Title: SCALE-BASED PARAMETER ACQUISITION METHODS AND APPARATUS

Abstract: Certain aspects of the disclosure are directed to weighing scale apparatus. The weighing scale apparatus includes a platform in which a plurality of electrodes and force sensor circuitry are integrated, and processing circuitry arranged under the platform. The weighing scale apparatus further includes a user interface to output user-specific information for the user. The processing circuitry is electrically integrated with the plurality of electrodes and the force sensor circuitry and is used to provide an instruction to the user directing the user to have a particular posture until an alert is provided, collect physiologic data from the user while the user is standing on the platform, provide the alert to the user indicating the user may move in response to collecting the physiologic data, and provide user-specific cardio data to the user based on the collected physiologic data.
OVERVIEW

Various aspects of the present disclosure are directed toward methods, systems and apparatuses that are useful in acquiring and assessing physiologic parameters of a user using user data obtained by a scale.

Various aspects of the present disclosure are direct toward monitoring different physiological characteristics for many different applications. For instance, physiological monitoring instruments are often used to measure a number of patient vital signs, including blood oxygen level, body temperature, respiration rate and electrical activity for electrocardiogram (ECG) or electroencephalogram (EEG) measurements. For ECG measurements, a number of electrocardiograph leads may be connected to a patient's skin, and are used to obtain a signal from the patient. Obtaining physiological signals can often require specialty equipment and intervention with medical professionals. For many applications, such requirements may be costly or burdensome. These and other matters have presented challenges to monitoring physiological characteristics.

Various aspects of the present disclosure are directed toward multisensory biometric devices, systems and methods. Aspects of the present disclosure include user-interactive platforms, such as scales, large and/or full platform-area or dominating-area displays and related weighing devices, systems, and methods. Additionally, the present disclosure relates to electronic body scales that use impedance-based biometric measurements. Various other aspects of the present disclosure are directed to biometrics measurements such as body composition and cardiovascular information. Impedance measurements can be made through the feet to measure fat percentage, muscle mass percentage and body water percentage. Additionally, foot impedance-based cardiovascular measurements can be made for an ECG and sensing the properties of blood pulsations in the arteries, also known as impedance plethysmography (IPG), where both techniques can be used to quantify heart rate and/or pulse arrival timings (PAT). Cardiovascular IPG measures the change in impedance through the corresponding arteries between the sensing electrode pair segments synchronous to each heartbeat.

In certain embodiments, the present disclosure is directed to a weighing scale apparatus, such as a weighing scale. The scale includes a platform for a user to stand on, processing circuitry. The platform has a plurality of electrodes and force sensor circuitry
(e.g., strain gauges) are integrated within and is configured and arranged for engaging a user. The user interface can either be integrated with the platform and the plurality of electrodes and/or can be integrated with external circuitry that is not located within the platform. The scale can further include or be in communication with a user interface that is used to output user-specific information, such as an instruction and/or cardio-data, for the user while the user is standing on the platform. The processing circuitry includes a CPU and a memory circuit with user data stored in the memory circuit. The processing circuitry is arranged with (e.g., electrically integrated with or otherwise in communication) the force sensor circuitry and the plurality of electrodes and configured and arranged to provide, via the user interface, an instruction to the user directing the user to have a particular posture until an alert is provided in response to the user standing on the platform and collect physiologic data, sometimes referred to herein as "cardio-related physiologic data and/or physiological data, from the user while the user is standing on the platform using signals obtained by the plurality of electrodes and the force sensor circuitry. The processing circuitry further provides the alert to the user indicating the user may move in response to collecting the physiologic data and provides user-specific cardio data to the user using the user interface based on the physiologic data.

