



US 20170196484A1

(19) **United States**

(12) **Patent Application Publication**
Beckman

(10) **Pub. No.: US 2017/0196484 A1**

(43) **Pub. Date: Jul. 13, 2017**

(54) **SPECIALIZED SENSORS AND TECHNIQUES FOR MONITORING PERSONAL ACTIVITY**

(71) Applicant: **Group Mee LLC**, Brooklyn, NY (US)

(72) Inventor: **Christopher V. Beckman**, San Diego, CA (US)

(73) Assignee: **Group Mee LLC**, Brooklyn, NY (US)

(21) Appl. No.: **15/471,957**

(22) Filed: **Mar. 28, 2017**

Related U.S. Application Data

(63) Continuation of application No. 13/830,174, filed on Mar. 14, 2013, now Pat. No. 9,636,048.

Publication Classification

(51) **Int. Cl.**

| | |
|-------------------|-----------|
| <i>A61B 5/11</i> | (2006.01) |
| <i>G06Q 30/02</i> | (2006.01) |
| <i>A61B 1/015</i> | (2006.01) |
| <i>A61B 5/00</i> | (2006.01) |
| <i>A63B 24/00</i> | (2006.01) |
| <i>G09B 19/00</i> | (2006.01) |

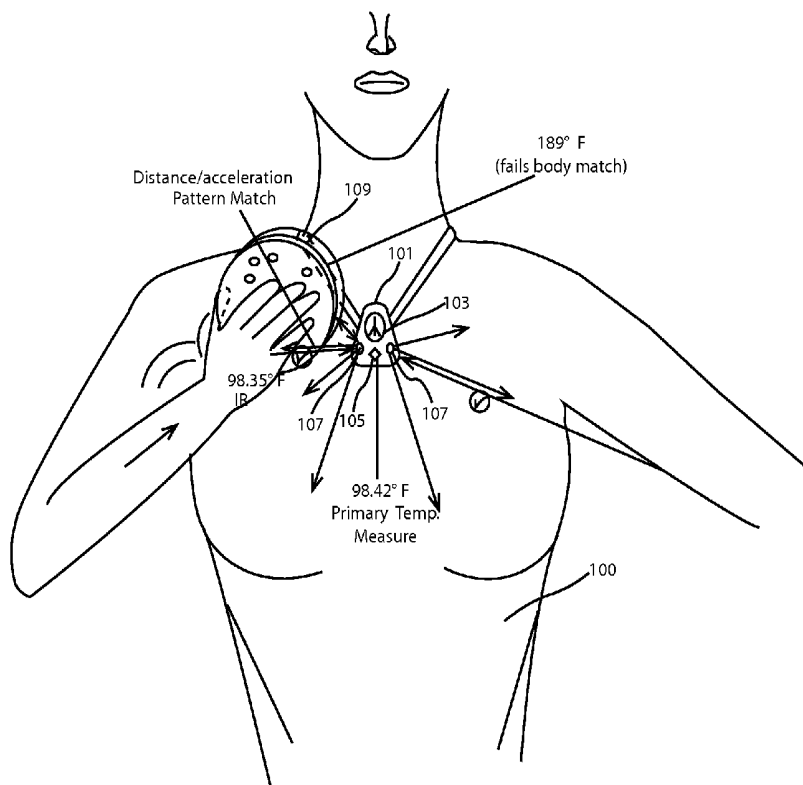
(52) **U.S. Cl.**
CPC *A61B 5/1118* (2013.01); *A63B 24/0062* (2013.01); *G09B 19/0092* (2013.01); *A61B 1/015* (2013.01); *A61B 5/6801* (2013.01); *A61B 5/0082* (2013.01); *A61B 5/4833* (2013.01); *G06Q 30/0226* (2013.01); *A63B 2230/50* (2013.01); *A63B 2220/836* (2013.01)

(57) **ABSTRACT**

New activity recognition, recording, analysis and control techniques, systems and sensors are provided. In some aspects of the invention, multiple sensory tags with unique identification and data transfer attributes, create positional, movement, orientation and acceleration data and supply it to a control system. The tags may be placed at location(s) on the user's body, clothing, personal effects, exercise equipment and other activity-relevant locations, to enhance activity recognition and mapping. For example, a specialized PDA may comprise part of the control system, and may provide, reflect and/or receive modified data signals to and from such tags.

In other aspects, a system defines a personal activity space, samples data preferentially from that space, and performs a simplified form of object-recognition to determine, record and analyze personal activities.

A GUI interface within the control system may also aid in recognizing and recording activity patterns, in addition to tags.



