
1	A user will not reach energy goal and daily caloric intake is below budget	(energy expenditure < goal energy expenditure) and (daily caloric intake <= goal daily caloric intake) Where = has a tolerance of ± is 50 calories
2	A user has or will have burned more calories than the goal, and daily caloric intake is below budget	(energy expenditure >= goal energy expenditure) and (daily caloric intake <= goal daily caloric intake) Where = has a tolerance of ± is 50 calories
3	A user hasn't exercised enough and has eaten too much	(energy expenditure < goal energy expenditure) and (daily caloric intake > goal daily caloric intake) Where = has a tolerance of ± is 50 calories
4	A user has exceeded caloric intake goals, but energy expenditure should make up for it	(energy expenditure >= goal energy expenditure) and (daily caloric intake > goal daily caloric intake) && (predicted energy balance >= goal energy balance) Where = has a tolerance of ± is 50 calories
5	A user has exceeded caloric intake goals, but energy expenditure goals will not make up for it	(energy expenditure >= goal energy expenditure) and (daily caloric intake > goal daily caloric intake) && (predicted energy balance < goal energy balance) Where = has a tolerance of ± is 50 calories

The user's current energy balance is also used to determine part of the selection criteria.

TABLE 4

String	Calculation
Black	(energy expenditure - daily caloric intake) > 40
Even	−40 < (energy expenditure - daily caloric intake) < 40
Red	40 < (energy expenditure - daily caloric intake)

The last part of the selection criteria depends on the type of view selected, as previously described above. Specifically, the today view incorporates two parameters to predict the ability of the user to correct the energy balance deficiencies by the end of the relevant time period:

TABLE 5

String	Description
Early	A favorite activity takes less than an hour to correct the energy balance and it is before 11:00 PM; or an activity appropriate for the user will correct the energy balance and enough time remains in the relevant period for its completion.
Late	A favorite activity takes more than an hour to correct the energy balance or it is after 11:00 PM; or there is insufficient time to complete an activity which will return a positive result for energy balance.

All other views use two types of information for estimating the validity of the goals:

TABLE 6

String	Calculation
validgoals	If (state 2 or 4) then 80% > % DCI or % EE > 120% and there is a valid activity to make up the difference in less than an hour else just based on percent

TABLE 6-continued

String	Calculation
suspectgoals	If (state 2 or 4) then 80% > % DCI or % EE > 120% or there is NOT a valid activity to make up the difference in less than an hour else just based on percent

where % DCI or % EE represents the current percent of daily caloric intake or energy expenditure, as appropriate, in relation to the goal of the user.

A similar method is used to determine the messages below each horizontal bar chart as shown in FIG. **15**. The next part of the selection criteria is achievement status, which is determined by the current value of daily caloric intake or energy expenditure in relation to the goal set by the user. The parameters are as follows:

TABLE 7

String	Calculation
above	Value > goal
even	Value = goal
below	Value < goal

In alternative embodiments, the representation underlying the method for choosing the feedback could be, but are not limited to being, a decision tree, planning system, constraint satisfaction system, frame based system, case based system rule-based system, predicate calculus, general purpose planning system, or a probabilistic network. In alternative embodiments, another aspect of the method is to adapt the subsystem choosing the feedback. This can be done, for example, using a decision-theoretic adaptive probabilistic system, a simple adaptive planning system, or a gradient descent method on a set of parameters.

With respect to the calculation of energy balance, the armband sensor device continuously measures a person's energy expenditure. During the day the human body is continuously burning calories. The minimal rate that a human body expends energy is called resting metabolic rate, or RMR. For an average person, the daily RMR is about 1500 calories. It is more for larger people.

Energy expenditure is different than RMR because a person knows throughout the day how many calories have been burned so far, both at rest and when active. At the time when the user views energy expenditure information, two things are known. First, the caloric burn of that individual from midnight until that time of day, as recorded by armband sensor device. Second, that user's RMR from the current time until the end of the day. The sum of these numbers is a prediction of the minimum amount of calories that the user expends during the day.

This estimate may be improved by applying a multiplicative factor to RMR. A person's lifestyle contributes greatly to the amount of energy they expend. A sedentary person who does not exercise burns calories only slightly more than those consumed by their RMR. An athlete who is constantly active burns significantly more calories than RMR. These lifestyle effects on RMR may be estimated as multiplicative factors to RMR ranging from 1.1 for a sedentary person to 1.7 for an athlete. This multiplicative factor may also calculated from an average measurement of the person's wear time based on the time of day or the time of year, or it may be determined from information a user has entered in date or time management program, as described above. Using such a factor greatly improves the predictive nature of the estimated daily expenditure for an individual.

The final factor in predicting a weight-loss trend is a nutrition log. A nutrition log allows a person keeps track of the food they are eating. This records the amount of calories consumed so far during the day.

Knowing the amount of calories consumed and a prediction of the amount of calories a person can burn allows the armband sensor device to compute a person's energy balance. Energy balance is the difference between calories burned and calories consumed. If a person is expending more calories than they are consuming, they are on a weight-loss trend. A person who is consuming more calories than they are burning is on a weight-gain trend. An energy balance prediction is an estimate made at any time during the day of a person's actual daily energy balance for that day.

Suggestions are provided in the form of intermittent status reports, which take one of three general forms. First, a person may be in compliance to achieve the preset goal. This means that the energy balance prediction is within a tolerance range which approximates the daily goal. Second, a person may have already achieved the preset goal. If that user's energy balance indicates that more calories may be burned during the day than have been consumed, the user may be congratulated for surpassing the preset goal. Lastly, a user may have consumed more calories than what is projected to be burned. In this case, the system can calculate how many more calories that user may need to burn to meet the goal. Using the predicted energy expenditure associated with common activities, such as walking, the system can also make suggestions on methods for achieving the goal within a defined period. For example, a person who needs to burn **100** more calories might be advised to take a 30 minute walk in order to achieve a goal given that the system is aware that such activity can burn the necessary calories.

Many people settle into routines, especially during the work week. For example, a person may wake up at about the same time every day, go to work, then exercise after work before going home and relaxing. Their eating patterns may also be similar from day to day. Detecting such similarities in a person's behaviors can allow the armband sensor device to make more accurate predictions about a person's energy balance and therefore that person's weight-loss trends.

There are several ways the energy balance predications can be improved by analyzing an user's past data. First, the amount of rest verses activity in a person's lifestyle can be used to improve the RMR estimate for the remainder of the day. Second, the day can be broken down into time units to improve estimation. For example, a person who normally exercises in the morning and rests in the evening has a different daily profile than a person who exercises in the evening. The energy expenditure estimate can be adjusted based on time-of-day to better predict an individual's energy balance. A person's activity may also vary depending on a daily or weekly schedule, the time of the year, or degree of progress toward preset goals. The energy expenditure estimate can therefore be adjusted accordingly. Again, this information may be obtained from a time or date management program. Third, creating an average of a person's daily energy expenditure over a certain time can also be used to predict how many calories a person normally burns.

Likewise, detecting trends in a person's eating habits can be used to estimate how many calories a person is expected to consume. For example, a person who eats a large breakfast but small dinner has a different profile than a person who skips breakfast but eats a number of small meals during the

day. These different eating habits can also be reflected in an user's energy balance to provide a more accurate daily estimate.

The concept of energy balance is not limited to single days. It may also be applied to multiple days, weeks, months or even years. For example, people often overeat on special occasions such as holidays, birthdays or anniversaries. Such unusual consumption eating spurts may be spurious or may contribute to long-term patterns. Actual energy balance over time can indicate weight-loss or weight-gain trends and help an individual adjust his goal to match actual exercise and eating habits.