The user interface includes or refers to interactive components of a device (e.g., the scale) and circuitry configured to allow interaction of a user with the scale (e.g., hardware input/output components, such as a screen, speaker components, keyboard, touchscreen, etc., and circuitry to process the inputs). The user interface can be or include a graphical user interface (GUI), a foot-controlled user interface (FUI), and/or voice input/output circuitry, each of which is further described herein. The user interface is integrated with the platform (e.g., internal to the scale) and/or is integrated with external circuitry that is not located under the platform, in various aspects.

Various aspects of the present disclosure are directed to an initialization mode for the weighing scale, such as providing an instruction to the user to have a particular posture in order to obtain accurate physiological data while the user is standing on the scale. The instructions directs the user to maintain a posture to render the body of the user stationary with a particular position of the head until an alert is provided in response to the user standing on the platform. For example, the scale can instruct the user to stand with their head up, to stand still with their eyes focused in a particular direction (e.g., straight forward) and/or to stand still to increase the accuracy of physiological data obtained by the scale. After obtaining the data, the scale can provide an alert indicating that the user can move
and/or look down at a user interface located within the platform of the scale. The signals/physiological data collected by the scale can be effected by the user's posture. For example, if the user is moving and/or not standing up straight while standing on the platform, the physiological data collected maybe inaccurate and/or have signal noise. In some implementations, user display of the scale can be located on the platform and/or near the user's feet when the user is standing on the platform. As such, the user may direct their attention, repetitively, down to their feet to view the user display, resulting in posture and/or movement that effects the physiological data collected. In other implementations, the scale communicates with the user via computer-generate voice messages. In such implementations, a user may direct their attention down to their feet out of habits as numerous commercial scales display weight in the platform of the scale. Further, in either implementation, the user may have an incorrect posture due to other reasons. In accordance with various embodiments, the scale operates in an initialization mode upon the user standing on the platform and/or approaching the platform in order to encourage the user to have appropriate posture.

In specific aspects, the processing circuitry and the user interface (e.g., FUI, GUI, and/or voice input/output circuitry) are used to provide the instruction that directs the user to remain still with their eyes focused in a direction until the alert is provided and/or the instruction further directs the user to hold their head up, or to continue to hold their head up, until the alert is provided. The processing circuitry can be used to verify that the obtained signals are accurate and that the user is remaining still and/or has a particular posture. In specific aspects, the processing circuitry, in response to verifying accuracy of the physiologic data, provide the alert that indicates to the user that they can move. In response to being unable to verifying the accuracy, the processing circuitry provides another instruction via the user interface to the user to re-collect the physiologic data and instruct the user to have the particular posture.

Specific aspects of the present disclosure are directed to a scale apparatus that provides various features using a FUI located at a platform of the scale apparatus, such as a body weight scale. The FUI is a user interface that allows the user to interact with the scale using foot-based user inputs to the FUI. Such user inputs include movement of the user's foot relative to the FUI, contacting the FUI with a foot of the FUI, tapping the FUI with a foot, the user shifting their weight between feet and/or front to back (e.g., toe to heel or vice versa), among other inputs. In various specific aspects, the FUI is used to provide (e.g., display) alerts correlated to scale-obtained data of the users. In specific aspects, the
additional information includes various advertisements, such as products and services available and correlated with the scale-obtained data, generic health information, updates on the social groupings, available diagnosis information from a physician, requests for participation in studies by a physician and/or other research, among other data. In various aspects, the scale operates in different communication modes using the FUI, registers different biometrics, and/or displays data using color coding that is indicative of data measured and used to abbreviate more complex information.

The FUI includes a display that provides the subset of user data and the indication of the user data that is available on the display for the user to view, the indication including an icon for the user to select to view the user. In specific aspects, the FUI is used to provide data to the user while the user is standing on the platform. The FUI receives a foot-based user input from the user for the user to interact with the scale. The foot-based user input includes a movement of at least one foot of the user relative to the platform of the scale. Example foot-based user inputs can include the user moving their foot, the user contacting a specific portion of the platform with their foot, the user shifting their weight, and a combination thereof. In specific aspects, the FUI includes a touch screen that receives the foot-based user inputs from the user responsive to at least one foot of the user contacting the touch screen.