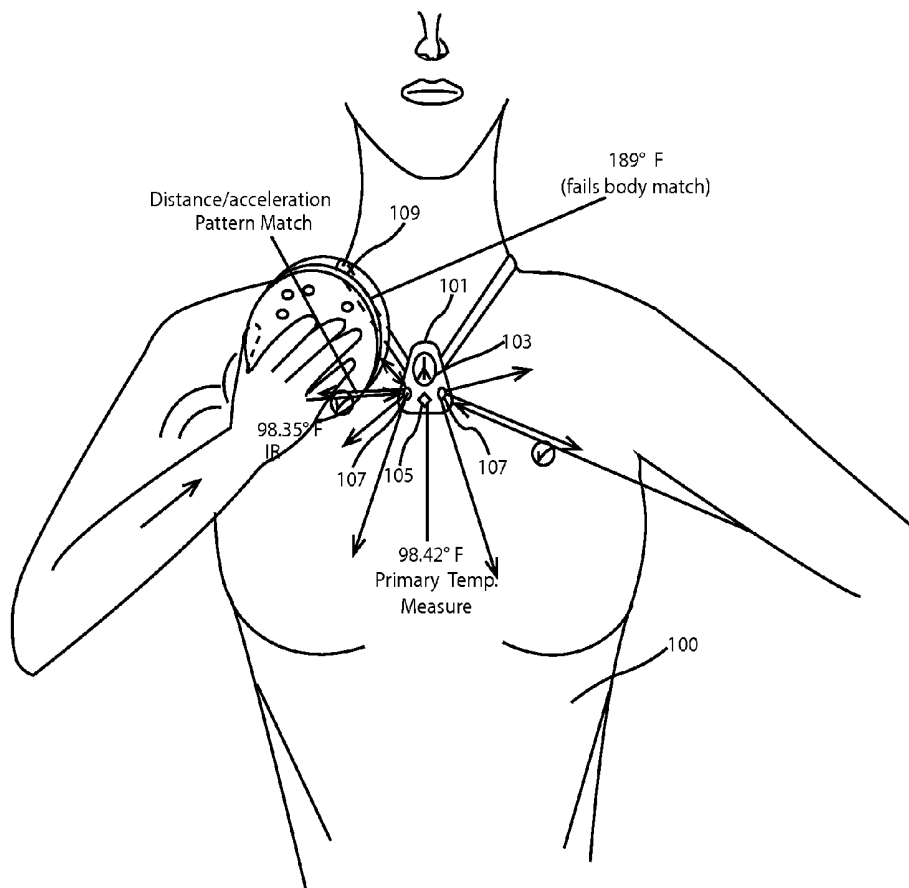


Fig. 1

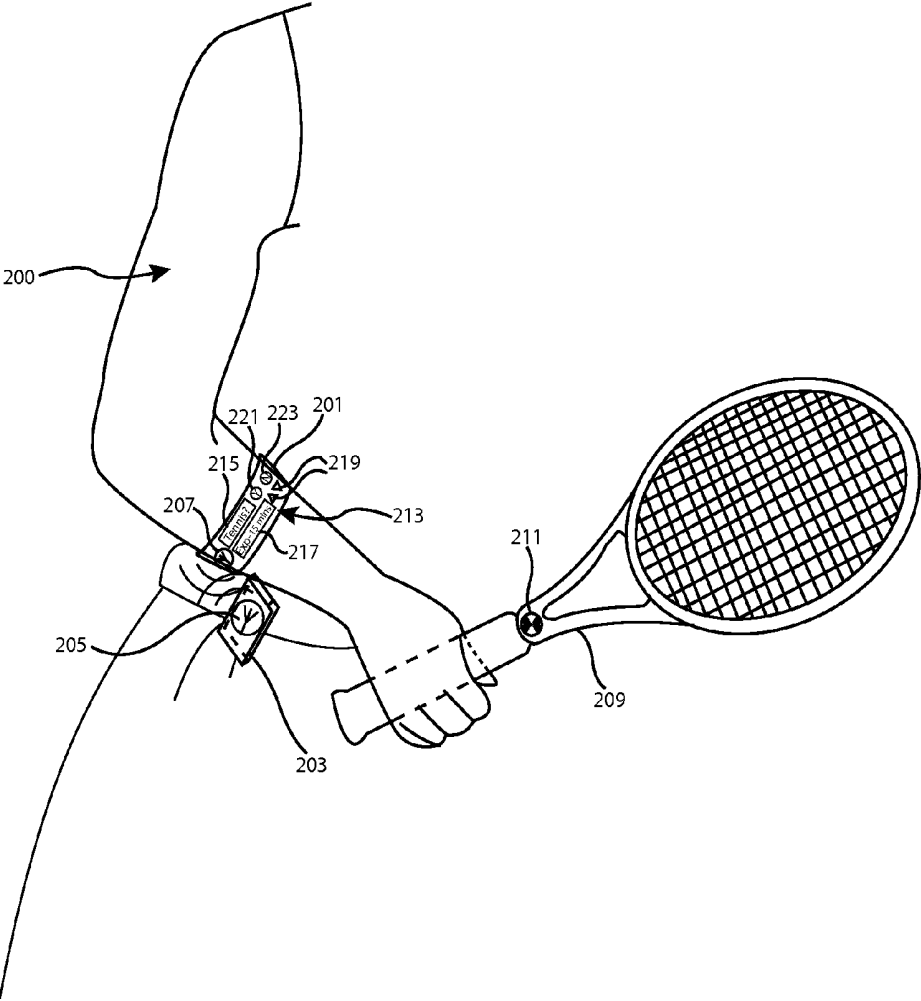


Fig. 2

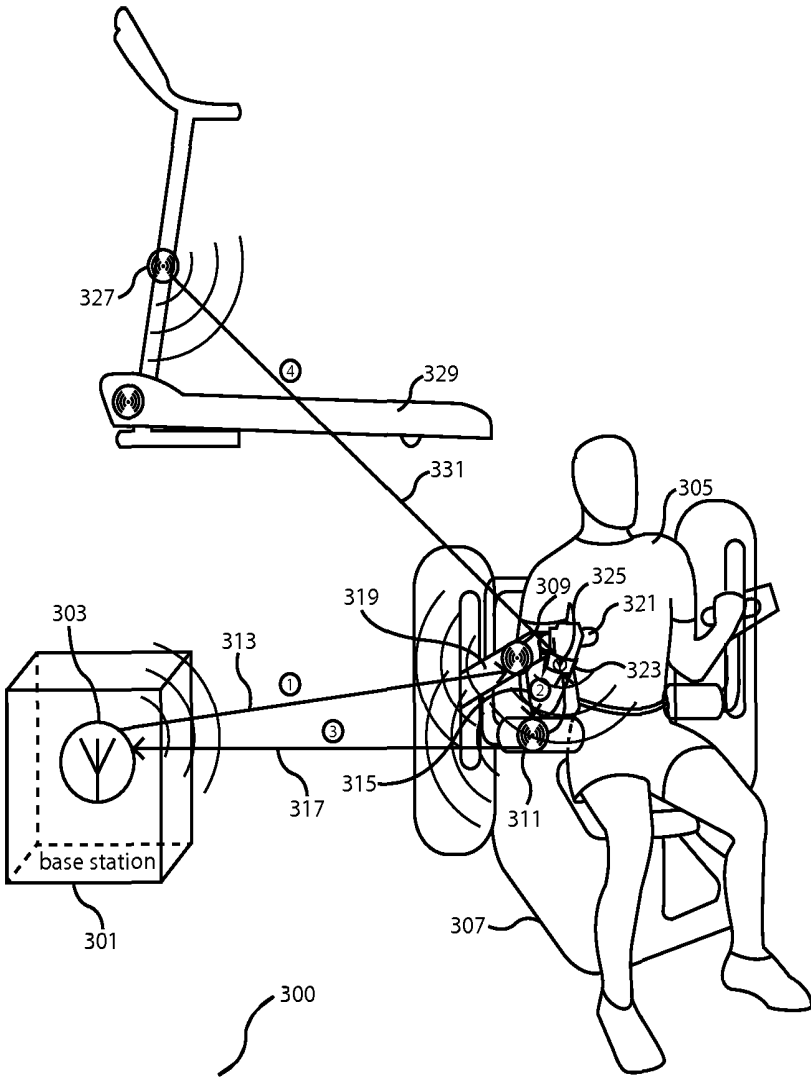


Fig. 3

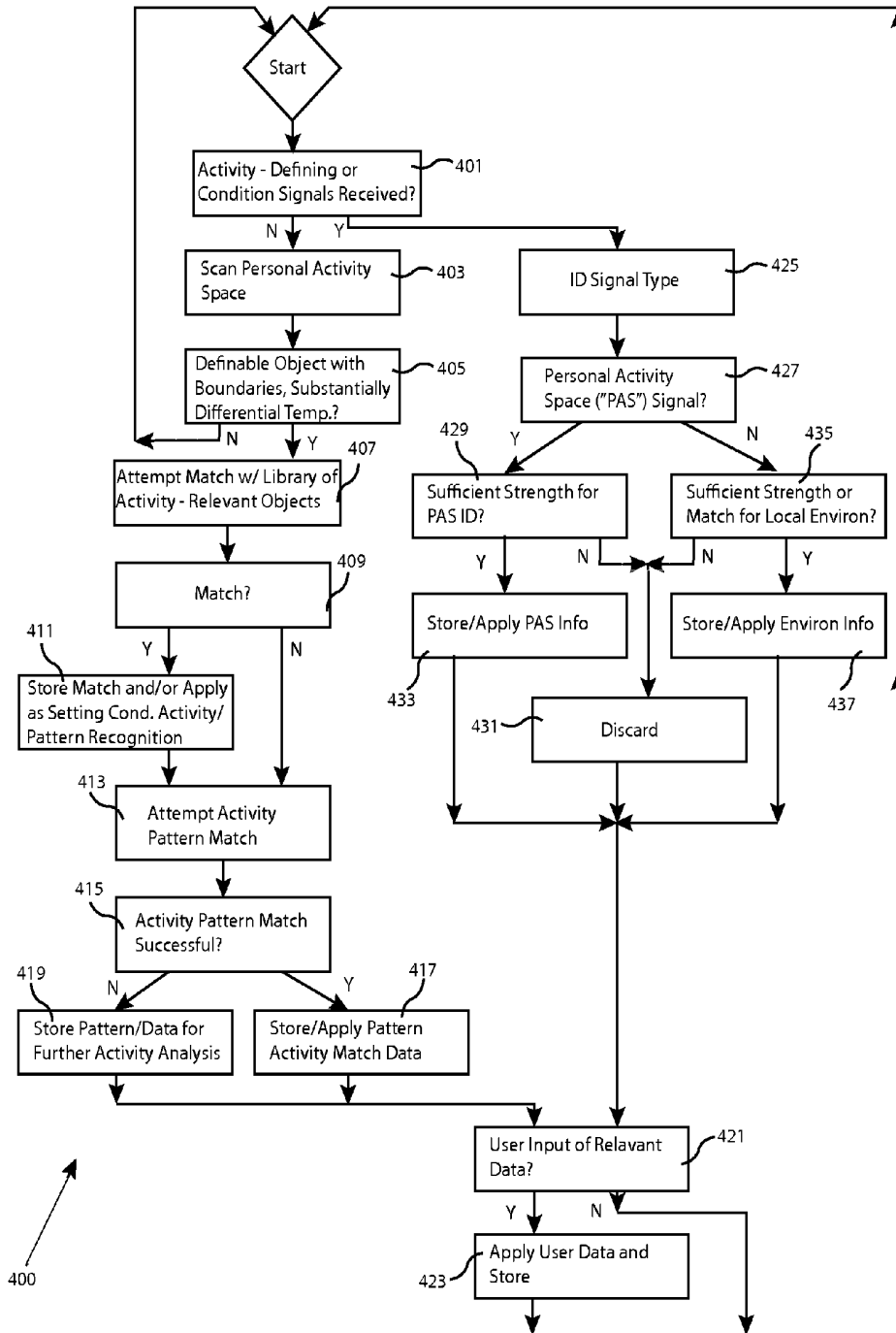


Fig. 4

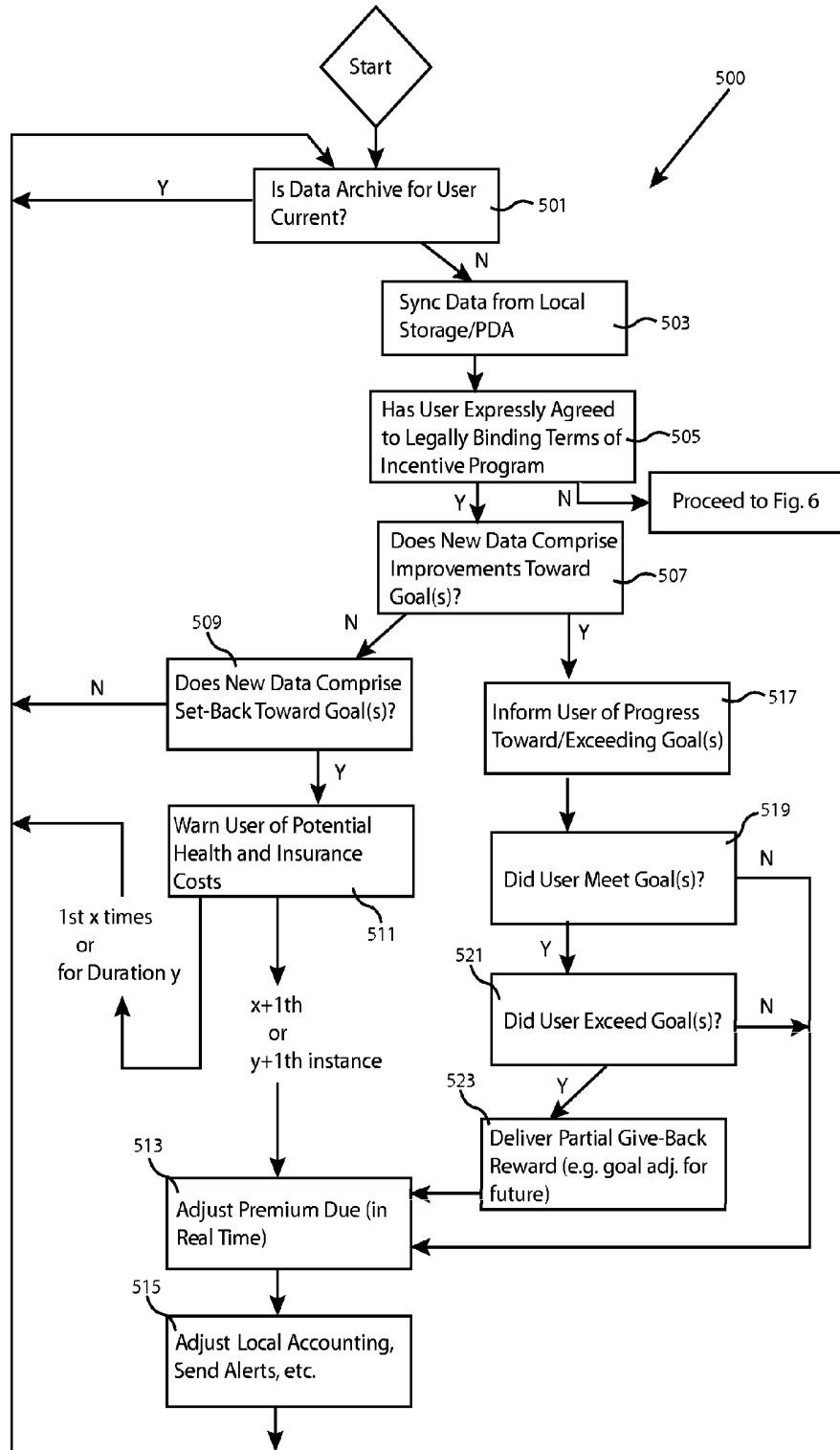


Fig. 5

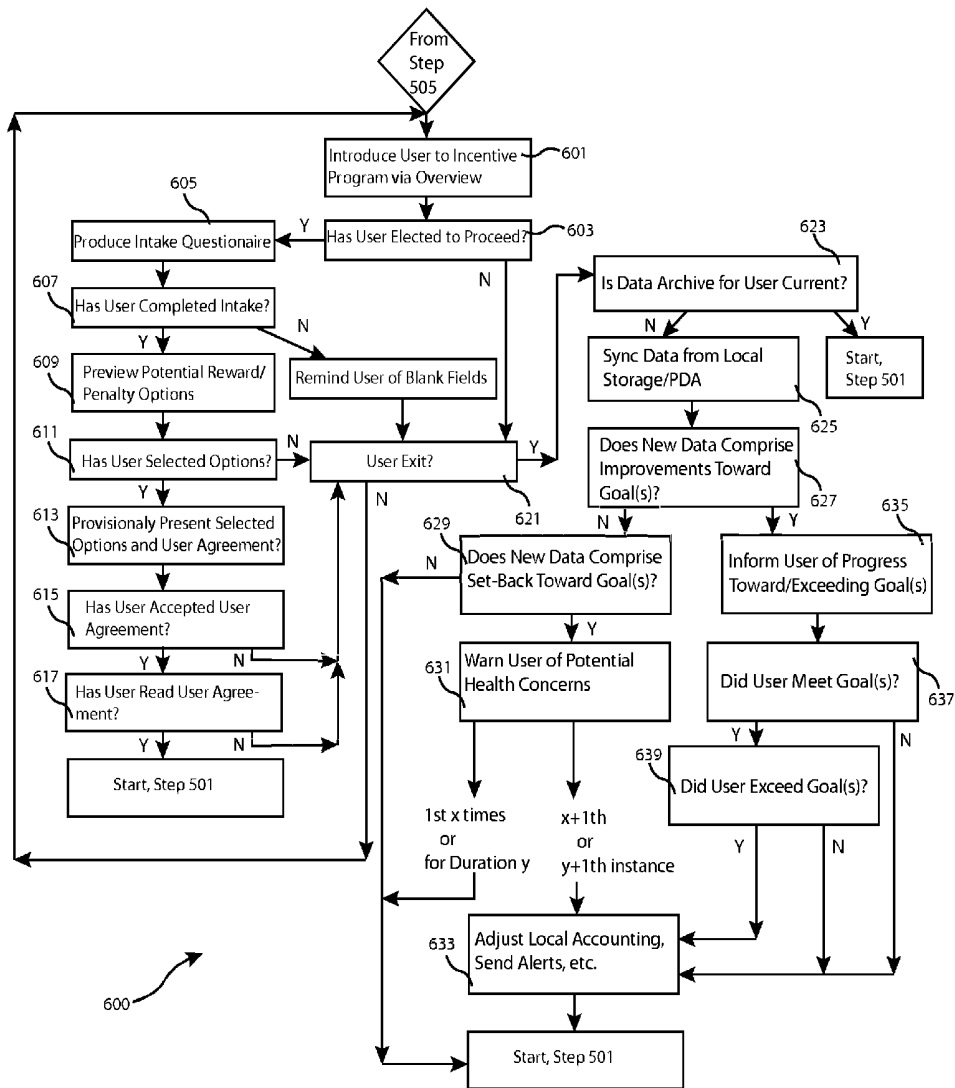


Fig. 6

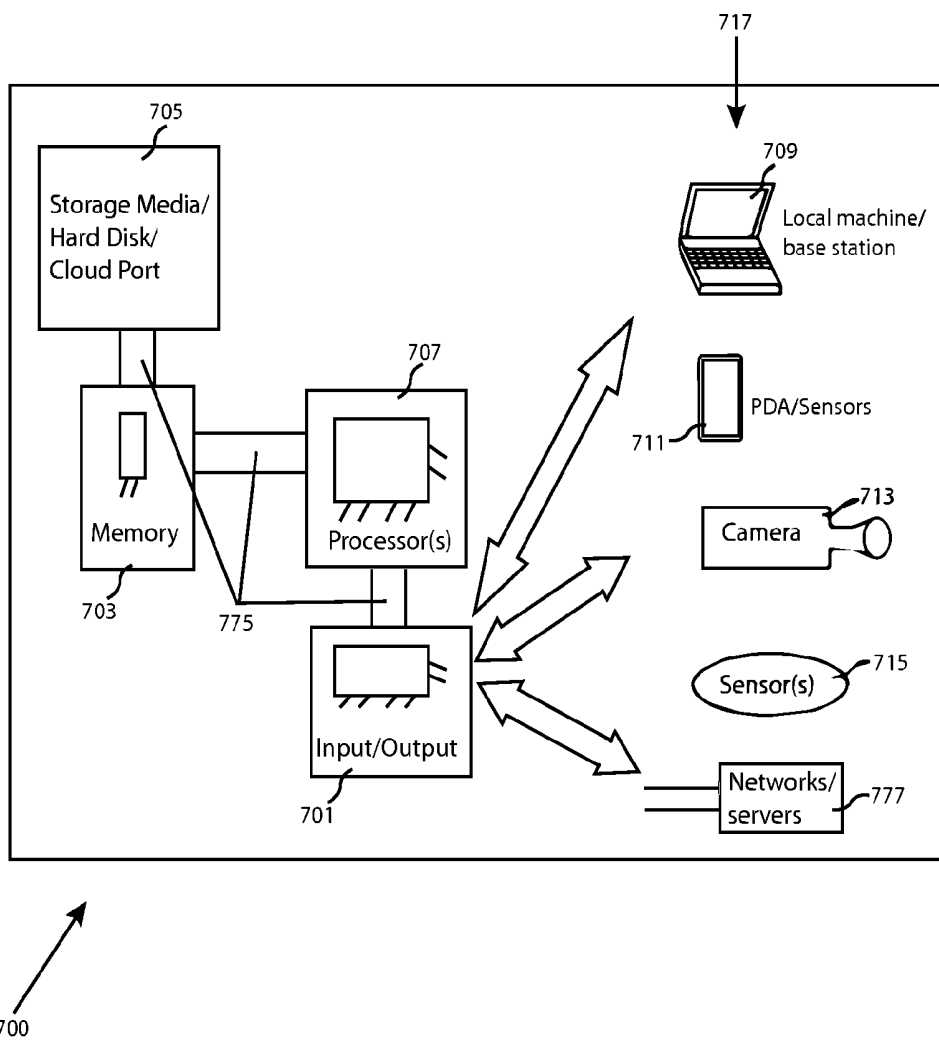


Fig. 7

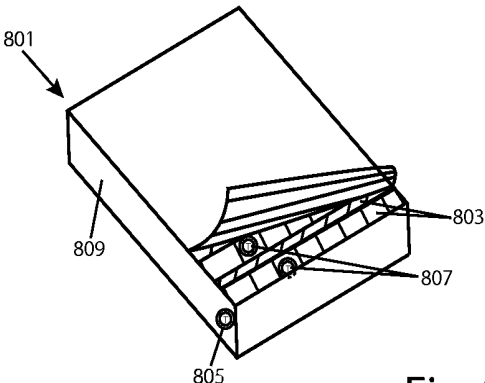


Fig. 8

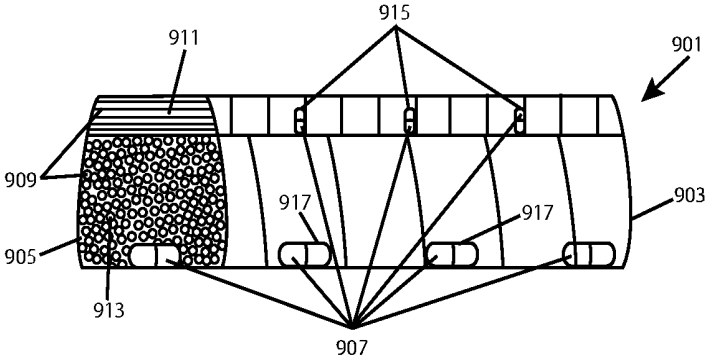


Fig. 9

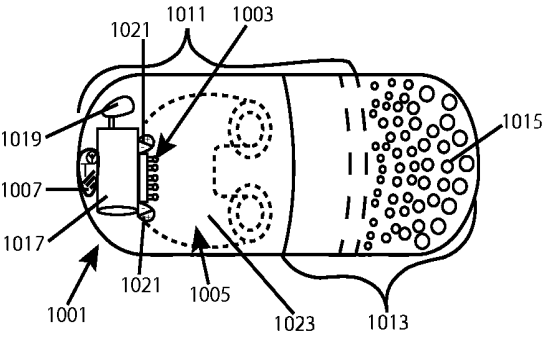


Fig. 10

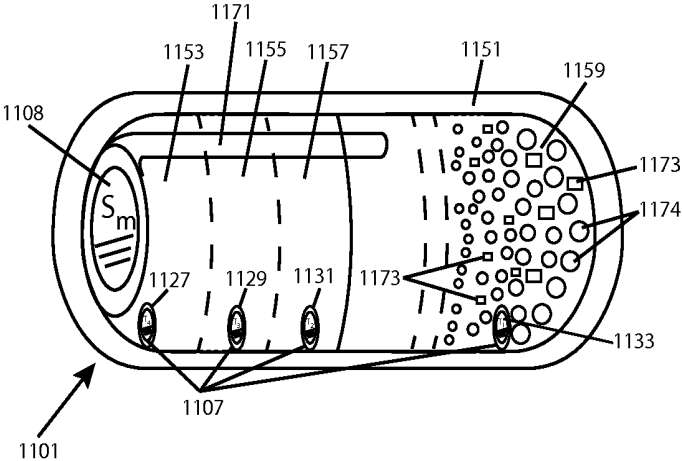


Fig. 11

SPECIALIZED SENSORS AND TECHNIQUES FOR MONITORING PERSONAL ACTIVITY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a continuation of U.S. Utility patent application Ser. No. 13/830,174, titled “Specialized Sensors and Techniques for Monitoring Personal Activity,” filed Mar. 14, 2013, which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to the field of sensory devices for use with computer hardware. The present invention also relates to the field of personal area networks and, more specifically, to establishing both wired and wireless personal area networks.

BACKGROUND

[0003] Human beings have implemented purposeful diets, exercise, medical regimens and other activities and routines (“personal activities”) for centuries, in an effort to restore, maintain or enhance personal health and physical performance.

[0004] In recent years, research has confirmed that the degree, frequency and type of personal activities can have profound affects on a person’s overall morbidity and mortality. See, e.g., Brown, W. J et al., *Updating the Evidence on Physical Activity and Health in Women*, Am. J. Prev. Med. 33 (5): 404-11 (2007). For example, it has long been understood that sedentary lifestyles are strongly associated with adverse health conditions and the risk of premature death. Matthews C E et al., *Amount of Time Spent in Sedentary Behaviors and Cause-Specific Mortality in US Adults*, Am. J. Clin. Nutr.; 95 (2): 437-45, Jan. 4, 2012. Flowing from this, millions of Americans now attempt to follow the advice of health professionals that they should make an effort to exercise frequently. When provided, a physician’s specific advice may vary widely, but guidelines from the Centers for Disease Control recommend: (1) a minimum of 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic activity, and (2) muscle-strengthening activities on 2 or more days a week that work all major muscle groups, among other possible regimen combinations for health benefits. Centers for Disease Control and Prevention, *How Much Physical Activity do Adults Need?*, available at <http://www.cdc.gov/physicalactivity/everyone/guidelines/adults.html>, accessed Jan. 21, 2013.

[0005] Strikingly, a majority of patients are still not advised to exercise at all by their physician, even in the face of recent studies establishing that a majority of adults in the United States are overweight or obese. Patricia M. Barnes, et al., *Trends in Adults Receiving a Recommendation for Exercise or Other Physical Activity From a Physician or Other Health Professional*, NCHS Data Brief, No. 86 (February 2012); National Center for Health Statistics, *Health, United States, 2011*, at 15 and FIG. 11 (Hyattsville, Md., 2012).

[0006] In recent years, the sufficiency and soundness of general advice on exercise from health authorities has been called into question by empirical research. Several studies now demonstrate that even a high level of regular, moderate-to-vigorous exercise may be insufficient to offset the

destructive effects of time spent sitting. See, e.g., Matthews C E et al., *supra*; see also J Lennert Veerman et al., *Television Viewing Time and Reduced Life Expectancy: A Life Table Analysis*, Br. J. Sports Med. 46: 927-930 (2011). Findings like these are extremely important today, because more and more workers in the United States spend most of their time sitting at work—specifically, while working at personal computer terminals. Many of these workers continue to labor under the delusion that, if they spend a half an hour at the gym on a lunch break or after work, they can offset the effects of a sedentary work routine. In fact, some studies may even support the disturbing conclusion that a person may actually be less active, overall, on days that they make an effort to exercise vigorously, offsetting the benefits.

[0007] Adherence to medical regimens and compliance with consumption-related instructions from medical and fitness personnel also presents long-standing, serious challenges for millions. In recent years, a plethora of medical compliance tools (such as reminder systems and calendared medicine containers) have flourished, but the issue of compliance with such regimens continues.

[0008] It should be understood that the disclosures in this application related to the background of the invention, in, but not limited to this section titled “Background,” do not necessarily set forth prior art or other known aspects exclusively, and may instead include art that was invented concurrently or after the present invention and conception, and details of the inventor’s own discoveries and work and work results.

SUMMARY OF THE INVENTION

[0009] New personal activity recognition, recording, analysis and control techniques are provided. Using the system, a user may enhance an exercise, diet and other personal activity regime.

[0010] In some aspects of the invention, activity pattern recognition is greatly improved by a new type of tag- and thermal data-assisted object recognition as well as system-wide and location-specific information sharing. In addition, the system may simplify its analysis by focusing data gathering into a variably-defined personal activity space. With respect to the tag(s), the detectable identity of tags may be assigned by an aspect of the system and/or a user, after which time their identity, range and/or more specific location in space relative to a user may be assessed. The presence, position, movement and relevance of such tags is simplified by a unique form of data transfer between tags.