The logic for the calculation of the intermittent status reports **1140** is provided in the references to FIGS. **16-19**. FIG. **16** illustrates the calculation of the intermittent status reports **1140** using information from both the energy expenditure and caloric intake values. If the intermittent status report status **1150** indicates that an intermittent status report **1140** has already been prepared for today, the intermittent status report program returns the energy balance value **1155** which is the difference between the energy expenditure and the daily caloric intake. An arbitrary threshold, for example 40 calories, is chosen as a goal tolerance to place the user into one of three categories. If the difference between the energy expenditure and the daily caloric intake is greater than +40 calories, a balance status indicator **1160** indicates that the user has significantly exceeded a daily energy balance goal for the day. If the difference between the values is less than −40 calories, a balance status indicator **1160** indicates that the user has failed to meet a daily energy balance goal. If the difference between the values is near or equal to 0, as defined by the tolerance between ±40 calories difference, a balance status indicator **1160** indicates that the user has met a daily energy balance goal. The program performs a time check **1165**. Depending on whether the current time is before or after an arbitrary time limit, the program determines if it is early or late. Further, the program displays an energy balance goal intermittent status report **1170** indicating whether an individual has time to meet their energy balance goal within the time limit of the day or other period, based on the time of day, in addition to a suggestion for an energy expenditure activity to assist in accomplishing the goal, all based upon the prior intermittent status report **1040** for that day.

If the intermittent status report status **1150** determines that an intermitted status report **1040** has not been prepared for today, the program retrieves the energy balance value **1155** and determines if the energy expenditure is greater or less than the caloric intake value. Depending on the value of the difference between the energy expenditure value and the caloric intake value which is indicated by the balance status indicator **1160**, the program performs a user state determination. The user state determination **1175** is the overall relationship between the user's goal and actual energy expenditure for the relevant time periods and the goal and actual daily caloric intake for that same period. After the program determines the user's state, the program determines the goal status **1180** of the user. If the status of the goals is within a certain percentage of completion, the program performs a time determination **1185** in regard to whether or not the user can still meet these goals, within the time frame, by performing a certain activity. The program displays a relevant energy balance goal intermittent status report **1170** to the user. The content of intermittent status report **1170** is determined by the outcome of these various determinations and is selected from an appropriate library of reference material.

FIG. **17** illustrates the generation of an intermittent status report based only on energy expenditure. If the intermittent status report status **1150** indicates that an intermittent status report **104** has been prepared for the day, the program calculates the energy expenditure goal progress **1190** which is the difference between the goal energy expenditure and the current energy expenditure. If the energy expenditure exceeds the goal energy expenditure, the program determines any required exercise amount **1195** that may be needed to enable the user to achieve energy expenditure goals for the day. Similarly, if the current or predicted energy expenditure value is less than the goal energy expenditure, the program determines any required exercise amount **1195** to enable to the user to meet the daily goal. An energy expenditure intermittent status report **1200** will be generated based on this information with suggested exercise activity.

If an intermittent status report **1040** has not already been prepared for the relevant time period, the intermittent status report status **1150** instructs the program to calculate the energy expenditure goal progress **1190** using the goal and predicted energy expenditure values. Based on this value, the program determines any required exercise amount **1195** to enable the user to achieve energy expenditure goals. An energy expenditure intermittent status report **1200***a* is generated based on this information with any suggested exercise activity.

FIG. **18** illustrates how the program generates an intermittent status report based solely on caloric intake. The caloric status **1205** is calculated, which is the difference between the goal caloric intake and predicted caloric intake. If the predicted caloric intake is greater than the goal caloric intake, the user has exceeded the caloric budget. If the predicted caloric intake is less than the goal caloric intake the user has consumed less calories than the caloric budget. If the value is near or equal to 0, the user has met their caloric budget. A caloric intake intermittent status report **1210** is generated based on this information.

Similarly, FIG. **18** illustrates how the program makes a user state status determination **1215** of the user's caloric intake. This calculation may be the same for the determination of the user's state of energy expenditure. The user state status is determined by subtracting the difference between the predicted caloric intake and the goal caloric intake. An arbitrary threshold, for example **50**, is chosen as a goal tolerance to place the user into one of three categories. If the difference between the predicted caloric intake and the goal caloric intake is greater than +50 calories, the state status determination result is 1. If the difference between the predicted caloric intake and the goal caloric intake is less than −50 calories, the state status determination result is −1. If the goal amount is greater than the predicted amount, the program returns a negative 1. If the difference between the values is near or equal to 0, as defined by the tolerance between ±50 caloric difference, the state status determination result is 0.

Based on the user state status determination described above, FIG. **19** illustrates how the program ultimately makes the user state determination **1175**. The program makes a user state status determination **1215** of the user's caloric intake determination based on the above calculation. After the program returns the value of 1, 0 or −1, the program makes a user state status determination **1215** of the user's energy expenditure. Based on the combination of the values, a user state determination **1 175** is calculated.

A specific embodiment of sensor device **10** is shown which is in the form of an armband adapted to be worn by an individual on his or her upper arm, between the shoulder and the elbow, as illustrated in FIGS. **20-25**. Although a similar sensor device may be worn on other parts of the individual's body, these locations have the same function for single or

multi-sensor measurements and for the automatic detection and/or identification of the user's activities or state. For the purpose of this disclosure, the specific embodiment of sensor device **10** shown in FIGS. **20-25** will, for convenience, be referred to as armband sensor device **400**. Armband sensor device **400** includes computer housing **405**, flexible wing body **410**, and, as shown in FIG. **25**, elastic strap **415**. Computer housing **405** and flexible wing body **410** are preferably made of a flexible urethane material or an elastomeric material such as rubber or a rubber-silicone blend by a molding process. Flexible wing body **410** includes first and second wings **418** each having a thru-hole **420** located near the ends **425** thereof. First and second wings **418** are adapted to wrap around a portion of the wearer's upper arm.

Elastic strap **415** is used to removably affix armband sensor device **400** to the individual's upper arm. As seen in FIG. **25**, bottom surface **426** of elastic strap **415** is provided with velcro loops **416** along a portion thereof. Each end **427** of elastic strap **415** is provided with velcro hook patch **428** on bottom surface **426** and pull tab **429** on top surface **430**. A portion of each pull tab **429** extends beyond the edge of each end **427**.

In order to wear armband sensor device **400**, a user inserts each end **427** of elastic strap **415** into a respective thru-hole **420** of flexible wing body **410**. The user then places his arm through the loop created by elastic strap **415**, flexible wing body **410** and computer housing **405**. By pulling each pull tab **429** and engaging velcro hook patches **428** with velcro loops **416** at a desired position along bottom surface **426** of elastic strap **415**, the user can adjust elastic strap **415** to fit comfortably. Since velcro hook patches **428** can be engaged with velcro loops **416** at almost any position along bottom surface **426**, armband sensor device **400** can be adjusted to fit arms of various sizes. Also, elastic strap **415** may be provided in various lengths to accommodate a wider range of arm sizes. As will be apparent to one of skill in the art, other means of fastening and adjusting the size of elastic strap may be used, including, but not limited to, snaps, buttons, or buckles. It is also possible to use two elastic straps that fasten by one of several conventional means including velcro, snaps, buttons, buckles or the like, or merely a single elastic strap affixed to wings **418**.

Alternatively, instead of providing thru-holes **420** in wings **418**, loops having the shape of the letter D, not shown, may be attached to ends **425** of wings **418** by one of several conventional means. For example, a pin, not shown, may be inserted through ends **425**, wherein the pin engages each end of each loop. In this configuration, the D-shaped loops would serve as connecting points for elastic strap **415**, effectively creating a thru-hole between each end **425** of each wing **418** and each loop.

As shown in FIG. **18**, which is an exploded view of armband sensor device **400**, computer housing **405** includes a top portion **435** and a bottom portion **440**. Contained within computer housing **405** are printed circuit board or PCB **445**, rechargeable battery **450**, preferably a lithium ion battery, and vibrating motor **455** for providing tactile feedback to the wearer, such as those used in pagers, suitable examples of which are the Model 12342 and 12343 motors sold by MG Motors Ltd. of the United Kingdom.