In various aspects, the weighing scale apparatus includes assessment circuitry. The assessment circuitry is used to further assess and process the user-specific cardio data and/or other user data. The assessment circuitry can be integrated with the processing circuitry and under the platform upon which the user stands or can be integrated with external circuitry that is not located under the platform and includes output circuitry to communicate with the processing circuitry of the scale (e.g., is external to the scale). The weighing scale can further include output circuitry that can output user data to the FUI for display and/or to other devices, such as the external circuitry.

The physiologic data collected can be indicative of a physiological status of the user and is used for assessment of a condition or treatment of the user that corresponds with the physiologic status. For example, the physiologic data is processed by the processing circuitry, and therefrom, the processing circuitry derives and outputs derivation data indicative of the physiological status of the user. Example derivation data includes time-stamped raw signals obtained using the electrodes, physiological parameters determined using the physiological parameter data, and/or time-stamped physiological parameters, among other data that is correlated with various user-corresponding data. Example user-
corresponding data includes age, weight, height, gender, exercise habits, cholesterol levels, etc. The processing circuitry stores, in responsive to the derivation data, additional data in the memory circuit to supplement the user-corresponding data with information corresponding to the physiological parameter data obtained. The additional data can include physiological parameter data, additional user-corresponding data (e.g., age, weight, height, gender, cholesterol level), and/or other data.

In some aspects, the assessment circuitry can derive and output derivation data indicative of a physiological status for assessment of a condition or treatment of the user that corresponds with the physiologic status. In a specific example, the assessment circuitry can compare the derivation data, including the physiologic data, to reference information and determining an adjusted dose for a prescription drug in response to the comparison. In such examples, the assessment circuitry may be integrated with the external circuitry. The reference information includes symptoms of a health condition being treated by the prescription drug and potential side effects of the prescription drug. The assessment can determine an adjusted dose in response to identifying at least one of: a symptom above a threshold and a side effect above a threshold.

Aspects of the present disclosure are directed to a scale apparatus that provides various features including communicating with other user devices, such as a remote user-physiologic device, in response to a dual authorization of the communication. The scale apparatus, such as a scale, provides various features such as collecting scale-obtained data including a scale-based biometric and cardio-physiological measurements from a user while the user is standing on the platform apparatus and outputting the scale-obtained data to external circuitry in response to verifying the scale-based biometric in addition to authorization data received from the external circuitry. The scale-obtained data can be correlated (e.g., combined) with user-device obtained data and additional processing can be performed on the correlated data sets by the scale and/or user device. By authorizing communication between the scale and the user device responsive to the scale-based biometric and authorization data from the user circuitry, user sensitive data such as health data is communicated between the devices only when both devices are authorized. In various aspects, the devices are authorized in response to the platform apparatus verifying both devices are being used by the same user.

The scale can further include a communication activation circuit. The communication activation circuit can activate communication between the scale and the remote-user physiologic device. The activation can be responsive to identifying and
verifying that both a scale-based biometric and authorization data received from the remote-user physiologic device corresponds to the same user. The processing circuitry identifies a scale-based biometric of the user using signals collected from at least one of the force sensor circuitry and the plurality of electrodes, and therefrom, validate user data as concerning the user associated with the scale-based biometric. In specific aspects, the communication activation circuitry includes an AND gate, which activates communication between the scale and the remote user-physiologic device in response to receiving both the identified scale-based biometric from the processing circuitry and the authorization data from the remote user-physiologic device, and verifying both the scale-based biometric and the authorization data correspond to the user.