[0011] To assist in analyzing, tracking and other related activities, a smartphone, personal digital assistant (“PDA”) or other user-defining system aspect with a near-field, tagging or other communication sub-system identifies relevant tag(s), their location relative to the user, and contributes that information in aid of defining the user’s activity patterns. Other activity pattern data contributed to the system for activity and activity pattern analysis and recordation are positional, movement, orientation and acceleration data, which may be contributed by conventional global positioning system (“GPS”), accelerometer and other methods. Activity mapping (including algorithms applied by the system for the definition of tagged areas and sub-areas by many different users) may aid the system in identifying and ascribing relevant environmental and activity qualities to the tags.

[0012] In some aspects of the invention, identifying beacons are used, for example from a local base station defining an environmental area, in addition to or in place of tags, to aid in area, article and other environmentally-relevant activity definition.

[0013] The system may also benefit from implementing local object recognition, benefiting from a new form of thermal differential analysis, to aid in identifying consumption and other activity. For example, the system may obtain information relevant to consuming foodstuffs, including the potential food type, size and caloric properties, among other consumption and other activity-relevant data.

[0014] Further aspects of the invention and specific embodiments will be set forth below, with reference to the drawings.

Cannons of Construction and Definitions

[0015] The following terms shall have the following meanings, significance and senses, in addition to their ordinary and specific meanings, significances and senses in general usage and within the technological field(s) in which they are used.

[0016] "GUI," in addition to its ordinary meaning and special meaning in the arts to which it relates and that may be relevant to this application, means any device, object, method or technique comprising controls assisting or enabling a user to carry out or affect the performance, actuation, parameters, or other aspects of the invention, or any part thereof. A graphical user interface ("GUP") comprises, but is not limited to, virtual controls, or a set thereof, represented by computer hardware and software (for example, actuable visual representations of tools by a computer system on a computer screen).

[0017] Where any term is set forth in a sentence, clause or statement ("statement"), each possible meaning, significance and/or sense of any term used in this application should be read as if separately, conjunctively and/or alternatively set forth in additional statements, as necessary to exhaust the possible meanings of each such term and each such statement.

[0018] It should also be understood that, for convenience and readability, this application may set forth particular pronouns and other linguistic qualifiers of various specific gender and number, but, where this occurs, all other logically possible gender and number alternatives should also be read in as both conjunctive and alternative statements, as if equally, separately set forth therein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. 1 is a front perspective view of a user whose activity is being tracked by an exemplary system implementing aspects of the invention.

[0020] FIG. 2 depicts an alternate form of personal activity defining, tracking and analyzing device used in conjunction with a second sensor set, which may track one another, in addition to recognizing, defining, tracking and analyzing objects, in aid of personal activity definition and analysis by a system.

[0021] FIG. 3 depicts a personal activity defining, tracking and analyzing base station, used in conjunction with specialized sensor tags by a system to identify, define, track and analyze personal activity, in accordance with aspects of the present invention.

[0022] FIG. 4 is an exemplary process flow diagram of exemplary steps that may be taken by a system, such as (but not limited to) a hardware and software control system, for example, of the nature discussed with reference to FIG. 7, implementing aspects of the present invention.

[0023] FIG. 5 is another exemplary process flow diagram of exemplary steps that may be taken by a system, such as (but not limited to) a hardware and software control system, for example, of the nature discussed with reference to FIG. 7, implementing aspects of the present invention.

[0024] FIG. 6 is another exemplary process flow diagram of exemplary steps that may be taken by a system, such as (but not limited to) a hardware and software control system of the nature discussed with reference to FIG. 7, implementing additional aspects of the present invention.

[0025] FIG. 7 is a schematic block diagram of some elements of an exemplary control system that may be used in accordance with aspects of the present invention.

[0026] FIG. 8 is a perspective drawing of partially-opened food packaging containing several food bars, implementing a nutritional inventory and tracking system according to aspects of the present invention.

[0027] FIG. 9 is a perspective drawing of a partially-consumed individual food bar item, similar to the food bars discussed above, with reference to FIG. 8, and comprising multiple inventory tags and inventory tag types at spatial intervals throughout the item, which may be used in conjunction with a consumption tracking system according to aspects of the present invention, and in accordance with aspects of the present invention.

[0028] FIG. 10 depicts an exemplary consumable tag, such as the consumable tags discussed above, but also containing a sensor array and sensor-exposing pump/conduit, which may comprise an ion pump/conduit, which may be used in conjunction with a consumption tracking system according to aspects of the present invention, and in accordance with aspects of the present invention.