Top portion **435** and bottom portion **440** of computer housing **405** sealingly mate along groove **436** into which **0**-ring **437** is fit, and may be affixed to one another by screws, not shown, which pass through screw holes **438***a* and stiffeners **438***b* of bottom portion **440** and apertures **439** in PCB **445** and into threaded receiving stiffeners **451** of top portion **435**. Alternately, top portion **435** and bottom portion **440** may be snap fit together or affixed to one another with an adhesive. Preferably, the assembled computer housing **405** is sufficiently water resistant to permit armband sensor device **400** to be worn while swimming without adversely affecting the performance thereof.

As can be seen in FIG. **13**, bottom portion **440** includes, on a bottom side thereof, a raised platform **430**. Affixed to raised platform **430** is heat flow or flux sensor **460**, a suitable example of which is the micro-foil heat flux sensor sold by RdF Corporation of Hudson, N.H. Heat flux sensor **460** functions as a self-generating thermopile transducer, and preferably includes a carrier made of a polyamide film. Bottom portion **440** may include on a top side thereof, that is on a side opposite the side to which heat flux sensor **460** is affixed, a heat sink, not shown, made of a suitable metallic material such as aluminum. Also affixed to raised platform **430** are GSR sensors **465**, preferably comprising electrodes formed of a material such as conductive carbonized rubber, gold or stainless steel. Although two GSR sensors **465** are shown in FIG. **21**, it will be appreciated by one of skill in the art that the number of GSR sensors **465** and the placement thereof on raised platform **430** can vary as long as the individual GSR sensors **465**, i.e., the electrodes, are electrically isolated from one another. By being affixed to raised platform **430**, heat flux sensor **460** and GSR sensors **465** are adapted to be in contact with the wearer's skin when armband sensor device **400** is worn. Bottom portion **440** of computer housing **405** may also be provided with a removable and replaceable soft foam fabric pad, not shown, on a portion of the surface thereof that does not include raised platform **430** and screw holes **438***a*. The soft foam fabric is intended to contact the wearer's skin and make armband sensor device **400** more comfortable to wear.

Electrical coupling between heat flux sensor **460**, GSR sensors **465**, and PCB **445** may be accomplished in one of various known methods. For example, suitable wiring, not shown, may be molded into bottom portion **440** of computer housing **405** and then electrically connected, such as by soldering, to appropriate input locations on PCB **445** and to heat flux sensor **460** and GSR sensors **465**. Alternatively, rather than molding wiring into bottom portion **440**, thru-holes may be provided in bottom portion **440** through which appropriate wiring may pass. The thru-holes would preferably be provided with a water tight seal to maintain the integrity of computer housing **405**.

Rather than being affixed to raised platform **430** as shown in FIG. **21**, one or both of heat flux sensor **460** and GSR sensors **465** may be affixed to the inner portion **466** of flexible wing body **410** on either or both of wings **418** so as to be in contact with the wearer's skin when armband sensor device **400** is worn. In such a configuration, electrical coupling between heat flux sensor **460** and GSR sensors **465**, whichever the case may be, and the PCB **445** may be accomplished through suitable wiring, not shown, molded into flexible wing body **410** that passes through one or more thru-holes in computer housing **405** and that is electrically connected, such as by soldering, to appropriate input locations on PCB **445**. Again, the thru-holes would preferably be provided with a water tight seal to maintain the integrity of computer housing **405**. Alternatively, rather than providing thru-holes in computer housing **405** through which the wiring passes, the wiring may be captured in computer housing **405** during an overmolding process, described below, and ultimately soldered to appropriate input locations on PCB **445**.

As shown in FIGS. **12**, **16**, **17** and **18**, computer housing **405** includes a button **470** that is coupled to and adapted to activate a momentary switch **585** on PCB **445**. Button **470**

may be used to activate armband sensor device **400** for use, to mark the time an event occurred or to request system status information such as battery level and memory capacity. When button **470** is depressed, momentary switch **585** closes a circuit and a signal is sent to processing unit **490** on PCB **445**. Depending on the time interval for which button **470** is depressed, the generated signal triggers one of the events just described. Computer housing **405** also includes LEDs **475**, which may be used to indicate battery level or memory capacity or to provide visual feedback to the wearer. Rather than LEDs **475**, computer housing **405** may also include a liquid crystal display or LCD to provide battery level, memory capacity or visual feedback information to the wearer. Battery level, memory capacity or feedback information may also be given to the user tactily or audibly.

Armband sensor device **400** may be adapted to be activated for use, that is collecting data, when either of GSR sensors **465** or heat flux sensor **460** senses a particular condition that indicates that armband sensor device **400** has been placed in contact with the user's skin. Also, armband sensor device **400** may be adapted to be activated for use when one or more of heat flux sensor **460**, GSR sensors **465**, accelerometer **495** or **550**, or any other device in communication with armband sensor device **400**, alone or in combination, sense a particular condition or conditions that indicate that the armband sensor device **400** has been placed in contact with the user's skin for use. At other times, armband sensor device **400** would be deactivated, thus preserving battery power.

Computer housing **405** is adapted to be coupled to a battery recharger unit **480** shown in FIG. **27** for the purpose of recharging rechargeable battery **450**. Computer housing **405** includes recharger contacts **485**, shown in FIGS. **12**, **15**, **16** and **17**, that are coupled to rechargeable battery **450**. Recharger contracts **485** may be made of a material such as brass, gold or stainless steel, and are adapted to mate with and be electrically coupled to electrical contacts, not shown, provided in battery recharger unit **480** when armband sensor device **400** is placed therein. The electrical contacts provided in battery recharger unit **480** may be coupled to recharging circuit **481** a provided inside battery recharger unit **480**. In this configuration, recharging circuit **481** would be coupled to a wall outlet, such as by way of wiring including a suitable plug that is attached or is attachable to battery recharger unit **480**. Alternatively, electrical contacts **480** may be coupled to wiring that is attached to or is attachable to battery recharger unit **480** that in turn is coupled to recharging circuit **481**b external to battery recharger unit **480**. The wiring in this configuration would also include a plug, not shown, adapted to be plugged into a conventional wall outlet.

Also provided inside battery recharger unit **480** is RF transceiver **483** adapted to receive signals from and transmit signals to RF transceiver **565** provided in computer housing **405** and shown in FIG. **28**. RF transceiver **483** is adapted to be coupled, for example by a suitable cable, to a serial port, such as an RS 232 port or a USB port, of a device such as personal computer **35** shown in FIG. **1**. Thus, data may be uploaded from and downloaded to armband sensor device **400** using RF transceiver **483** and RF transceiver **565**. It will be appreciated that although RF transceivers **483** and **565** are shown in FIGS. **19** and **20**, other forms of wireless transceivers may be used, such as infrared transceivers. Alternatively, computer housing **405** may be provided with additional electrical contacts, not shown, that would be adapted to mate with and be electrically coupled to additional electrical contacts, not shown, provided in battery recharger unit **480** when armband sensor device **400** is placed therein. The additional electrical contacts in the computer housing **405** would be coupled to the processing unit **490** and the additional electrical contacts provided in battery recharger unit **480** would be coupled to a suitable cable that in turn would be coupled to a serial port, such as an RS R32 port or a USB port, of a device such as personal computer **35**. This configuration thus provides an alternate method for uploading of data from and downloading of data to armband sensor device **400** using a physical connection.

FIG. **28** is a schematic diagram that shows the system architecture of armband sensor device **400**, and in particular each of the components that is either on or coupled to PCB **445**.