As used herein, a user device includes processing circuitry and output circuitry to collect various data (e.g., signals) and communicate the data to the scale and/or other circuitry. Example user devices include cellphones, tablets, standalone servers, among other devices. A wearable device is a user device (and/or a remote user-physiologic device) that is worn by a user, such as on a user's wrist, head, or chest. Example wearable devices include smartwatches and fitness bands, smart glasses, chest heart monitors, etc. A remote user-physiologic device is a user device (and/or a wearable device) that further includes sensor circuitry or other circuit to collect physiologic data from the user, and, can optionally be in secured communication with the scale or other circuitry. Example remote user-physiological devices include smartwatches or fitness bands that collect heart rate and/or ECG and/or body temperature, medical devices, implanted medical devices, smartbeds, among other devices. Example physiologic data collected by remote user-physiologic devices includes glucose measurements, blood pressure, ECG or other cardio-related data, body temperature, among other data. As used herein, the terms "user device", "wearable device", and "remote user-physiologic device" can be interchangeably used, as one of skill may appreciate that in specific examples, a particular device may be considered one or more of a user device, a wearable device, a remote user-physiologic device. As a specific example, a particular remote user-physiologic device is a smartwatch and can be referred to as a wearable device or a user device. In other aspects, the remote user physiologic device may not be a wearable device, such as a medical device that is periodically or temporarily used.

In some aspects, in response to the activation of communication and obtaining data from both the scale and the remote-user physiologic device, the processing circuitry of the scale (or the remote-user physiologic device) determines cardio-related data using physiologic data collected by the remote-user physiologic device and the physiologic data.
collected by the weighing scales. The processing circuitry can perform additional cardio-related processing of the cardio-related data. Examples of additional cardio-related processing includes deriving clinical indication data for assessment of a condition or treatment of the user using the cardio-related data and/or historical cardio-related data within a user profile corresponding to the user. The processing circuitry can correlate the cardio-related physiologic data with the user data based on additional data selected from the group consisting of: time stamping of each data set, time ranges of each data set, time scales of each data set, a phase of at least one of the data sets, and a combination thereof. In various aspects, the scale and the remote-user physiologic device (or other devices) are time synchronized prior to obtaining the user data. As further discussed herein, the scale and remote-user physiologic device can be time synchronized while the user is standing on the scale and/or by tapping the remote-user physiologic device on the scale to time synchronize via the force sensor circuitry (e.g., strain gauges) of the scale and a built-in accelerometer of the remote-user physiologic device.

The additional processing optionally includes determining physiological parameters of the user, medically assessing the user, such as identifying clinical indications that the user has or is at risk for a disease or condition, updating a medical file of the user, providing generic health information that is tailored to the user, and/or providing alerts in response to the physiological parameter indicating a potential emergency. By using the correlated data from both devices, the data used for additional analysis is of a higher quality (e.g., more accurate, less noise, more information) and/or results in more detail processing of data than data from one of the respective devices.

In a specific implementation, the additional processing can result include generating physiological parameters. Some users may have parameters that indicate an emergency is occurring, such as a physiological parameter that is outside at threshold value. The scale, as previously described, can include output circuitry to provide outputs to the user on the user interface of the scale and/or to external circuitry. For example, the processing circuitry and the output circuitry can output a signal to external circuitry associated with the user in response to the cardio-related data including a physiological parameter that is outside a threshold value. The signal includes a message indicating the user should visit a physician and/or an emergency room and/or otherwise indicates an issues is occurring without actually diagnosing the user.

Aspects of the present disclosure are directed to a scale apparatus that authorizes various communication modes of the scale apparatus responsive to verifying or not verifying
one or more biometrics. The scale apparatus, such as a scale, provides various features, such as collecting signals from a user standing on the scale apparatus and authorizing various communication modes of the scale apparatus in response to verifying or not verifying one or more biometrics of the user from the collected signals. In accordance with various aspects, the various communication modes of the scale apparatus provide tiered communication of scale-obtained data from the scale apparatus to other circuitry that is responsive to identifying or not identifying different biometrics to communicate user data of different sensitivity levels. Furthermore, the different biometrics verify identification of the user to a different degree. Thereby, the tiered communication enables user-sensitive data of different degrees to be communicated based on user settings and identification of the user.