[0029] FIG. 11 depicts an exemplary consumable tag comprising multiple signal/response elements, which may interact with one another as well as a control system, in accordance with aspects of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0030] FIG. 1 is a front perspective view of a user **100** whose activity is being tracked by an exemplary system implementing aspects of the invention. A radiation transceiver device **101** is an aspect comprised in that system, and includes a series of additional, sub-aspects. Each aspect may be variably or permanently networked or otherwise connected and capable of communication with one another and/or other aspects of the system and present invention. Such sub-aspects may comprise an antenna **103**, capable of both sending and receiving electromagnetic (e.g., microwave) and/or other radiation signals, which may be with the aid of an internal or external control system and power source. In some embodiments, received radiation (at either antenna **103** or otherwise), or a part thereof, may comprise the power source but, in others, a battery within device **101** provides the power source. In some embodiments, transceiver device **101** also may comprise a directional thermometer (such as an infrared thermometer) or pyrometer **105** as a sub-aspect, which may be directed toward at least a part of the user's body **101**, for example, from the side of device

101 facing the user (into the page, in the perspective of the figure). Because all sub-aspects may be in communication with the control system, the control system may therefore take readings of the user's body temperature, which may, in a typical user, be approximately 98.2 degrees Fahrenheit, as a mean temperature, and 99.9 degrees Fahrenheit as an upper normal limit, although this figure may change (but remain correlated to average core body temperature) depending on the exact location of the measurements taken, and may also fluctuate throughout the day. For example, as pictured, if the thermometer/pyrometer **105** takes a reading of cutaneous and/or core body temperature from a user's chest, the readings may be significantly lower than core body temperature from other readings, but, nonetheless, a core body temperature may be correlated and extrapolated by the system based on the user's chest-based temperature data. In some embodiments, the correlation may be calibrated based on the mean or floating mean differential between a separately, substantially simultaneously measured core body temperature reading and readings from thermometer/pyrometer **105**, but readings of great precision may not always be required to implement aspects of the invention.

[0031] Based on extrapolated core body temperatures and/or actual chest and/or cutaneous temperature readings, and in addition to other temperature or temperature-related radiation (e.g., infrared radiation) readings, aspects of the system may make useful relative temperature comparisons of nearby objects and the user's body (and/or the ambient temperature in the personal activity space, or beyond) to aid in activity recognition and analysis. In some embodiments, infra-red radiation readings may be taken from defined objects only, within a set distance, by imaging or otherwise directional temperature-related external infrared sensor(s) **107**. The set distance may be variably set by the user and/or system, to define objects relevant to their physical activity, for example, by use of lenses or other selective or focal elements for focusing infra-red or other heat-related radiation emanating from such nearby objects. For example, in the figure, a focal and/or depth-of-field of the lens(es) may substantially render objects for object recognition, definition and analysis if they lie within a radius surrounding the device **101** or sensors **107** between 4 and 70 inches (for adult males), or smaller radii for children or women, for example, but such radii may be variably set by the user and/or system, and for different activity types and/or times of day as they occur or are recognized, on an ongoing basis. But preferably, the radius or other spatial and distance limit for object recognition, definition and tracking is sufficient to substantially include most personal activity-relevant objects for the user (thus defining a "personal activity space"), while eliminating recognition, definition and tracking of from more distant objects, or, at least, placing them in a different category for activity-relevant analysis, such as those factors defining a more general venue relevant to the user's activity, rather than being included as movement directly caused by the user's activity. Preferably, at least two infrared sensors **107** are used, to aid in object location in three-dimensional space, but three such sensors are preferred, to simplify 3-D object definition and location in space. A single sensor may also be used, however, in some embodiments.

[0032] At least one exemplary tracked, defined and analyzed moving object is depicted in the figure: namely, a burger **109**. As shown in the figure, the core temperature of burger **109** is, at the time depicted, 189 degrees Fahrenheit.

As such, the sensors **107** may, for example, recognized the burger **109** as an object with a temperature substantially heightened from the core temperature of the user, with boundaries between 5 and 10 inches away from the device **101** and/or sensors **107** and, depending upon the embodiment, may further define the size of the object and likely matches for the object. As the user begins to consume the burger, the device and sensors may track the burger **109**'s movement as an object, as it is carried into different positions, acceleration and movement vectors (or patterns thereof) relative to the user **100**, device **101** and sensors **107** (for example, arcing toward the user's mouth, above the device **101** and sensors **107**). That sensed data may then be delivered to a CPU or other control system for storage and further analysis by the system. An exemplary control system is discussed in greater detail below, in reference to FIG. 7.

[0033] Based on a wide variety of possible object recognition, definition and tracking algorithms, each of which fall within the scope of the invention, but do not limit it, the control system may determine that, based on the shape, size, temperature, temperature loss and loss rate, movement, other activity and other sensed and recorded factors, that the user is likely consuming a burger, and may further determine the burger's type based on a library of profile data for each such factor recorded. This recognition activity may be enhanced at the time, and enhanced in future object and activity tracking (by adjusting object and activity-recognition library factors recorded for the object or activity) by the user indicating to the system, using a separate GUI, the nature of her activity at the relevant time—which indications may be carried out simultaneously, or at a different time, and may be conducted (but need not be) on a GUI of another device (for example, on a PDA), networked to the system, with specialized software and hardware for presenting, communicating with and controlling such a GUI.

[0034] Furthermore, the control system, with the aid of sensor data, may determine the change in size of the object, or transfer of part of the object to a different, relevant location, such as the user's mouth and/or throat. The system may take such attrition in the object to correlate with object consumption and, based on such activity, maintain a count of likely calories, vitamins, protein and other nutritional information, as consumed by the user, in aid of other data storage, analysis and software presentations on computer hardware. Some such consumption information may be gathered by direct sensation, for example, by a swallowed or implanted sensor in communication with the system, present or scanning at least a part of the user's digestive tract, and determining the presence of food products, digestive products, enzymes, bowel sounds, and other indicators of digestive activity. Alternatively, digestive activity itself may be inferred by secondary, sensed data. For example, a pattern of body temperature increase may be correlated by the system with a conclusion that the user is or may be consuming different types and amounts of food, with different caloric and other nutritional and other properties. As another example, a user and/or a system element, such as transceiver **101**, may take a photograph of an object to match it with a food type and assess its size, caloric value and other nutritional profile, through photographic object-recognition. As still another example, nearby beacons (but outside of the user's personal activity area) may send signals relevant to the user's general environment and activity that may be relevant to identifying the user's objects in her personal

activity space, as will be discussed in greater detail below. Generally, any technique set forth in this application may be blended, factorially applied, or otherwise combined with other (extant or new) object and activity pattern recognition techniques, to improve the accuracy of each technique.

[0035] The form of sensor/transceiver device **101**, although preferred, is by no means exhaustive of the myriad devices and device locations that may be used as discussed above. In some embodiments, a wristband, armband or other belt or sticker may be used. In others, an implanted or skin adherent version may be used, rather than a necklace form, as pictured. In some embodiments, a conventional PDA device, or other device, with all or part of a specialized sensor/monitor set or device, as discussed above, may be used for all or some of the sensing aspects discussed above. Some alternate forms of such a sensor/monitor set or device are discussed in greater detail, for example, with reference to FIGS. 2 and 3, below. As another possibility, but again not exhaustive, the sensors and system aspects within device **101** may be consolidated with other aspects, or may be separated, in a place peripheral the person. In that instance, distance calculations may be inferred from relative distances from the user of both the user and other recognized objects, and rather than from sensors on a device or the device itself, exclusively. A local tag held on the person, however, such as the tags discussed in greater detail below, may also be used in such embodiments to aid in locating and defining the user and his/her relevant personal activities. It should also be noted that the sensor types and number(s) discussed with reference to this figure are not exhaustive of the possibilities that may be used to carry out aspects of the present invention. For example, in some embodiments, accelerometers, GPS or other local movement-defining systems, and tracking tags (which may be active or passive in generating signals), as discussed below, may also be used to aid in recognition of the user's personal activities.

[0036] In addition to object, motion and activity definition and tracking aspects set forth above, the system may extrapolate a wide variety of additional relevant, activity and other health-related data to enrich its resources relative to a user's account on the system. For example, sensors **107**, or other sensors, in a device such as **101** may sense heat flux (influx and efflux across the surface of the user's body) to determine or approximate the amount of heat energy currently being lost by a user, to make caloric loss inferences as well as aid in defining a user's activity level. Similarly, humidity sensors and meters for ambient and user-transpiration-caused humidity, and galvanic resistance sensors, inferring sweat and other evaporative heat loss as well as radiative heat loss, may be included in device **101**, to aid, among other things, in defining the user's exertion level and/or heat stress, as well as caloric energy loss (and compare it to food and drink caloric consumption information, and losses caused by exercise that is non-redundant with that loss, to determine a complete caloric profile). With data from such sensors indicating higher-than-average calorie burning by the individual, and within a range associated by the system with greater exertion, such as high-cardiovascular-impact exercise, the system may implement an algorithm making determination that the user is presently exercising, and may further record and analyze that conclusion for later purposes. As another example, additional sensors on device **101** may take an ambient temperature, to

better estimate the user's heat differential (and stress) with respect to his or her environment.

[0037] Some sensor methods may be newly-blended to obtain better results. For example, active irradiation and reception for ranging, location, collocation and tracking of objects may also, as reflected back, indicate other conditions of the user, as with infrared irradiation and radiation, which, based on differences in intensity from reflection, reabsorption and resulting efference from the object, also may indicate temperature(s) of the object. In addition, a new form of differentiated radar, sonar or other reflective radiation tracking, where angular ranges of efferent radiation are sent with signature coding, and reception back may aid the system in determining whether a signal has been reflected multiple times or has otherwise been scattered, to more highly resolve object, its contours in space, and object activity maps and patterns by inferring 3-dimensional repeated reflection (and surface angle) information.

[0038] The device **101** may contain blood pressure monitors, ECG contacts, heart-rate monitors, a breathing-rate monitor, air quality and V02 sensors on or about the user, other internal or external bodily activity monitors (which may be with the aid of internal sensors indicating the status of internal bodily operations) and other health and vitals monitoring sensors and gears for recording, transferring and analyzing such information to the system.

[0039] FIG. 2 depicts an alternate form of personal activity defining, tracking and analyzing device **201**, used in conjunction with a second sensor set **203**, which may track one another, in addition to recognizing, defining, tracking and analyzing objects, in aid of personal activity definition and analysis by a system. As with device **101** and its sensors **107** from FIG. 1, above, each device **201** and **203** are located on or about a user's body, **200**. But, as should be understood with respect to FIG. 1, a wide variety of alternate locations, on or about a user's body, clothing or personal effects, may, alternatively, or in addition, be used. Also as with device **101**, either device **201** or **203** may include a set of infra-red and/or other sensors, capable of carrying out but restricting types of object recognition to a relevant radius from the sensors (not specifically pictured). In addition, one or both devices **201** and **203** may include accelerometers, GPS or other local movement-defining systems, and trackable tag(s) or transmitting, receiving or transceiving antennas, such as those pictured as antennae **205** and **207**. Antennae **205** and **207**, among other things, may sense the relative position, distance, movement, acceleration (and patterns thereof) between one another, to assist in assessing the personal activity of the user, by delivering such data to a CPU or other control system for storage and further analysis by the system, including, but not limited to, personal activity definition and analysis. By using such multiple devices **203** and **201**, with such sensor arrays, and with defined relative position, speed and acceleration data, the system may, in some embodiments, better define personal activity than with one device and sensor array, although the cost may also be greater.