As shown in FIG. **25**, PCB **445** includes processing unit **490**, which may be a microprocessor, a microcontroller, or any other processing device that can be adapted to perform the functionality described herein. Processing unit **490** is adapted to provide all of the functionality described in connection with microprocessor **20** shown in FIG. **2**. A suitable example of processing unit **490** is the Dragonball EZ sold by Motorola, Inc. of Schaumburg, Ill. PCB **445** also has thereon a two-axis accelerometer **495**, a suitable example of which is the Model ADXL210 accelerometer sold by Analog Devices, Inc. of Norwood; Mass. Two-axis accelerometer **495** is preferably mounted on PCB **445** at an angle such that its sensing axes are offset at an angle substantially equal to **45** degrees from the longitudinal axis of PCB **445** and thus the longitudinal axis of the wearer's arm when armband sensor device **400** is worn. The longitudinal axis of the wearer's arm refers to the axis defined by a straight line drawn from the wearer's shoulder to the wearer's elbow. The output signals of two-axis accelerometer **495** are passed through buffers **500** and input into analog to digital converter **505** that in turn is coupled to processing unit **490**. GSR sensors **465** are coupled to amplifier **510** on PCB **445**. Amplifier **510** provides amplification and low pass filtering functionality, a suitable example of which is the Model AD8544 amplifier sold by Analog Devices, Inc. of Norwood, Mass. The amplified and filtered signal output by amplifier **510** is input into amp/offset **515** to provide further gain and to remove any bias voltage and into filter/conditioning circuit **520**, which in turn are each coupled to analog to digital converter **505**. Heat flux sensor **460** is coupled to differential input amplifier **525**, such as the Model INA amplifier sold by Burr-Brown Corporation of Tucson, Ariz., and the resulting amplified signal is passed through filter circuit **530**, buffer **535** and amplifier **540** before being input to analog to digital converter **505**. Amplifier **540** is configured to provide further gain and low pass filtering, a suitable example of which is the Model AD8544 amplifier sold by Analog Devices, Inc. of Norwood, Mass. PCB **445** also includes thereon a battery monitor **545** that monitors the remaining power level of rechargeable battery **450**. Battery monitor **545** preferably comprises a voltage divider with a low pass filter to provide average battery voltage. When a user depresses button **470** in the manner adapted for requesting battery level, processing unit **490** checks the output of battery monitor **545** and provides an indication thereof to the user, preferably through LEDs **475**, but also possibly through vibrating motor **455** or ringer **575**. An LCD may also be used.

PCB **445** may include three-axis accelerometer **550** instead of or in addition to two-axis accelerometer **495**. The three-axis accelerometer outputs a signal to processing unit **490**. A suitable example of three-axis accelerometer is the μPAM product sold by I.M. Systems, Inc. of Scottsdale, Ariz. Three-axis accelerometer **550** is preferably tilted in the manner described with respect to two-axis accelerometer **495**.

PCB **445** also includes RF receiver **555** that is coupled to processing unit **490**. RF receiver **555** may be used to receive

signals that are output by another device capable of wireless transmission, shown in FIG. **28** as wireless device **558**, worn by or located near the individual wearing armband sensor device **400**. Located near as used herein means within the transmission range of wireless device **558**. For example, wireless device **558** may be a chest mounted heart rate monitor such as the Tempo product sold by Polar Electro of Oulu, Finland. Using such a heart rate monitor, data indicative of the wearer's heart rate can be collected by armband sensor device **400**. Antenna **560** and RF transceiver **565** are coupled to processing unit **490** and are provided for purposes of uploading data to central monitoring unit **30** and receiving data downloaded from central monitoring unit **30**. RF transceiver **565** and RF receiver **555** may, for example, employ Bluetooth technology as the wireless transmission protocol. Also, other forms of wireless transmission may be used, such as infrared transmission.

Vibrating motor **455** is coupled to processing unit **490** through vibrator driver **570** and provides tactile feedback to the wearer. Similarly, ringer **575**, a suitable example of which is the Model SMT916A ringer sold by Projects Unlimited, Inc. of Dayton, Ohio, is coupled to processing unit **490** through ringer driver **580**, a suitable example of which is the Model MMBTA14 CTI darlington transistor driver sold by Motorola, Inc. of Schaumburg, Ill., and provides audible feedback to the wearer. Feedback may include, for example, celebratory, cautionary and other threshold or event driven messages, such as when a wearer reaches a level of calories burned during a workout.

Also provided on PCB **445** and coupled to processing unit **490** is momentary switch **58.5**. Momentary switch **585** is also coupled to button **470** for activating momentary switch **585**. LEDs **475**, used to provide various types of feedback information to the wearer, are coupled to processing unit **490** through LED latch/driver **590**.

Oscillator **595** is provided on PCB **445** and supplies the system clock to processing unit **490**. Reset circuit **600**, accessible and triggerable through a pin-hole in the side of computer housing **405**, is coupled to processing unit **490** and enables processing unit **490** to be reset to a standard initial setting.

Rechargeable battery **450**, which is the main power source for the armband sensor device **400**, is coupled to processing unit **490** through voltage regulator **605**. Finally, memory functionality is provided for armband sensor device **400** by SRAM **610**, which stores data relating to the wearer of arm band sensor device **400**, and flash memory **615**, which stores program and configuration data, provided on PCB **445**. SRAM **610** and flash memory **615** are coupled to processing unit **490** and each preferably have at least 512K of memory.

In manufacturing and assembling armband sensor device **400**, top portion **435** of computer housing **405** is preferably formed first, such as by a conventional molding process, and flexible wing body **410** is then overmolded on top of top portion **435**. That is, top portion **435** is placed into an appropriately shaped mold, i.e., one that, when top portion **435** is placed therein, has a remaining cavity shaped according to the desired shape of flexible wing body **410**, and flexible wing body **410** is molded on top of top portion **435**. As a result, flexible wing body **410** and top portion **435** will merge or bond together, forming a single unit. Alternatively, top portion **435** of computer housing **405** and flexible wing body **410** may be formed together, such as by molding in a single mold, to form a single unit. The single unit however formed may then be turned over such that the underside of top portion **435** is facing upwards, and the contents of computer housing **405** can be placed into top portion **435**, and top portion **435** and bottom portion **440** can be affixed to one another. As still another alternative, flexible wing body **410** may be separately formed, such as by a conventional molding process, and computer housing **405**, and in particular top portion **435** of computer housing **405**, may be affixed to flexible wing body **410** by one of several known methods, such as by an adhesive, by snap-fitting, or by screwing the two pieces together. Then, the remainder of computer housing **405** would be assembled as described above. It will be appreciated that rather than assembling the remainder of computer housing **405** after top portion **435** has been affixed to flexible wing body **410**, the computer housing **405** could be assembled first and then affixed to flexible wing body **410**.

In a variety of the embodiments described above, it is specifically contemplated that the activity or nutritional data be input or detected by the system for derivation of the necessary data. As identified in several embodiments, the automatic detection of certain activities and/or nutritional intake may be substituted for such manual input. One aspect of the present invention relates to a sophisticated algorithm development process for creating a wide range of algorithms for generating information relating to a variety of variables from the data received from the plurality of physiological and/or contextual sensors on sensor device **400**. Such variables may include, without limitation, energy expenditure, including resting, active and total values, daily caloric intake, sleep states, including in bed, sleep onset, sleep interruptions, wake, and out of bed, and activity states, including exercising, sitting, traveling in a motor vehicle, and lying down, and the algorithms for generating values for such variables may be based on data from, for example, the 2-axis accelerometer, the heat flux sensor, the GSR sensor, the skin temperature sensor, the near-body ambient temperature sensor, and the heart rate sensor in the embodiment described above.

Note that there are several types of algorithms that can be computed. For example, and without limitation, these include algorithms for predicting user characteristics, continual measurements, durative contexts, instantaneous events, and cumulative conditions. User characteristics include permanent and semi-permanent parameters of the wearer, including aspects such as weight, height, and wearer identity. An example of a continual measurement is energy expenditure, which constantly measures, for example on a minute by minute basis, the number of calories of energy expended by the wearer. Durative contexts are behaviors that last some period of time, such as sleeping, driving a car, orjogging. Instantaneous events are those that occur at a fixed or over a very short time period, such as a heart attack or falling down. Cumulative conditions are those where the person's condition can be deduced from their behavior over some previous period of time. For example, if a person hasn't slept in 36 hours and hasn't eaten in 10 hours, it is likely that they are fatigued. Table 8 below shows numerous examples of specific personal characteristics, continual measurements, durative measurements, instantaneous events, and cumulative conditions.