[0040] As an example, the user in FIG. 2 is currently engaging in a sporting personal activity—namely, playing tennis. As such, she is holding a tennis racket **209** in her right hand, which is the same hand on which she wears device **201** (preferably her dominant hand). Each device **201** and **203** may then track the tennis racket **209** as an object within their focal radii (depth-of-field of their infra-red sensors' lenses)

and, in conjunction with their relative physical data, better define the location, size, shape, movements and other characteristics of the racket from multiple angles. In such an embodiment, the sensors on each device **201** and **205** may be made fewer on each device, and a single rather than multiple infrared sensors may, for instance, be used due to the multiple locations of the two devices, **201** and **203**. Lensing may also be omitted in favor of the system analyzing varying angle, orientation and positional data from the two devices, **201** and **205**, to define and analyze objects from simpler (e.g., range only) data. In any event, as with the single device discussed with reference to FIG. 1, the multiple devices **201** and **205** may determine that the temperature of the racket **209** from which infrared radiation is emanating is substantially below the user's core body temperature. From this, the system may infer that a moving object within the user's personal activity space (or radii) defined by the depth-of-field or variably set distance parameter, is shaped like a racket and an inanimate object that has not been, for example, recently cooked for consumption, unlike the foodstuff object discussed in FIG. 1. From these data, delivered to a control sub-system of the system (such as the control system discussed with reference to FIG. 7, below, and other pattern and object matching, the system may determine that the user is presently engaging in the personal activity of playing tennis. Further data, for example, related to patterns of relative movement between the two devices **201**'s and **203**'s sensors, other sensors, and/or accelerometers, may also be delivered to the control system and further aid the system in determining activity levels (e.g., intensity of exercise) likely calories burned, cardiovascular impact, and other analytical outcomes. Such additional sensors may include, for example, other local tags, for example, tag **211**, placed on the racket by a user of the system. Such tags, if placed, may define objects on which they are placed and transmit data to the system (for example, via one of the devices **201** and **203**, which may include and/or be networked to a control system. As with the antennas **205** and **207** of devices **201** and **203**, from such transmitted data from tag **211**, a control system may determine the range or more complex movement data for the tagged object, as well as its identity and orientation, to aid in activity pattern matching, definition and further analysis. In some aspects of the invention, a user may assign identities and types to a form of tag with uniquely-identifiable transmissions (in comparison to other tags) from a library of possible object types within the system (which may be expanded by the user and/or system, as can a similar library of possible activity types and intensity levels), and the proper orientation of the tags may be correlated with the position of the object on which it is placed, either by user-definition and/or calibration routines, or by orientation instructions from the system to the user (e.g. what location and orientation to place the tag on the object, based on its definition). For example, such tags may have unique, coded reactions to external radiation pings, for example, transmitted from one or both of the devices **201** or **203**, such as resonant or partially absorbed vibrations or re-transmissions of such pings to the device(s) **201** or **203**, which then may recognize the tag, and associated, defined object currently within the personal activity space of the user, and its movements, and extrapolate other analysis therefrom.

[0041] As mentioned above, to further aid the system in recognizing, defining, recording and analyzing personal

activity, a user may utilize a GUI, which may be presented on one of the devices **201** and/or **203**. Such a GUI is depicted as GUI **213**, on device **201**. GUI **213** may include display element(s), areas or element orders, such as **215** and **217**, and user-actuable controls, such as exemplary scroll arrows **219**, and "yes" or "no" input buttons **221** and **223**. Display **215** may, among other things, and as pictured, display the system's current evaluation of the present personal activity of the user. In the instance of the figure, for example, the system may have determined, through the data sources discussed above, and applying matching profile libraries, that the user is most likely currently playing tennis. The user may therefore view this analytical conclusion on element **215** and, if she agrees, indicate to the system that she is, in fact, undertaking the assessed activity by actuating "yes" button **221**, next to it. If, however, the system's assessment is wrong, she may so indicate by actuating the "no" button **223**. After that, another displayed message, such as the system's next best guess for activity, may be offered. The system may take such input from a GUI from the user and, based on alterations to system-alterable algorithms, define or improve its definition of the user's activity, and the resulting influence of that activity definition on calorie burning, cardiovascular impact, and other analyses for the user's personal activity. Display element **217** may display additional (possibly secondary), relevant information to the user relevant to his or her personal activity, and such as (as pictured) the amount of time that the system has determined has been spent performing the currently assessed activity type (i.e., playing tennis). In some embodiments, the user may actuate a GUI control to set the start and end points of new activities and make other commands, such as selecting a displayed, actuable GUI aspect (not pictured) and the user may scroll through various displayed data, using scroll controls **219**.

[0042] The types of data input and output and user controls set forth above are exemplary only, and any form of user setting and/or control necessary or possible by a user, as set forth in this application, may be carried out in alternate GUIs, GUI-providing or other device(s), and/or sensor(s) or set(s) thereof, which may be used alternatively, or in addition to the GUI and sensor examples discussed above. In addition, any other personal activity- or other health-relevant data may be entered and transmitted to the system for processing, in other embodiments of the invention—not just personal activity types and durations, as discussed specifically above. For example, a user and/or system may gather, identify, track, record and analyze data concerning eating behavior, sleep activity and patterns and compliance with medical regimens, among myriad other possibilities.

[0043] FIG. 3 depicts a personal activity defining, tracking and analyzing base station **301**, used in conjunction with specialized sensor tags by a system to identify, define, track and analyze personal activity, in accordance with aspects of the present invention. The base station **301** may comprise or be networked with a control system, such as the exemplary control system discussed with reference to FIG. 7, below, and further comprises communications capability and, preferably, wireless communications and power-providing capability, such as transceiver antenna **303**. Also preferably, base station **301** is placed in an area near, but outside of the personal activity space used by a user, whose activity is identified, defined, tracked and analyzed by the system. Even more preferably, base station **301** is placed near

enough to a personal activity space that communications will be possible with tags placed on or about the personal activity space, but does not physically interfere with that personal activity space, or the depth-of-field or other personal activity space or radii otherwise defined by the user and/or system.

[0044] A user **305** is pictured in a seated position, performing bicep curls on a bicep curl machine **307**. Within, on or about the machine **307**, and also within the user **305**'s personal activity space, are specialized tags **309** and **311**, each of which is unique and capable of receiving a radiated signal and, as a result, transmitting a somewhat weaker resonant signal with unique identification properties indicating from which tag it originated. For example, the base station may send an initial signal **313**, for example in a pulse or burst format, at a frequency with which tag **309** resonates and, as a result, next produces its own unique resulting (and uniquely resulting from the nature of the signal it received) signal **315**. Next, tag **311** receives signal **315** and, owing to its properties, may resonate with that signal and produce its own unique resulting (and uniquely resulting from the nature of the signal it received) signal **317**, which may then be received by the base station. Although directional lines are shown for each of the signals, to demonstrate where they are received, they may not be directional in nature. In fact, each resulting signal from a tag loses substantial strength in comparison to its source signal, from which it radiates, as it radiates outward and due to energy losses in the resonant process. But, in any condition of the equipment and ambient environment, including with interceding bodies between the base station and tag **311** (or **309** if it, instead, is used as the final tag in the signal chain, in another embodiment), the final resulting signal **317** is strong and complete enough that the base station is capable of receiving, processing identifying and analyzing it. The unique reaction to unique signals of each tag may be by the resonant properties of the tag (which may be multi-variate and react to unique frequency patterns and other coding) may be due to the properties of a resonant material, selective absorption and reflection, or from active modulation (for example, with the aid of a local processor on board each tag).

[0045] As the user **305** performs bicep curls on machine **307**, a lever **319** attached to curling bar handles **321** may variably rise upward (on the user's bicep flexion) and downward (on the user's arm extension by relaxing his biceps). Tag **309** has been placed within, on or about lever **319** and, as a result, will rise upward and downward along with the movements of lever **319**. Tag **311**, by contrast, is placed within, on or about a fixed part of machine **307** relative to the floor **300** and majority of machine **307** and user **305**, and, therefore, tag **309** will move relative to tag **311** as the user **305** performs the bicep curl exercise. Because each of tags **309** and **311** receives a signal (**313** and **315**, respectively) that has experienced power attrition over the course of its travel, and because the power attrition of signal **315** as it reaches tag **311** will vary based on the variable distance between tags **309** and **311**, the strength of the resonance or other harmonic or other resulting unique signal **317** will itself vary based on the position of lever **319**. In addition, the change in signal strength will directly and proportionately relate to the change in distance between the stationary and moving tag pair, making movement tracking easier to accomplish, with less variables, than with ordinary object position tracking. In some embodiments, the nature of

the final, efferent signal from a tag to the base station may vary in a character other than strength, however, in reaction to receiving different strength signals, to accomplish the same movement tracking objective. From this, over time, the base station **301** may analyze the variation in signal strength (or other, distance-variable properties, in other embodiments) of signal **317** to infer when exercise is occurring on the machine. Likewise, a PDA or other system element **323** on or about the user (e.g., a wrist-mounted device, as pictured) may also receive signal **317** with an antenna **325**, since it need not be directional, and perform the same hardware and software steps to determine that the exercise is taking place, the number of repetitions of the exercise, and the amount of time spent performing the exercise, or may directly communicate with the base station to receive that information and/or identify the user performing the exercise, for example, by assessing that the machine's tags **309** and **311** are on or about the user **305**'s personal activity space. Likewise, the base station may ping the user's device **323**, to locate it, or co-locate it with the machine in the same way as with the lever **319**, and establish his identity as the user of the machine. Other tags defining other machine movements may further aid the system in assessing personal activity information. For example, additional unique signal-generating tags (not pictured) may be placed on weight plates, to identify the amount of weight used, based on their movement and/or location relative to fixed tag **311**, in accomplishing the exercise repetitions. In an environment with several tagged machines, such as a gym using the system, the base station may emit different resonant frequencies to which each initial tag, such as tag **309**, responds, and leading to unique resonant frequencies to which each second resonating tag, such as **311**, responds. Alternatively, the system may differentiate between resonating frequencies that are too weak to correspond with resonance caused between co-located tags on one machine, and disregard them as indicators of personal activity. For example, if the same initial signal **313** reaches an initial receiving tag **327** on a treadmill **329**, and which then sends a fourth resulting resonant signal **331**, the system and/or the user's device **323**, may disregard that signal as too distant in origin to correspond with that user's location. However, such signals emanating from neighboring personal activity spaces of others may still be used, for example, to aid in defining the user's environment and, secondarily, his activities.

[0046] FIG. 4 is an exemplary process flow diagram of exemplary steps **400** that may be taken by a system, such as (but not limited to) a hardware and software control system of the nature discussed, for example, with reference to FIG. 7, implementing aspects of the present invention, and which may be a part of a larger personal activity monitoring and analysis system.

[0047] Beginning in step **401**, the control system first determines whether Activity-defining or -condition signals have been received by the control system. Such signals may come in a multitude of forms, as discussed further below, and elsewhere in this application, and may assist the control system in determining a type, amount, nature, direction, frequency, duration, and intensity of personal activity(ies) that are, have or may occur with respect to a user whose personal activity is being tracked by the system. If no such new signals are currently being received, however, the control system may proceed to step **403**, in which it may cause transceiver(s) to detect radiation (of any type) to test

the local environment (specifically, the user's variably definable personal activity space), for example, with radar, sonar, or infrared object recognition, definition, tracking imaging, analysis and/or ranging, as discussed elsewhere in this application. Following this, the system may next determine whether there is a definable object, apart from the user's body (as well as, in some embodiments, extensions of the user's body, such as arms and legs, the activities of which may also be tracked) by assessing a significant difference in temperature between such object(s) and the user's core body temperature, in step 405. If no such object is found, or tracked as moving, in the instance of embodiments tracking the user's body movement, the system returns to the starting position. If, however, the system does so define an object, it may next attempt to match it—for example, by shape, temperature, size, motion and/or other physical characteristics—with profiles of such characteristics for objects and object types from a library accessible and so comparable by the system, in step 407. If such an object match, or type of object match is made by the system (for example, within a confidence interval which may be variably set by the user) in step 409, the system may proceed, in step 411, to record the match and/or apply it as a setting or condition influencing further activity and/or activity pattern recognition. For example, to extend the example provided in FIG. 2, if the system identifies an object in a user's hand as a tennis racket for a given duration, the system may store that fact for later use, and create and apply an influential factor in its current pattern recognition analysis based on that match. For that duration of time, for example, swinging movements of the user's arm that might otherwise have been interpreted as other movements are more likely to be identified as tennis playing activity, due to that new factor taken from object recognition in the user's personal activity space. Similarly, if an object in the user's hand is identified as a burger, as in FIG. 1, that fact may be converted into a factor making eating activity more likely, and more likely to be recognized by a user's hand and head activity than otherwise might be the case (rather than, for example, the user's hand movement towards her face being interpreted as more likely an activity of blowing her nose, absent the object recognition of the burger). In any event, the control system next proceeds, in step 413, to attempt to perform personal activity pattern matching, from any movement perceived in the user's personal, again, with a library accessible to the control system—this time, a library of movements, accelerations, postures and other indicators of personal activity status. This activity pattern matching may be aided by sensors or other activity-monitoring data sources providing data to the system, such as accelerometers and/or GPS sub-systems, and by recognized object movement of objects that themselves have not been defined by the system (for example, if no match is achieved in step 409, also leading to step 413). Next, if an activity pattern match is achieved by the system in step 415 (for example, again, within a variably set confidence interval for matching), the system again may store data relating to that match and/or use that match as a factor influencing its further personal activity monitoring activities and analysis, in step 417. But even if no such activity pattern match is not achieved, the system may nonetheless store and analyze the unmatched data, for example, to determine likely calories burned, cardiovascular intensity and impact, and other outcomes of personal activity, based on default or general functions applied by the system, in step 419.

[0048] Next, the system may proceed, in step 421, to determine whether a user has input further, relevant information—for example, utilizing a GUI of a type such as that discussed with reference to FIG. 2, above. If so, the system may both store and apply such data, as indicated with reference to that figure, in step 423.

[0049] If, returning to step 401, the system instead determines that activity-defining or -condition signals (designed and programmed for assisting the system in that regard) have been received by the control system, the system may proceed, in step 425, to determine the nature of the signal—such as its radiative type, frequency and any encoding—to determine which type of signal(s) for assisting the system it is. First, the system may determine whether the signal(s) is a Personal Activity Space (“PAS”) signal—meaning that it is of a type used by the system to indicate activities within a user's personal activity space—in step 427. For example, the types of resonant signal examples emanating from tag(s) provided in reference to FIG. 3, above, are PAS signals, because they originate from and directly indicate activity within the user's personal activity space. Next, if such a PAS signal is detected, the system may proceed, in step 429, to determine whether that PAS signal is of a sufficient strength to originate within the user's personal activity space. If not, the system disregards and may discard data regarding the signal, as emanating from another person's personal activity space, in step 431. However, in some aspects of the invention, and embodiments, a PAS signal originating from beyond the user's personal activity space may nonetheless be used by the system as an environmental condition indicator, which may influence the system's algorithms and personal activity matching and analysis, as other such factors so influence the system, as discussed above. If the PAS signal is of sufficient strength that the system determines it to directly indicate the user's personal activities, however, in step 429, the system proceeds, in step 433, to store and apply data corresponding with that signal in its personal activity analysis, and other actions based on that analysis, as discussed further herein. The system may then proceed to steps 421 et seq., as discussed above, and, then, to the starting position. If, at step 427, the system determines that the signal received is not a PAS signal, it may next determine, in step 435, whether the signal is of a sufficient strength to originate in, about or near the user's local environment, such that it may be relevant in defining the user's potential personal activities. The sufficient strength and distance of origin to render that determination may, as all factors discussed in this application, be variably set by the user and/or system. If it is of such sufficient strength, the system may store and apply data relating to that determination as a factor influencing its determination, definition, recording, matching and analysis of further personal activities. For example, if a local signal (for example, from a transmitter of a shopping mall) is sufficiently strong and local to indicate that the user is present in the shopping environment, a bag, hand-swinging of the bag, and article movement will more likely be interpreted by the system as of a shopping personal activity nature, rather than, for example, croquet, even if, otherwise, the arm movement might slightly more greatly match a hand movement profile stored in the library as relating to croquet, than one relating to shopping.

[0050] FIG. 5 is another exemplary process flow diagram of exemplary steps 500 that may be taken by a system, such as (but not limited to) a hardware and software control

system of the nature discussed with reference to FIG. 7, implementing aspects of the present invention. The exemplary steps may be undertaken by such a control system to govern aspects of a larger personal activity and health data tracking system, comprising the control system. In particular, with respect to the steps set forth with respect to this figure, the system may implement goal achievement or underachievement rewards and penalties, and administer legally-binding agreements regarding the same between tracked and other incentivizing, insuring users. The series of steps 500 undertaken as set forth in this figure may be undertaken periodically, for example, according to an agreed schedule, or may be undertaken on an ongoing, real-time basis, based on when new, relevant data is received by the system, or substantial amounts or other trigger amounts and/or types of such data, are taken in.

[0051] Beginning with step 501, the control system first assesses whether a current archive data storage device, preferably in the immediate and ongoing control of the control system (such as memory device 703 or 705, discussed in reference to FIG. 7, below) has been updated to contain the latest substantial or other significant amount or type of data relevant to a user's personal activities, from the remainder of the tracking system—for example, from storage on a PDA's local drive. If so, the control system may return to the starting position. If not, however, the control system proceeds, in step 503, to import, or copy and import, those data for local storage more immediately and controllably accessible and modifiable by the control system ("Syncing" the data), and for further processing and analysis. In step 505, the system assesses whether the user has expressly agreed to the terms of use of the control system sub-services implementing incentives, as set forth in subsequent steps of the figure. If not, the control system proceeds to the first step of FIG. 6, below. If so, however, the control system proceeds to step 507, in which it may determine whether the data represents personal activity that constitutes improvement(s) towards goal(s). Such goal(s) may be variably set by the system and/or a user, according to input by at least one user and/or the system, or by agreement between users (such as a tracked user and control system administrative user, with the authority to set and deliver incentives). If the data does not reflect an improvement towards a goal, the control system proceeds to step 509, in which it determines if the data reflects a set-back, or worsened state of personal activity in comparison to such goal(s). If so, the control system may proceed to step 511, in which it warns the user with a message (for example, delivered on the user's PDA based on network communications) warning the user of potential health and other costs of their personal activity status, in moving away from the user's set goals. Depending on the embodiment of the invention, if such warnings occur more than a preset number of times or recur for more than a permitted length of time, the system may proceed to adjust the user's insurance premiums upward, or take other negative incentive measures (e.g., increasing the costs of a gym membership, in step 513. Following such actions, the control system may undertake various accounting and other administrative steps recording and effecting relevant control system changes in light of the changed incentives, such as, but not limited to, alerting the user of the changes, or a healthcare provider of the user, or other peers that the user has agreed to alert, or increasing counseling or specialized healthcare visits in light of the failure to reach the goal(s),

and the goal(s) may be redefined by user(s) and/or the system in light of the occurrence of the steps that have occurred. Following those actions, the control system may return to the starting point.

[0052] If, however, the system determines, back at step 507, that the Synced data represents personal activity that is progress towards, or that meets or exceeds, goal(s), the control system may proceed to step 517, in which it immediately reports that progress and/or other success to the user (for example, via network communication represented on the user's (whose personal activity is being tracked) PDA. Next, the control system may determine whether the user's personal activity met his or her personal activity goal(s), in step 519. If not, the system may proceed to steps 513 and 515, and carry out actions as discussed above with reference to those steps. If the user has at least met his or her personal activity goal(s), the control system may then proceed to step 521, in which it further determines whether the user's personal activity has exceeded his or her personal activity goals. If not, the control system again continues to steps 513 and 515 and carries out actions as discussed above with reference to those steps, but, in this instance, reflecting that the user has met his or her goal. Such actions may include delivering a promised positive reward (given as an incentive), such as lowering a user's premium cost for insurance, and alerts and notifications related to the same. If the user has, in fact, substantially exceeded his or her personal activity goal(s), the system may proceed, in step 523, in which it may deliver a special incentivizing reward, in which the amount by which the goal has been exceeded is partially awarded back to the user, for example, as a future goal adjustment. Such a technique for "Partial Give-Back" rewards is discussed in greater detail, below.

[0053] Among other incentivizing rewards and penalties contractually agreed to by a user, the system may set and issue penalties and rewards based on compliance with or exceeding a personal activity goal set by the system, which may be a goal set with the agreement, including, but not limited to the express written legally binding agreement. In some aspects, a reward for compliance and/or a penalty for non-compliance, per event or upon a count of a series of such goals, may include reduced or increased costs of fitness-related expenses or insurance coverage premiums. In other aspects, such rewards and penalties may be on a sliding scale, based on the degree of exceeding or underachieving relative to such goals, and future overachievement may remove the affect of previous underachievement, and vice versa. In a preferred embodiment, overachievement may create a reward of lower goal levels for future compliance, which may be only partial in comparison to the level of overachievement. For example, if a user has agreed to a system assessed goal of consuming 1800 calories per day, the system may reward a user who is assessed to have consumed 1600 calories only, in a given day, by rewarding that user with a partial give-back of 100 of the 200 calories overachieved, for a total caloric limit of 1900 calories for the following day. Such rewards may be phased out over time, to prevent licensing outright binge eating, for example. The term for such incentivizing rewards is a "Partial Give-Back" reward. Conversely, a partial-take-back penalty, in which a user's failure to meet a goal is partly reflected in future goal(s) may not preferred (to prevent a preferred incentive to cheat) and, instead, a complete assignment of the underachieved amount, or an even greater amount, is assigned to

future goals. Generally, the system may implement a system of floating goals and rewards, to best achieve the user's longer-term objectives. For example, if a user's objective relates to increasing their muscle mass, while decreasing body fat, daily, weekly or other goals for food consumption and physical activity may vary based on the user's bio-rhythms, such as recent sleep quality, starvation-mode assessment (whereby the user's body begins to burn muscle, rather than fat, due to caloric consumption falling too low at a given point in the day), among any other possibility. The effect on consumption of different types of activities, and net calorie gains resulting, can be monitored by the system, and change the recommendations of the system. For example, the importance of at least some low-intensity exercise may be surprisingly emphasized in an algorithm applied by the associated control system, to offset the calorie-intake/hunger boosts of higher intensity exercise only. Moore M S, *Short-Term Appetite and Energy Intake Following Imposed Exercise in 9-10 year-old-girls*, *Appetite* 43 (2):127-34 (October 2004).

[0054] In further aspects of the invention, the incentives may require no legal authority and meted out consequence to administer, but, rather, the system may simply offer observations that may incentivize the user as a natural consequence. For example, when the system warns a user of health consequences for deterioration in personal activity levels, or such levels that fall below advised levels for a user's age and other demographics, or personal situation, or when the user's other personal health-relevant data does not meet safe or desired levels, there may be a natural incentivizing effect. By communicating and illustrating likely outcomes and events (including, but not limited to, long-term outcomes) for personal activity and other health status data, the system may underscore such natural incentives.

[0055] FIG. 6 is another exemplary process flow diagram of exemplary steps 600 that may be taken by a system, such as (but not limited to) a hardware and software control system of the nature discussed with reference to FIG. 7, implementing additional aspects of the present invention. More specifically, in the event that a user of the system whose personal activity is being tracked has not yet set goals for personal activity, or legally agreed to participation in a contract or program incentivizing rewards and penalties ("Incentive Program"), as determined in step 505, above, the terms of which may be carried out as shown in the remainder of FIG. 5, above, the system may proceed to the steps set forth in this figure.

[0056] Beginning at step 601, the system proceeds to present the user with an overview of program aspects, for example, in the form of statements displayed on the user's PDA concerning the Incentive Program's goals, conditions and rewards and penalties, as well as other major terms and conditions to participation in the Incentive Program. If, after reviewing that overview, the user elects to proceed in step 603, the system may proceed to produce a questionnaire, in step 605, for gathering basic information necessary for the further administration of the Incentive Program (for example, user identity, age, occupation, proof thereof, credit card information for charging penalties, current personal activity and other health-related information, etc.). If the user has successfully completed the information requested in the intake questionnaire in step 607, the system may proceed, in step 609, to preview for the user a series of Incentive Program options, such as varying levels and types of goals

for improving personal activity and activity levels, such as, but not limited to, exercise activities, medicine compliance and dietary intake—along with the potential rewards and penalties for meeting or failing to meet those goals. If the system determines that the user has accepted or selected certain of those options as goals, in step 611, the system may proceed to present those options as accepted options (provisionally) and further present the user with a full copy of an Incentive Program contract, dictating the entire understanding of the participating user and any person, business entity or other individual or organization responsible for and/or running the Incentive Program with the aid of the system (an "administrator") in step 613. The user to be subject to personal activity analysis then may formally accept that agreement, in step 615, or, if no longer interested (or at any other point) may exit in step 621, to use the system without the influence of the Incentive Program. If the user has accepted the agreement, but his or her failure to scroll through it, or specifically indicate that he or she has read the agreement (for example, in a check box) indicates that he or she may not have read through the entire agreement, the system may request that the user so read through every part of the agreement, and so indicate, in step 617. At that point, the user may be an active participant in the Incentive Program, and may return to step 501, to continue use of the system in that capacity.

[0057] If, however, the user has exited at step 621, at any point, the system may instead enter an operational mode for users who are not participating in the Incentive Program, at steps 623 et seq. Steps 623 et seq. are similar to steps described in reference to FIG. 5, but without provisions requiring legal participation in the Incentive Program. At step 623, as with step 501, the system assesses whether a current archive data storage device, preferably in the immediate and ongoing control of the control system (such as memory device 703 or 705, discussed in reference to FIG. 7, below) has been updated to contain the latest substantial or other significant amount or type of data relevant to a user's personal activities, from the remainder of the tracking system—for example, from storage on a PDA's local drive. If so, the control system may return to the starting position of FIG. 5. If not, however, the control system proceeds, in step 625, to import, or copy and import, those data for local storage more immediately and controllably accessible and modifiable by the control system ("Syncing" the data), and for further processing and analysis. The control system next proceeds to step 627, in which it may determine whether the data represents personal activity that constitutes improvement(s) (which may include improvement(s) towards goal(s) non-legally bindingly set by the user and/or system). Such goal(s) may be variably set by the system and/or a user, according to input by at least one user and/or the system, or by agreement between users (such as a tracked user and control system administrative user, with the authority to set and deliver incentives). If the data does not reflect an improvement towards a goal, the control system proceeds to step 629, in which it determines if the data reflects a set-back, or worsened state of personal activity in comparison to such goal(s). If so, the control system may proceed to step 631, in which it warns the user with a message (for example, delivered on the user's PDA based on network communications) warning the user of potential health and other costs of their personal activity status, in moving away from the user's set goals. Following such action, the control

system may undertake various accounting and other administrative steps recording and effecting relevant control system changes in light of the changed incentives, such as, but not limited to, alerting the user of the changes, or a healthcare provider of the user, or other peers that the user has agreed to alert, or increasing counseling or specialized healthcare visits in light of the failure to reach the goal(s), and the goal(s) may be redefined by user(s) and/or the system in light of the occurrence of the steps that have occurred, in step 633. Following those actions, the control system may return to the starting point of FIG. 5.