TABLE 8

personal characteristics	age, sex, weight, gender, athletic ability, conditioning, disease, height, susceptibility to disease, activity level, individual detection, handedness, metabolic rate, body composition
continual measurements	mood, beat-to-beat variability of heart beats, respiration, energy expenditure, blood glucose levels, level of ketosis, heart rate, stress levels, fatigue levels, alertness levels, blood pressure, readiness, strength, endurance, amenability to

TABLE 8-continued

	interaction, steps per time period, stillness level, body position and orientation, cleanliness, mood or affect, approachability, caloric intake, TEF, XEF, 'in the zone'-ness, active energy expenditure, carbohydrate intake, fat intake, protein intake, hydration levels, truthfulness, sleep quality, sleep state, consciousness level, effects of medication, dosage prediction, water intake, alcohol intake, dizziness, pain, comfort, remaining processing power for new stimuli, proper use of the armband, interest in a topic, relative exertion, location, blood-alcohol level
durative measurements	exercise, sleep, lying down, sitting, standing, ambulation, running, walking, biking, stationary biking, road biking, lifting weights, aerobic exercise, anaerobic exercise, strength-building exercise, mind-centering activity, periods of intense emotion, relaxing, watching TV, sedentary, REM detector, eating, in-the-zone, interruptible, general activity detection, sleep stage, heat stress, heat stroke, amenable to teaching/learning, bipolar decompensation, abnormal events (in heart signal, in activity level, measured by the user, etc), startle level, highway driving or riding in a car, airplane travel, helicopter travel, boredom events, sport detection (football, baseball, soccer, etc), studying, reading, intoxication, effect of a drug
instantaneous events	falling, heart attack, seizure, sleep arousal events, PVCs, blood sugar abnormality, acute stress or disorientation, emergency, heart arrhythmia, shock, vomiting, rapid blood loss, taking medication, swallowing
cumulative conditions	Alzheimer's, weakness or increased likelihood of falling, drowsiness, fatigue, existence of ketosis, ovulation, pregnancy, disease, illness, fever, edema, anemia, having the flu, hypertension, mental disorders, acute dehydration, hypothermia, being-in-the-zone

It will be appreciated that the present invention may be utilized in a method for doing automatic journaling of a wearer's physiological and contextual states. The system can automatically produce a journal of what activities the user was engaged in, what events occurred, how the user's physiological state changed over time, and when the user experienced or was likely to experience certain conditions. For example, the system can produce a record of when the user exercised, drove a car, slept, was in danger of heat stress, or ate, in addition to recording the user's hydration level, energy expenditure level, sleep levels, and alertness levels throughout a day. These detected conditions can be utilized to time- or event-stamp the data record, to modify certain parameters of the analysis or presentation of the data, as well as trigger certain delayed or real time feedback events.

According to the algorithm development process, linear or non-linear mathematical models or algorithms are constructed that map the data from the plurality of sensors to a desired variable. The process consists of several steps. First, data is collected by subjects wearing sensor device **400** who are put into situations as close to real world situations as possible, with respect to the parameters being measured, such that the subjects are not endangered and so that the variable that the proposed algorithm is to predict can, at the same time, be reliably measured using, for example, highly accurate medical grade lab equipment. This first step provides the following two sets of data that are then used as inputs to the algorithm development process: (i) the raw data from sensor device **400**, and (ii) the data consisting of the verifiably accurate data measurements and extrapolated or derived data made with or calculated from the more accurate lab equipment. This verifiable data becomes a standard against which other analytical or measured data is compared. For cases in which the variable that the proposed algorithm is to predict relates to context detection, such as traveling in a motor vehicle, the verifiable standard data is provided by the subjects themselves, such as through information input manually into sensor device **400**, a PC, or otherwise manually recorded. The collected data, i.e., both the raw data and the corresponding verifiable standard data, is then organized into a database and is split into training and test sets.

Next, using the data in the training set, a mathematical model is built that relates the raw data to the corresponding verifiable standard data. Specifically, a variety of machine learning techniques are used to generate two types of algorithms: 1) algorithms known as features, which are derived continuous parameters that vary in a manner that allows the prediction of the lab-measured parameter for some subset of the data points. The features are typically not conditionally independent of the lab-measured parameter e.g. VO2 level information from a metabolic cart, douglas bag, or doubly labeled water, and 2) algorithms known as context detectors that predict various contexts, e.g., running, exercising, lying down, sleeping or driving, useful for the overall algorithm. A number of well known machine learning techniques may be used in this step, including artificial neural nets, decision trees, memory-based methods, boosting, attribute selection through cross-validation, and stochastic search methods such as simulated annealing and evolutionary computation.

After a suitable set of features and context detectors are found, several well known machine learning methods are used to combine the features and context detectors into an overall model. Techniques used in this phase include, but are not limited to, multilinear regression, locally weighted regression, decision trees, artificial neural networks, stochastic search methods, support vector machines, and model trees. These models are evaluated using cross-validation to avoid over-fitting.

At this stage, the models make predictions on, for example, a minute by minute basis. Inter-minute effects are next taken into account by creating an overall model that integrates the minute by minute predictions. A well known or custom windowing and threshold optimization tool may be used in this step to take advantage of the temporal continuity of the data. Finally, the model's performance can be evaluated on the test set, which has not yet been used in the creation of the algorithm. Performance of the model on the test set is thus a good estimate of the algorithm's expected performance on other unseen data. Finally, the algorithm may undergo live testing on new data for further validation.

Further examples of the types of non-linear functions and/or machine learning method that may be used in the present invention include the following: conditionals, case statements, logical processing, probabilistic or logical inference, neural network processing, kernel based methods, memory-based lookup including kNN and SOMs, decision lists, decision-tree prediction, support vector machine prediction, clustering, boosted methods, cascade-correlation, Boltzmann classifiers, regression trees, case-based reasoning, Gaussians, Bayes nets, dynamic Bayesian networks, HMMs, Kalman filters, Gaussian processes and algorithmic predictors, e.g. learned by evolutionary computation or other program synthesis tools.

Although one can view an algorithm as taking raw sensor values or signals as input, performing computation, and then producing a desired output, it is useful in one preferred embodiment to view the algorithm as a series of derivations that are applied to the raw sensor values. Each derivation

produces a signal referred to as a derived channel. The raw sensor values or signals are also referred to as channels, specifically raw channels rather than derived channels. These derivations, also referred to as functions, can be simple or complex but are applied in a predetermined order on the raw values and, possibly, on already existing derived channels. The first derivation must, of course, only take as input raw sensor signals and other available baseline information such as manually entered data and demographic information about the subject, but subsequent derivations can take as input previously derived channels. Note that one can easily determine, from the order of application of derivations, the particular channels utilized to derive a given derived channel. Also note that inputs that a user provides on an Input/Output, or I/O, device or in some fashion can also be included as raw signals which can be used by the algorithms. For example, the category chosen to describe a meal can be used by a derivation that computes the caloric estimate for the meal. In one embodiment, the raw signals are first summarized into channels that are sufficient for later derivations and can be efficiently stored. These channels include derivations such as summation, summation of differences, and averages. Note that although summarizing the high-rate data into compressed channels is useful both for compression and for storing useful features, it may be useful to store some or all segments of high rate data as well, depending on the exact details of the application. In one embodiment, these summary channels are then calibrated to take minor measurable differences in manufacturing into account and to result in values in the appropriate scale and in the correct units. For example, if, during the manufacturing process, a particular temperature sensor was determined to have a slight offset, this offset can be applied, resulting in a derived channel expressing temperature in degrees Celsius.