[0058] If, however, the system determines, back at step 627, that the Synced data represents personal activity that is progress towards, or that meets or exceeds, goal(s), the control system may proceed to step 635, in which it immediately reports that progress and/or other success to the user (for example, via network communication represented on the user's (whose personal activity is being tracked) PDA. Next, the control system may determine whether the user's personal activity met his or her personal activity goal(s), in step 637. If not, the system may proceed to step 633, and carry out actions as discussed above with reference to that step. If the user has at least met his or her personal activity goal(s), the control system may then proceed to step 639, in which it further determines whether the user's personal activity has exceeded his or her personal activity goals. Regardless of whether or not the user exceeded his or her goals, the control system again continues to step 633 and carries out actions as discussed above with reference to that step, but, in this instance, reflecting that the user has met his or her goal or exceeded it. Such actions may include alerts and notifications related to the same.

[0059] The sequence and pathways, and exemplary steps themselves, as set forth in reference to FIGS. 4-6 are illustrative, and not exhaustive, of the many possibilities that fall within the scope of the invention.

[0060] FIG. 7 is a schematic block diagram of some elements of an exemplary control system 700 that may be used in accordance with aspects of the present invention, such as, but not limited to gathering data from sensor(s), sending alerts and other communications, sensing user or person's personal activity within personal activity space(s), provisioning user settings and permissions, presenting and recording legally binding agreements, and receiving control commands and managing input interfaces, such as, but not limited to a GUI, as defined and discussed elsewhere in this application. The generic and other components and aspects described herein are not exhaustive of the many different systems and variations, including a number of possible hardware aspects and machine-readable media that might be used, in accordance with the present invention. Rather, the system 700 is described to make clear how aspects may be implemented. Among other components, the system 700 includes an input/output device 701, a memory device 703, storage media and/or hard disk recorder and/or cloud storage port or connection device 705, and a processor or processors 707. The processor(s) 707 is (are) capable of receiving, interpreting, processing and manipulating signals and executing instructions for further processing and for output, pre-output or storage in and outside of the system. The processor(s) 707 may be general or multipurpose, single- or multi-threaded, and may have a single core or several processor cores, including, but not limited to, microprocessors. Among other things, the processor(s) 707 is/are capable

of processing signals and instructions for the input/output device 701, to cause a display, light-affecting apparatus and/or other user interface with active physical controls (any of which may be comprised in a GUI) to be provided for use by a user on hardware, such as a personal computer monitor or PDA screen (including, but not limited to, monitors or touch- and gesture-actuable displays) or terminal monitor with a mouse and keyboard or other input hardware and presentation and input software (as in a software application GUI), and/or other physical controls.

[0061] For example, and with particular emphasis on the further aspects of the invention discussed in this application, in connection with FIGS. 1-6, the system may carry out any aspects of the present invention as necessary with associated hardware and using specialized software, including, but not limited to, application window presentation user interface aspects that may present a user with a software GUI for selecting properties, changing permissions for user and other person's entry, creating and changing settings for tracking, defining, identifying, analyzing and recording objects and personal activity, generating alerts and other communications, syncing data from local sources to more local and immediately controllable storage locations for the control system (such as memory 703 and storage media 705), data compiling and analysis, implementing incentive rewards and penalties and generally carrying out any control system steps set forth with reference to the remainder of the figures in this application. As another example, with reference to FIG. 2, such hardware and software may, with or without the presentation of options to a user for selection on a conventional display, carry out any control aspect of the invention as necessary and proper, such as, but not limited to interpreting, implementing and responding to user input for identifying activity types, and the timing of such activity, among other GUI entries, sending alerts, and other user interface and processing aspects that may be used in the art, such as physics engines, physical modeling, detection, internet or other network protocols and encryption, image-creation, recording and remote or local (such as wired or physical interface) control (and related software).

[0062] The processor 707 is capable of processing instructions stored in memory devices 703 and/or 705 (and/or read-only memory ("ROM") or random-access memory ("RAM")), and may communicate with any of these, and/or any other connected component, via system buses 775. Input/output device 701 is capable of input/output operations for the system, and may include/communicate with any number of input and/or output hardware, such as a computer mouse, keyboard, entry pad, actuable display, networked or connected second computer, other GUI aspects, camera(s) or scanner(s), sensor(s), sensor/motor(s), range-finders, GPS systems, receivers(s), transmitter(s), transceiver(s), transceiving tag(s) (both active and passive, resonant or otherwise-uniquely-responding to an input signal with a uniquely-identifiable product signal), antennas, electromagnetic actuator(s), mixing board, reel-to-reel tape recorder, external hard disk recorder (solid state or rotary), additional hardware controls and actuators, light sources, speakers, additional video and/or sound editing system or gear, filters, computer display screen or touch screen. It is to be understood that the input and output of the system, and the tag(s), may be in any useable form, including, but not limited to, signals, data, commands/instructions and output for presentation and manipulation by a user in a GUI. Such a GUI

hardware unit and other input/output devices could implement a user interface created by machine-readable means, such as software, permitting the user to carry out any of the user settings, commands and input/output discussed above, and elsewhere in this application.

[0063] **701, 703, 705, and 707** are connected and able to communicate communications, transmissions and instructions via system busses **775**. Storage media and/or hard disk recorder and/or cloud storage port or connection device **705** is capable of providing mass storage for the system, and may be a computer-readable medium, may be a connected mass storage device (e.g., flash drive or other drive connected to a U.S.B. port or Wi-Fi) may use back-end (with or without middle-ware) or cloud storage over a network (e.g., the internet) as either a memory backup for an internal mass storage device or as a primary memory storage means, or may simply be an internal mass storage device, such as a computer hard drive or optical drive.

[0064] Generally speaking, the system may be implemented as a client/server arrangement, where features of the invention are performed on a remote server, networked to the client and made a client and server by software on both the client computer and server computer. Input and output devices may deliver their input and receive output by any known means of communicating and/or transmitting communications, signals, commands and/or data input/output, including, but not limited to, input through the devices illustrated in examples shown as **717**, such as **709, 711, 713, 715** and **777** and any other devices, hardware or other input/output generating and receiving aspects. Any phenomenon that may be sensed may be managed, manipulated and distributed and may be taken or converted as input or output through any sensor or carrier known in the art, or that may become so known. It is understood that any form of electromagnetism, compression wave or other sensory phenomenon may include such sensory directional and 3D locational information, which may also be made possible by multiple locations of sensing, preferably, in a similar, if not identical, time frame. The system may condition, select all or part of, alter and/or generate composites from all or part of such direct or analog image or other sensory transmissions, including physical samples (such as DNA, fingerprints, iris, and other biometric samples or scans) and may combine them with other forms of data, such as image files, dossiers or metadata, if such direct or data encoded sources are used.

[0065] While the illustrated system example **700** may be helpful to understand the implementation of aspects of the invention, it is understood that any form of computer system may be used to implement many control system and other aspects of the invention—for example, a simpler computer system containing just a processor (datapath and control) for executing instructions from a memory or transmission source. The aspects or features set forth may be implemented with, and in any combination of, digital electronic circuitry, hardware, software, firmware, or in analog or direct (such as electromagnetic wave-based, physical wave-based or analog electronic, magnetic or direct transmission, without translation and the attendant degradation, of the medium) systems or circuitry or associational storage and transmission, any of which may be aided with enhancing media from external hardware and software, optionally, by wired or wireless networked connection, such as by local area network (“LAN”), wide area network (“WAN”) or the many connections forming the internet or local networks.

The system can be embodied in a tangibly-stored computer program, as by a machine-readable medium and propagated signal, for execution by a programmable processor. The method steps of the embodiments of the present invention also may be performed by such a programmable processor, executing a program of instructions, operating on input and output, and generating output. A computer program includes instructions for a computer to carry out a particular activity to bring about a particular result, and may be written in any programming language, including compiled and uncompiled, interpreted languages, assembly languages and machine language, and can be deployed in any form, including a complete program, module, component, subroutine, or other suitable routine for a computer program.

[0066] FIG. **8** is a perspective drawing of a partially-opened food packaging container **801**, containing several food bars, such as the examples shown as **803**. Together, and with further aspects described below, food bars **803** and their packaging **801** may implement a nutritional inventory and tracking system according to aspects of the present invention. That system may also comprise a computer hardware and software control system, examples of which are discussed in greater detail above, and, specifically, with reference to FIG. **7**.

[0067] Container **801** may include, contain or comprise at least one master tag **805**, which, as with other tags discussed above, may be locally powered or powered by an external aspect, such as the control system, and may be uniquely identifiable (containing, for example, UPC information, or other encoding readable by the system to determine product information to be tracked by the system). As with other tag aspects discussed above, to be readable and trackable by the control system, the master tag **805** may reflect, partially reflect, resonate, partially absorb or otherwise process and return a radiation or other signal sent from an aspect external to the master tag **805**, such as an aspect of the control system, or inventory tags (which will be discussed below) and such efferent signals may be unique and uniquely originate from each tag in response to particular signals received. Alternatively, or in addition, the master tag itself may broadcast unique radiation and other signals, readable by the control system (for example, via an antenna aspect of the control system) and containing the same information as a signal processed and returned by the master tag **805**.

[0068] Each food bar item **803** may be individually packaged, with packaging that contains additional, uniquely identifiable inventory tags **807**. Alternatively, and as will be discussed in greater detail below, bar items **803** may themselves contain consumable or removable inventory tags **807**. As with other secondary tags, set forth above, inventory tags **807** may uniquely respond with an uniquely identifying signal (for example, by harmonic resonance, partial absorption, partial reflection, or a combination of any of these) to unique signals received by them from an external source, such as an aspect of the control system, master tag **805**, or another external source, by emitting their own uniquely-identifiable signals. Also as with other tags set forth in this application, tags **807** may, alternatively, or in addition, themselves broadcast unique radiation and/or other signals, readable by the control system (for example, via an antenna aspect of the control system). In any event, in a preferred embodiment, a unique signal so emitted by inventory tags **807** may then interact with master tag **805**, causing it to uniquely respond by emitting its own unique signal, which

is unique to the both the source(s) signal and the master tag, and uniquely identifiable by the control system, for example, to determine the number of tags, and other meta data. Master tag **805** may be uniquely situated, bridging both sides (inside and outside) of the outer wall **809** of a food container, such that signals from the master tag are easier for an external control system to read. In addition, where a master tag simultaneously receives and responds to multiple uniquely identifiable symbols from differing numbers and identities of food items **803** within the container **801**, it may produce a unique summation signal(s), which is readable by the system to determine a count and identity of all food items within the container, as well as the unique information discussed above concerning the container itself. In this way, the control system can rapidly determine the identity and amounts of available or consumed food items **803**, within each unique container **801** that may, for example, be within a larger inventory managed and tracked by the control system. Master tag **805** also may be uniquely capable in other respects, for example, in receiving power from a control system and creating an efferent signal. Master tag **805** may also have the ability to perceptibly alter its signal that it returns to the base station in reaction to signals, which may be with the aid of such external power, based on far weaker received signals from other tags. The same capability differentials may exist for other tag sets (for example, for tracking personal activity) a main signal element, and other signal elements, within the context of a consumable tag, as discussed below.

[0069] FIG. 9 is a perspective drawing of a partially-consumed individual food bar item **901**, such as the food bars **803** discussed above, with reference to FIG. 8, and comprising multiple inventory tags **907** and inventory tag types at spatial intervals throughout the item, in accordance with aspects of the present invention. Food bar **901** comprises entirely relatively safely consumable material, including tags **907**, and further comprises an edible outer layer or surface **903**. Food bar **901** has, however, been bitten into by a consuming user, removing part of the bar **901**, and, as a result, a left-hand side **905** of the bar is shown that is not covered by outer layer or surface **903**. As a result, from side **905**, one may see internal food stuff **909** of two varieties: an upper nougat **911** and a main vitamin and protein blend **913**, in separate sections of the bar **901**. Embedded in each food stuff **909** are individually uniquely identifiable consumable tags **907**, and, in some embodiments, those tags may be uniquely identifiable based on which food stuff they are embedded in. In other words, tags **907** may be of two types, each with an at least partial encoding in signals transmitted from them reflecting the type of food stuff they are embedded in: nougat tags, such as those examples shown as **915**, and blend tags, such as those examples shown as **917**. In addition, in some embodiments, tags **907** may be differentiated in their efferent signal encoding based on their location within bar **901**. The tags **907** are preferably placed at uniform distances from one another throughout the bar and each food stuff, or randomly so distributed, such that a count of such tags may correspond with a proportion of food remaining, in which they are deposited. In this way, a control system pinging or otherwise sending signals to the tags (which may be through a master tag(s), as discussed above), or simply receiving their efferent signals, can infer how much of the bar **901** as a whole, and how much of each food stuff has been consumed. As will be explained further,

below, the identity of consumer users ingesting the food stuffs, and more complex data, such as food absorption and caloric uptake, can also be determined by more complex types of consumable tags. But, in some embodiments, each tag **907** may not be uniquely identifiable in comparison to all other tags **907**, but, instead, they are identifiable as tags of a common type, and a control system may infer some (albeit less) consumption information from counts of instances of signals received when scanning a food unit, such as food bar **901**.

[0070] FIG. 10 depicts an exemplary consumable tag **1001**, such as the consumable tags discussed above, but also containing a sensor array **1003** and sensor-exposing pump/conduit **1005**, which may comprise an ion pump/conduit. Consumable tag **1001** is preferably streamlined for passage through a consumer/user's digestive tract, and, as mentioned above, composed of materials safe for human or other animal consumption. Tags **1001** comprise an antenna or other radiative signal/response element **1007**, which, as discussed in detail above, may emit a uniquely-identifying signal, from its own power source and/or an external power source, and may so emit unique signals in response to receiving pinging or other signals unique to a source (such as a control system). As discussed above, such unique signals may be unit (tag) specific in their identification properties, and may include useful information concerning the tag and/or associated items (such as food stuffs consumed with the tag), and/or may uniquely identify types of items associated with the type of tag. In addition, tag **1001** may comprise multiple functional sections such as: (1) a sensory/communications section **1011** and (2) a deployment/hatch section **1013**, which preferably partially overlap to maintain an airtight seal prior to deployment (in consumption by ingestion). Those multiple sections may disengage upon some stimulus related to a point in digestion, or selectively disengage upon signaled instruction from a control system, but preferably disengage upon ingestion by enteric dissolution of one of the section's outer linings. Upon so disengaging, deployment/hatch section **1013** may, optionally, deploy a payload for consumption, such as a medicine or vitamin payload, **1015**. In such event, the sensor array **1003** may test for medicinal, vitamin or other payload concentration and/or reaction products, but, if embedded and associated with food, sensor array **1003** may test for the concentration and/or reaction products of the associated food, or components thereof, to infer absorption and digestion information, as well as other gastrointestinal conditions and activities. When sensor **1001** is deployed, and sections **1011** and **1015** are separated, sensor array **1003** is preferably then at least partially exposed within the pathway of the digestive fluid surrounding it after ingestion, which may be pumped across it with the aid of pump/conduit **1005**. Pump/conduit **1005** may use ion-driving variable charge components, such as those shown as **1021**, to polarize and drive, or simply drive ions in the surrounding fluid through a channel **1023** containing at least part of the sensor array **1003** with rhythmic, ion-moving charge oscillation patterns. For example, the lower component **1021** may take a positive charge in one instant, pulling oppositely charged ions toward it after the upper component **1021** has taken on the same charge, locking such ions from passing from above and, as a result, create an inward-rushing current from the lower section of channel **1023**. The upper component **1021** may then release its positive charge and permit the flow to

continue upward, while the lower component **1021** begins reversing its charge, as the ions pass beyond it, upward. But other, for example, electromechanical, pump methods may also, or alternatively, be used. A local processor, such as a CPU, **1017**, may communicate with, run and manage sensor array **1003** and such a pump, with the aid of a power source **1019**, but an at least partially external power source and/or processor may also, or alternatively, aid in running, managing and powering the sensor array **1003**, for example, by emitting radiative power and signals, both powering and managing the array.

[0071] FIG. 11 depicts an exemplary consumable tag **1101** comprising multiple signal/response elements **1107**, which may interact with one another as well as a control system, in accordance with aspects of the present invention. Each signal element **1107** is held within a separate section of tag **1101**, such that, as each chamber may variably and separately open to the outer environment (i.e., a consumer user's digestive tract) at selectably different times and empty and deliver a payload (for example, of medicine, vitamins, markers and/or other agents) the signal element **1107** held in that section is removed from the tag **1101**. By being removed from the tag **1101**, any signal element may then no longer communicate with a main signal element **1108**, which (owing to its positioning, size and/or different shielding from the exterior components of tag **1101** and signal communications properties) is more capable of communicating with a control system (e.g., sending and/or receiving signals from the control system's antenna) than the remainder of signal elements **1107**. However, owing to their proximity and other properties relative to main signal element **1108**, the remainder of the signal elements **1107** are able to communicate with and alter or condition signals emitted from the main signal element **1108**, in such a way that main signal element **1108**'s signals to and from a control system will indicate the presence (and, in some embodiments) other properties of those remaining signal elements **1107**. The usefulness of these properties will be better understood from the further discussion, below.

[0072] Tag **1101** may include an outer coating or shell layer **1151**. Layer **1151** is preferably optimized to survive and ease passage through at least part of a user's upper digestive tract, such as the mouth and esophagus. After ingestion by a consumer user, shell layer **1151** may dissolve, to expose sub-coatings and surrounding layers. For example, each payload compartment, including compartments **1153**, **1155**, **1157** and **1159**, may comprise its own unique signal element **1107**—**1127**, **1129**, **1131** and **1133**, respectively—and its own unique payload and coatings. Owing to the different properties of their different coatings, the compartments may variably dissolve and open, in any desired order, while maintaining an effective distance for signal transmission between any of their signal elements (if still held) and main signal element **1108**, with the aid of a non-dissolving, or more slowly dissolving, compartment-linking bridge **1171**, which is attached to and holds each compartment together with main signal element **1108**, and holds the main signal element. A similar non-dissolving or more slowly dissolving material may be used to separate the chambers from one another, where they abut. In some embodiments, signals received by signal elements **1107** may trigger the selective energizing of system-selected signal element(s), to create a catalyzing effect for a reagent, either for selectively dissolving a compartment coating or for affecting a medi-

nal reaction (such as between reagent **1173** and reagent **1174** in compartment **1159**), by creating reaction energy necessary for such chemical reactions, or actuating mechanisms dependent on such energy. In such embodiments, main signal element **1108** may serve as a conduit, intermediary or bridge to carry such reaction and other actuation activating signals and energy to individually-selected signal elements **1107**. For example, if a physician or medical technician and/or control system chooses to precisely control the moment of deployment of a medicine within a patient's digestive tract (or blood stream, if tag **1101** is ingested) he/she/it may track the location of tag **1101** via main signal element **1108**, and use main signal element **1108** to actuate individually-selected compartments for actuation at precisely selected points for deployment of medicine and other agents.

[0073] In some embodiments of the invention, inferential activity data, other than from sensor data or background and environmental (base station, beacon, or emanating from other personal activity areas than the user's) signal data, may aid in further defining a user's tracked activities and/or consumption data. For example, if a user provides access to his or her financial or other systematic data relating to food consumption, that data indicating consumption, location attendance, and other such data, that data may be applied as a factor by a computer hardware and software control system to an activity and/or consumption assessment, recording and an analysis program also incorporating or applying the other sensed and recorded data and signal types discussed in this application. In some embodiments, a specialized program, with accounts held by user's and participating venues, may be comprised within the system to aid in specialized information sharing to improve activity and consumption-related data. For example, if both a restaurant and restaurant patron participates in such a program, the patron's food consumption data (for example, from the restaurant billing system) may share enable the extraction of nutritional information, for use by the control system in recording and analyzing, and reporting on the patron's consumption-relevant data. Other personal activity, consumption and health data sensors of a wide variety may also supply such inferential data, or direct data, such as waste sensors placed in lavatories, and local environmental (e.g., air quality) sensors.

[0074] In some embodiments, a control system tracking a user's activities in accordance with aspects of the present invention may provide feedback, which may be live or real-time feedback, regarding the qualities of personal activity, which may be enriched by any of the sources of activity-relevant data discussed above. For example, proper speed and form, and/or deviations therefrom, for athletic movements may be assessed by the control system using a goal-form library of movement patterns for a matched activity, and relayed to a user or administrator (e.g., coach) on a GUI.

I claim:

1. A system for determining an activity of a user comprising:
 - a wearable device worn by the user, the device comprising:
 - a plurality of temperature sensors, comprising:
 - at least one thermometer adapted to measure temperature information of a user; and
 - at least one infrared imaging sensor comprising a focal element configured to receive infrared radi-

- tion information emanating from a detected object located within a predefined personal activity space and not within a space surrounding said personal activity space;
- a memory in communication with the wearable device, the memory adapted to store:
- object information relating to a plurality of potential object types with which the user may interact;
 - activity information relating to a plurality of potential activities the user may undertake with one or more of the potential object types;
 - measured user temperature information at one or more times; and
 - detected object infrared radiation information at the one or more times; and
- a processor in communication with the wearable device and the memory, the processor configured to:
- determine a first position of the detected object in three-dimensional space at a first time, based on the detected object infrared radiation information;
 - determine a three-dimensional shape of the detected object at the first time, based on the detected object infrared radiation information;
 - determine an object type of the detected object from the plurality of potential object types stored in the memory, based on the determined shape of the determined object; and
 - determine the activity of the user from the plurality of potential activities stored in the memory, based on the determined object type and the first position of the detected object.
- 2.** A system according to claim 1:
- wherein the processor is further configured to determine a first temperature of the detected object at the first time; and
- wherein said determining the object type of the detected object is further based on the first temperature of the detected object.
- 3.** A system according to claim 2:
- wherein the processor is further configured to determine a first temperature of the user at a first time; and
- wherein said determining the activity of the user is further based on the first user temperature.
- 4.** A system according to claim 1, wherein the processor is further configured to determine a second position of the detected object.
- 5.** A system according to claim 4:
- wherein the processor is further configured to determine an object movement of the detected object, based on the first position and the second position of the detected object; and
- wherein said determining the activity of the user is further based on the object movement.
- 6.** A system according to claim 5:
- wherein the processor is further configured to:
- determine a second size of the detected object; and
 - determine a change in size of the detected object, based on the first size and the second size; and
- wherein said determining the activity of the user is further based on the change in size of the detected object.
- 7.** A system according to claim 6:
- wherein the processor is further configured to:
- determine a second temperature of the user; and
 - determine a change in user temperature, based on the first and second user temperatures; and
- wherein said determining the activity of the user is further based on the change in user temperature.
- 8.** A system according to claim 7:
- wherein the detected object comprises a food;
- wherein the user activity comprises eating the food; and
- wherein the processor determines a number of calories consumed by the user during eating of the food, based on one or more of: the movement of the detected object, the change in size of the detected object and the change in user temperature.
- 9.** A system according to claim 1, wherein the stored object information relating to a plurality of potential object types with which the user may interact comprises one or more of: object size, object shape, object temperature, object temperature loss, object temperature loss rate and object movement.
- 10.** The system of claim 1, wherein the processor is further configured to analyze radiation that emanates from outside of the predefined personal activity space differently from received object infrared radiation information corresponding to objects located inside the activity space.
- 11.** The system of claim 10, wherein the processor is further configured to treat said radiation that emanates from outside of the predefined personal activity space as an environmental condition indicator.
- 12.** The system of claim 1, wherein the predefined personal activity space comprises a radius of between 4 and 70 inches surrounding the wearable device.
- 13.** The system of claim 12, wherein the predefined personal activity space is automatically determined by the system based on a time of day.

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| 专利名称(译) | 用于监控个人活动的专业传感器和技术 | | |
| 公开(公告)号 | US20170196484A1 | 公开(公告)日 | 2017-07-13 |
| 申请号 | US15/471957 | 申请日 | 2017-03-28 |
| [标]申请(专利权)人(译) | 玻璃面 | | |
| 申请(专利权)人(译) | 组面有限责任公司 | | |
| 当前申请(专利权)人(译) | 组面有限责任公司 | | |
| [标]发明人 | BECKMAN CHRISTOPHER V | | |
| 发明人 | BECKMAN, CHRISTOPHER V. | | |
| IPC分类号 | A61B5/11 G06Q30/02 A61B1/015 A61B5/00 A63B24/00 G09B19/00 | | |
| CPC分类号 | A61B5/1118 A63B24/0062 G09B19/0092 A61B1/015 A63B2220/836 A61B5/0082 A61B5/4833 G06Q30/0226 A63B2230/50 A61B5/6801 A61B5/015 A61B5/1127 A61B5/1128 | | |
| 其他公开文献 | US10383551 | | |
| 外部链接 | Espacenet | USPTO | |

摘要(译)

提供了新的活动识别，记录，分析和控制技术，系统和传感器。在本发明的一些方面，具有唯一识别和数据传输属性的多个传感标签创建位置，移动，定向和加速度数据并将其提供给控制系统。标签可以放置在用户身体，衣服，个人物品，运动器材和其他活动相关位置的位置，以增强活动识别和映射。例如，专用PDA可以包括控制系统的一部分，并且可以向这些标签提供，反射和/或接收修改的数据信号。在其他方面，系统定义个人活动空间，优先从该空间采样数据，并执行简化形式的对象识别以确定，记录和分析个人活动。除标签之外，控制系统内的GUI界面还可以帮助识别和记录活动模式。