For purposes of this description, a derivation or function is linear if it is expressed as a weighted combination of its inputs together with some offset. For example, if G and H are two raw or derived channels, then all derivations of the form A*G+B*H+C, where A, B, and C are constants, is a linear derivation. A derivation is non-linear with respect to its inputs if it can not be expressed as a weighted sum of the inputs with a constant offset. An example of a nonlinear derivation is as follows: if G>7 then return H*9, else return H*3.5±912. A channel is linearly derived if all derivations involved in computing it are linear, and a channel is nonlinearly derived if any of the derivations used in creating it are nonlinear. A channel nonlinearly mediates a derivation if changes in the value of the channel change the computation performed in the derivation, keeping all other inputs to the derivation constant.

According to a preferred embodiment of the present invention, the algorithms that are developed using this process will have the format shown conceptually in FIG. **29**. Specifically, the algorithm will take as inputs the channels derived from the sensor data collected by the sensor device from the various sensors, and demographic information for the individual as shown in box **1600**. The algorithm includes at least one context detector **1605** that produces a weight, shown as W**1** through WN, expressing the probability that a given portion of collected data, such as is collected over a minute, was collected while the wearer was in each of several possible contexts. Such contexts may include whether the individual was at rest or active. In addition, for each context, a regression algorithm **1610** is provided where a continuous prediction is computed taking raw or derived channels as input. The individual regressions can be any of a variety of regression equations or methods, including, for example, multivariate linear or polynomial regression, memory based methods, support vector machine regression, neural networks, Gaussian processes, arbitrary procedural functions and the like. Each regression is an estimate of the output of the parameter of interest in the algorithm, for example, energy expenditure. Finally, the outputs of each regression algorithm **1610** for each context, shown as A**1** through AN, and the weights W**1** through WN are combined in a post-processor **1615** which outputs the parameter of interest being measured or predicted by the algorithm, shown in box **1620**. In general, the post-processor **1615** can consist of any of many methods for combining the separate contextual predictions, including committee methods, boosting, voting methods, consistency checking, or context based recombination.

Referring to FIG. **30**, an example algorithm for measuring energy expenditure of an individual is shown. This example algorithm may be run on sensor device **400** having at least an accelerometer, a heat flux sensor and a GSR sensor, or an I/O device **1200** that receives data from such a sensor device as is disclosed in co-pending U.S. patent application Ser. No. 10/682,759, the specification of which is incorporated herein by reference. In this example algorithm, the raw data from the sensors is calibrated and numerous values based thereon, i.e., derived channels, are created. In particular, the following derived channels, shown at **1600** in FIG. **30**, are computed from the raw signals and the demographic information: (1) longitudinal accelerometer average, or LAVE, based on the accelerometer data; (2) transverse accelerometer sum of average differences, or TSAD, based on the accelerometer data; (3) heat flux high gain average variance, or HFvar, based on heat flux sensor data; (4) vector sum of transverse and longitudinal accelerometer sum of absolute differences or SADs, identified as VSAD, based on the accelerometer data; (5) galvanic skin response, or GSR, in both low and combined gain embodiments; and (6) Basal Metabolic Rate or BMR, based on demographic information input by the user. Context detector **1605** consists of a naive Bayesian classifier that predicts whether the wearer is active or resting using the LAVE, TSAD, and HFvar derived channels. The output is a probabilistic weight, W**1** and W**2** for the two contexts rest and active. For the rest context, the regression algorithm **1610** is a linear regression combining channels derived from the accelerometer, the heat flux sensor, the user's demographic data, and the galvanic skin response sensor. The equation, obtained through the algorithm design process, is A*VSAD+B*HFvar+C*GSR+D*BMR+E, where A, B, C, D and E are constants. The regression algorithm **1610** for the active context is the same, except that the constants are different. The post-processor **1615** for this example is to add together the weighted results of each contextual regression. If A**1** is the result of the rest regression and A**2** is the result of the active regression, then the combination is just W**1***A**1**+W**2***A**2**, which is energy expenditure shown at **1620**. In another example, a derived channel that calculates whether the wearer is motoring, that is, driving in a car at the time period in question might also be input into the post-processor **1615**. The process by which this derived motoring channel is computed is algorithm 3. The post-processor **1615** in this case might then enforce a constraint that when the wearer is predicted to be driving by algorithm 3, the energy expenditure is limited for that time period to a value equal to some factor, e.g. 1.3 times their minute by minute basal metabolic rate.

This algorithm development process may also be used to create algorithms to enable sensor device **400** to detect and measure various other parameters, including, without limitation, the following: (i) when an individual is suffering from duress, including states of unconsciousness, fatigue, shock, drowsiness, heat stress and dehydration; and (ii) an individu-

al's state of readiness, health and/or metabolic status, such as in a military environment, including states of dehydration, under-nourishment and lack of sleep. In addition, algorithms may be developed for other purposes, such as filtering, signal clean-up and noise cancellation for signals measured by a sensor device as described herein. As will be appreciated, the actual algorithm or function that is developed using this method will be highly dependent on the specifics of the sensor device used, such as the specific sensors and placement thereof and the overall structure and geometry of the sensor device. Thus, an algorithm developed with one sensor device will not work as well, if at all, on sensor devices that are not substantially structurally identical to the sensor device used to create the algorithm.

Another aspect of the present invention relates to the ability of the developed algorithms to handle various kinds of uncertainty. Data uncertainty refers to sensor noise and possible sensor failures. Data uncertainty is when one cannot fully trust the data. Under such conditions, for example, if a sensor, for example an accelerometer, fails, the system might conclude that the wearer is sleeping or resting or that no motion is taking place. Under such conditions it is very hard to conclude if the data is bad or if the model that is predicting and making the conclusion is wrong. When an application involves both model and data uncertainties, it is very important to identify the relative magnitudes of the uncertainties associated with data and the model. An intelligent system would notice that the sensor seems to be producing erroneous data and would either switch to alternate algorithms or would, in some cases, be able to fill the gaps intelligently before making any predictions. When neither of these recovery techniques are possible, as was mentioned before, returning a clear statement that an accurate value can not be returned is often much preferable to returning information from an algorithm that has been determined to be likely to be wrong. Determining when sensors have failed and when data channels are no longer reliable is a non-trivial task because a failed sensor can sometimes result in readings that may seem consistent with some of the other sensors and the data can also fall within the normal operating range of the sensor.

Clinical uncertainty refers to the fact that different sensors might indicate seemingly contradictory conclusions. Clinical uncertainty is when one cannot be sure of the conclusion that is drawn from the data. For example, the accelerometers might indicate that the wearer is motionless, leading toward a conclusion of a resting user, the galvanic skin response sensor might provide a very high response, leading toward a conclusion of an active user, the heat flow sensor might indicate that the wearer is still dispersing substantial heat, leading toward a conclusion of an active user, and the heart rate sensor might indicate that the wearer has an elevated heart rate, leading toward a conclusion of an active user. An inferior system might simply try to vote among the sensors or use similarly unfounded methods to integrate the various readings. The present invention weights the important joint probabilities and determines the appropriate most likely conclusion, which might be, for this example, that the wearer is currently performing or has recently performed a low motion activity such as stationary biking.

According to a further aspect of the present invention, a sensor device such as sensor device **400** may be used to automatically measure, record, store and/or report a parameter Y relating to the state of a person, preferably a state of the person that cannot be directly measured by the sensors. State parameter Y may be, for example and without limitation, calories consumed, energy expenditure, sleep states, hydration levels, ketosis levels, shock, insulin levels, physical exhaustion and heat exhaustion, among others. The sensor device is able to observe a vector of raw signals consisting of the outputs of certain of the one or more sensors, which may include all of such sensors or a subset of such sensors. As described above, certain signals, referred to as channels same potential terminology problem here as well, may be derived from the vector of raw sensor signals as well. A vector X of certain of these raw and/or derived channels, referred to herein as the raw and derived channels X, will change in some systematic way depending on or sensitive to the state, event and/or level of either the state parameter Y that is of interest or some indicator of Y, referred to as U, wherein there is a relationship between Y and U such that Y can be obtained from U. According to the present invention, a first algorithm or function f**1** is created using the sensor device that takes as inputs the raw and derived channels X and gives an output that predicts and is conditionally dependent, expressed with the symbol π, on (i) either the state parameter Y or the indicator U, and (ii) some other state parameter(s) Z of the individual. This algorithm or function f**1** may be expressed as follows:

$$f1(X) \pi U+Z$$

or

$$f1(X) \pi Y+Z$$

According to the preferred embodiment, f**1** is developed using the algorithm development process described elsewhere herein which uses data, specifically the raw and derived channels X, derived from the signals collected by the sensor device, the verifiable standard data relating to U or Y and Z contemporaneously measured using a method taken to be the correct answer, for example highly accurate medical grade lab equipment, and various machine learning techniques to generate the algorithms from the collected data. The algorithm or function f**1** is created under conditions where the indicator U or state parameter Y, whichever the case may be, is present. As will be appreciated, the actual algorithm or function that is developed using this method will be highly dependent on the specifics of the sensor device used, such as the specific sensors and placement thereof and the overall structure and geometry of the senor device. Thus, an algorithm developed with one sensor device will not work as well, if at all, on sensor devices that are not substantially structurally identical to the sensor device used to create the algorithm or at least can be translated from device to device or sensor to sensor with known conversion parameters.

Next, a second algorithm or function f**2** is created using the sensor device that takes as inputs the raw and derived channels X and gives an output that predicts and is conditionally dependent on everything output by f**1** except either Y or U, whichever the case may be, and is conditionally independent, indicated by the symbol $\perp\!\!\!\perp$, of either Y or U, whichever the case may be. The idea is that certain of the raw and derived channels X from the one or more sensors make it possible to explain away or filter out changes in the raw and derived channels X coming from non-Y or non-U related events. This algorithm or function f**2** may be expressed as follows:

$$f2(X) \pi Z \text{ and } (f2(X) \perp\!\!\!\perp Y \text{ or } fl2(X) \perp\!\!\!\perp U$$

Preferably, f**2**, like f**1**, is developed using the algorithm development process referenced above. f**2**, however, is developed and validated under conditions where U or Y, whichever the case may, is not present. Thus, the gold standard data used to create f**2** is data relating to Z only measured using highly accurate medical grade lab equipment.

Thus, according to this aspect of the invention, two functions will have been created, one of which, f1, is sensitive to U or Y, the other of which, f2, is insensitive to U or Y. As will be appreciated, there is a relationship between f1 and f2 that will yield either U or Y, whichever the case may be. In other words, there is a function f3 such that f3 (f1, f2)=U or f3 (f1, f2)=Y. For example, U or Y may be obtained by subtracting the data produced by the two functions (U=f1−f2 or Y=f1−f2). In the case where U, rather than Y, is determined from the relationship between f1 and f2, the next step involves obtaining Y from U based on the relationship between Y and U. For example, Y may be some fixed percentage of U such that Y can be obtained by dividing U by some factor.

One skilled in the art will appreciate that in the present invention, more than two such functions, e.g. (f1, f2, f3, . . . f_n−1) could be combined by a last function f_n in the manner described above. In general, this aspect of the invention requires that a set of functions is combined whose outputs vary from one another in a way that is indicative of the parameter of interest. It will also be appreciated that conditional dependence or independence as used here will be defined to be approximate rather than precise.

The method just described may, for example, be used to automatically measure and/or report the caloric consumption or intake of a person using the sensor device, such as that person's daily caloric intake, also known as DCI. Automatic measuring and reporting of caloric intake would be advantageous because other non-automated methods, such as keeping diaries and journals of food intake, are hard to maintain and because caloric information for food items is not always reliable or, as in the case of a restaurant, readily available.

It is known that total body metabolism is measured as total energy expenditure (TEE) according to the following equation:

$$TEE=BMR+AE+TEF+AT,$$

wherein BMR is basal metabolic rate, which is the energy expended by the body during rest such as sleep, AE is activity energy expenditure, which is the energy expended during physical activity, TEF is thermic effect of food, which is the energy expended while digesting and processing the food that is eaten, and AT is adaptive thermogenesis, which is a mechanism by which the body modifies its metabolism to extreme temperatures. It is estimated that it costs humans about 10% of the value of food that is eaten to process the food. TEF is therefore estimated to be 10% of the total calories consumed. Thus, a reliable and practical method of measuring TEF would enable caloric consumption to be measured without the need to manually track or record food related information. Specifically, once TEF is measured, caloric consumption can be accurately estimated by dividing TEF by 0.1 (TEF=0.1*Calories Consumed; Calories Consumed=TEF/0.1).

According to a specific embodiment of the present invention relating to the automatic measurement of a state parameter Y as described above, a sensor device as described above may be used to automatically measure and/or record calories consumed by an individual. In this embodiment, the state parameter Y is calories consumed by the individual and the indicator U is TEF. First, the sensor device is used to create f1, which is an algorithm for predicting TEE. f1 is developed and validated on subjects who ate food, in other words, subjects who were performing activity and who were experiencing a TEF effect. As such, f1 is referred to as EE(gorge) to represent that it predicts energy expenditure including eating effects. The verifiable standard data used to create f1 is a VO2 machine. The function f1, which predicts TEE, is conditionally dependent on and predicts the item U of interest, which is TEF. In addition, f1 is conditionally dependent on and predicts Z which, in this case, is BMR+AE+AT. Next, the sensor device is used to create f2, which is an algorithm for predicting all aspects of TEE except for TEF. f2 is developed and validated on subjects who fasted for a period of time prior to the collection of data, preferably 4-6 hours, to ensure that TEF was not present and was not a factor. Such subjects will be performing physical activity without any TEF effect. As a result, f2 is conditionally dependent to and predicts BMR+AE+AT but is conditionally independent of and does not predict TEF. As such, f2 is referred to as EE(fast) to represent that it predicts energy expenditure not including eating effects. Thus, f1 so developed will be sensitive to TEF and f2 so developed will be insensitive to TEF. As will be appreciated, in this embodiment, the relationship between f1 and f2 that will yield the indicator U, which in this case is TEF, is subtraction. In other words, EE (gorge)−EE (fast)=TEF.

Once developed, functions f_1 and f_2 can be programmed into software stored by the sensor device and executed by the processor of the sensor device. Data from which the raw and derived channels X can be derived can then be collected by the sensor device. The outputs of f_1 and f_2 using the collected data as inputs can then be subtracted to yield TEF. Once TEF is determined for a period of time such as a day, calories consumed can be obtained for that period by dividing TEF by 0.1, since TEF is estimated to be 10% of the total calories consumed. The caloric consumption data so obtained may be stored, reported and/or used in lieu of the manually collected caloric consumption data utilized in the embodiments described elsewhere herein.

Preferably, the sensor device is in communication with a body motion sensor such as an accelerometer adapted to generate data indicative of motion, a skin conductance sensor such as a GSR sensor adapted to generate data indicative of the resistance of the individual's skin to electrical current, a heat flux sensor adapted to generate data indicative of heat flow off the body, a body potential sensor such as an ECG sensor adapted to generate data indicative of the rate or other characteristics of the heart beats of the individual, and a temperature sensor adapted to generate data indicative of a temperature of the individual's skin. In this preferred embodiment, these signals, in addition the demographic information about the wearer, make up the vector of signals from which the raw and derived channels X are derived. Most preferably, this vector of signals includes data indicative of motion, resistance of the individual's skin to electrical current and heat flow off the body.

As a limiting case of attempting to estimate TEF as described above, one can imagine the case where the set of additional state parameters Z is zero. This results in measuring TEF directly through the derivational process using linear and non-linear derivations described earlier. In this variation, the algorithmic process is used to predict TEF directly, which must be provided as the verifiable-standard training data.

As an alternative to TEF, any effect of food on the body, such as, for example, drowsiness, urination or an electrical effect, or any other signs of eating, such as stomach sounds, may be used as the indicator U in the method just described for enabling the automatic measurement of caloric consumption. The relationship between U and the state parameter Y, which is calories consumed, may, in these alternative embodiments, be based on some known or developed scientific property or equation or may be based on statistical modeling techniques.

As an alternate embodiment, DCI can be estimated by combining measurements of weight taken at different times

with estimates of energy expenditure. It is known from the literature that weight change (measured multiple times under the same conditions so as to filter out effects of water retention and the digestive process) is related to energy balance and caloric intake as follows: (Caloric Intake−Energy Expenditure)/K=weight gain in pounds, where K is a constant preferably equal to 3500. Thus, given that an aspect of the present invention relates to a method and apparatus for measuring energy expenditure that may take input from a scale, the caloric intake of a person can be accurately estimated based on the following equation: Caloric Intake=Energy Expenditure+(weigh gain in pounds*K). This method requires that the user weigh themselves regularly, but requires no other effort on their part to obtain a measure of caloric intake.

Also note also that DCI can be estimated using an algorithm that takes sensor data and attempts to directly estimate the calories consumed by the wearer, using that number of calories as the verifiable standard and the set of raw and derived channels as the training data. This is just an instance of the algorithmic process described above.

Another specific instantiation where the present invention can be utilized relates to detecting when a person is fatigued. Such detection can either be performed in at least two ways. A first way involves accurately measuring parameters such as their caloric intake, hydration levels, sleep, stress, and energy expenditure levels using a sensor device and using the two function (f_1 and f_2) approach described with respect to TEF and caloric intake estimation to provide an estimate of fatigue. A second way involves directly attempting to model fatigue using the direct derivational approach described in connection with FIGS. **29** and **30**. This example illustrates that complex algorithms that predict the wearer's physiologic state can themselves be used as inputs to other more complex algorithms. One potential application for such an embodiment of the present invention would be for first-responders (e.g. firefighters, police, soldiers) where the wearer is subject to extreme conditions and performance matters significantly. In a pilot study, the assignee of the present invention analyzed data from firefighters undergoing training exercises and determined that reasonable measures of heat stress were possible using combinations of calibrated sensor values. For example, if heat flux is too low for too long a period of time but skin temperature continues to rise, the wearer is likely to have a problem. It will be appreciated that algorithms can use both calibrated sensor values and complex derived algorithms.

According to an alternate embodiment of the present invention, rather than having the software that implements f_1 and f_2 and determines U and/or Y therefrom be resident on and executed by the sensor device itself, such software may be resident on and run by a computing device separate from the sensor device. In this embodiment, the computing device receives, by wire or wirelessly, the signals collected by the sensor device from which the set of raw and derived channels X are derived and determines U and/or Y from those signals as described above. This alternate embodiment may be an embodiment wherein the state parameter Y that is determined by the computing device is calories consumed and wherein the indicator is some effect on the body of food, such as TEF. The computing device may display the determined caloric consumption data to the user. In addition, the sensor device may also generate caloric expenditure data as described elsewhere herein which is communicated to the computing device. The computing device may then generate and display information based on the caloric consumption data and the caloric expenditure data, such as energy balance data, goal related data, and rate of weight loss or gain data.

The terms and expressions which have been employed herein are used as terms of description and not as limitation, and there is no intention in the use of such terms and expressions of excluding equivalents of the features shown and described or portions thereof, it being recognized that various modifications are possible within the scope of the invention claimed. Although particular embodiments of the present invention have been illustrated in the foregoing detailed description, it is to be further understood that the present invention is not to be limited to just the embodiments disclosed, but that they are capable of numerous rearrangements, modifications and substitutions.

What is claimed is:

1. A system to provide feedback for an individual's weight-loss goal, said system comprising:

a. a wearable sensor device for detecting data; and

b. a processing unit in electronic communication with said sensor device, said processing unit configured to accomplish the following steps, thus providing said feedback:

(i) derive physiological and contextual data of the individual from data detected by said sensor device;

(ii) prompt said individual to establish a weight-loss goal;

(iii) generate a first suggestion to engage in an activity to assist said individual to achieve said weight-loss goal;

(iv) determine weight-loss;

(v) generate a second suggestion to engage in an activity to assist said individual to achieve said weight-loss goal if said weight-loss goal is not progressing toward the goal;

wherein said second suggestion is based upon a determination of whether or not the individual complied with said first suggestion; and

wherein said determination of whether or not the individual complied with said first suggestion is based on said derived physiological and contextual data of the individual.

2. The system of claim **1**, wherein said processing unit is further configured to derive an energy balance from said detected data.

3. The system of claim **2**, wherein the energy balance is derived from daily caloric intake and energy expenditure.

4. The system of claim **3**, wherein said feedback comprises the effect of daily caloric intake and energy expenditure upon each other.

5. The system of claim **2**, wherein said processing unit is configured to utilize said energy balance to track and predict changes in human physiological parameters.

6. The system of claim **1**, wherein said processing unit is further configured to identify a pattern of behavior from said detected data, to determine whether said pattern affects said user's progress, and to adapt said identified pattern of behavior.

7. The system of claim **6**, wherein said pattern is recorded for future review.

8. The system of claim **7**, wherein said processing unit is further configured to analyze said recorded patterns to detect one of: (i) current and (ii) future patterns of negative, positive and neutral human physiological status parameters.

9. The system of claim **8**, wherein said analysis of recorded patterns are based on one of (i) data from the individual's personal history and (ii) aggregate data of other individuals.

10. The system of claim **1**, further comprising a database comprising data.

11. The system of claim **10**, wherein said database includes patterns of physiological data.

12. The system of claim 10, wherein said database includes patterns of contextual data.

13. The system of claim 10, wherein said database includes patterns of activity data derived from said detected data.

14. The system of claim 10, wherein said processing unit is further configured to analyze said data in database to establish data patterns.

15. The system of claim 14, wherein said processing unit is further configured to instruct said system to store said data patterns.

16. The system of claim 15, wherein said processing unit is further configured to compare stored data patterns to detected data to identify and categorize said detected data into additional data patterns.

17. The system of claim 15, wherein said processing unit is further configured to (i) compare stored data patterns to detected data to identify such detected data as being similar to at least one of said stored data patterns and (ii) predict future data.

18. The system of claim 17, wherein said processing unit is configured to generate output based upon said prediction of said future data.

19. The system of claim 18, wherein said output is an alarm.

20. The system of claim 18, wherein said output is a report.

21. The system of claim 18, wherein said output is utilized as input by another device.

22. The system of claim 1, wherein said processing unit is further configured to utilize said feedback for the purpose of establishing an initial assessment for a health modification plan.

23. The system of claim 22, wherein said processing unit is further configured to utilize said feedback for assessing interim status of progress toward said health modification plan.

24. The system of claim 1, wherein said first suggestion comprises a plan.

25. The system of claim 1, further comprising an algorithm stored in a memory of the processing unit, the algorithm configured to calculate weight loss or weight gain using inputs from at least one of the sensor and the individual.

26. The system of claim 1, wherein said processing unit is further configured to derive energy expenditure data from said detected data.

27. The system of claim 26, wherein said processing unit is further configured to utilize said energy expenditure data to track and predict changes in the individual's human physiological parameters.

28. The system of claim 1, wherein the system is configured for use in the management of at least one of sleep, pregnancy,. diabetes, cardiovascular disease, wellness, and stress.

29. The system of claim 1, wherein said sensor device comprises at least one of a weight scale and a glucose monitor.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 8,398,546 B2
APPLICATION NO. : 10/940214
DATED : March 19, 2013
INVENTOR(S) : Pacione et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page:

The first or sole Notice should read --

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 486 days.

Signed and Sealed this
Second Day of December, 2014

Michelle K. Lee

Michelle K. Lee
Deputy Director of the United States Patent and Trademark Office