The scale can operate in different communication modes and can select a particular mode responsive to identification of a user using a scale-based biometric. For example, the output circuitry of the scale can operate in a default communication mode in response to an unidentified scale-based biometric. The default communication mode can include displaying user data using the user interface. The displayed user data can include default data, such as a user's weight and/or body mass index. The output circuitry can operate in a user verified communication mode in response to the user data and identifying one or more scale-based biometrics. The user verified communication mode includes outputting at least a portion of the user data from the scale to external circuitry.

For example, the scale can recognize a plurality of different scale-based biometrics and for a plurality of different users. The scale-based biometrics include a high security biometric and a low security biometric and the user verified communication mode includes a high verified communication mode and a low verified communication mode. The output circuit operates in the low verified communication mode in response to identifying the low security biometric and operates in the high verified communication mode in response to one of identifying the high security biometric and identifying both the low and the high security biometrics. The scale can further be used to instruct the user on how to use the scale to operate in the high verified communication mode. For example, in response to the output circuit operating in the default communication mode, the processing circuitry and the user interface instructs the user on using the weighing scale apparatus with or without foot coverings.

In various aspects, the scale is used as a hub to collect and communicate sensitive user data. For example, the processing circuitry of the scale can aggregate scale-obtained user data with user data received by the weighing scale apparatus from at least one separate
user device. The processing circuitry (and/or a communication activate circuitry) authorizes communication of at least a portion of the aggregated user data by identifying a scale-based biometric. The scale can have and/or recognize a hierarchy of different scale-based biometrics. The hierarchy of different scale-based biometrics include a plurality of scale-based biometrics of different security levels used to authorize communication of user data of different security levels. The scale, using the output circuitry, outputs at least a portions of the aggregated user data to external circuitry that is located remotely from the weighing scale apparatus in response the authorization.

The processing circuitry can authorize communication of user data of a plurality of different security levels using different levels of verification of user authorization based on identification of the scale-based biometrics of the different security levels and as a function of a value of a sensitivity of the respective user data to be communication. For example, the processing circuitry can authorize communication of a first set of user data to the external circuitry in response to identifying a first level biometric, and authorize communication of a second set of user data in response to identifying a second level biometric that is a higher level of security than the first level biometric. In addition, the processing circuitry can perform different levels of security on the user data in response to the authorization and as a function of the value of the sensitivity of the user data to be communication. The different levels of security performed on the user data prior to communication the user data includes security selected from the group consisting of: data encryption, hardware token key, software token key, and a combination thereof. In related aspects, the different levels of security measures can be performed based on and/or as a function of at least one of the sensitivity of the user data to be communication, identification of the external circuitry, and security of the external circuitry.

In a number of aspects, the scale, and optionally external circuitry, can be used to provide a hierarchy of services using the scale-obtained data. The hierarchy of services include different services enabled in response to user selection of one or more of the different services and activation of subscription levels of different weighted values. The scale collects scale-obtained data from the user and, optionally, outputs the scale-obtained data to external circuitry, such as a standalone central processing unit (CPU) and/or a server CPU. In specific aspects, the external circuitry includes a server CPU that pools user data from a plurality of scales and is used, in connection with the scale, to provide a hierarchy of services. A service, as used herein, includes a function and/or action performed using the platform system and uses and/or is in response to scale-obtained data. A hierarchy of
services include different services enabled in response to user selection and activation of subscription levels of different weighted values. For example, the scale-obtained data from the particular scale drives a physiological related prompt for a service. The physiological related prompt is displayed on a user interface of the scale and/or is displayed on an external user interface that is in communication with the scale. The user selection of the prompt drives another physiological related prompt for a (more) specific service. The specific service has a weighted value pertaining to subscribed access for data resulting from the specific service. In further specific aspects, the service includes generic health information pertaining to the scale-obtained data, products or services correlated to the scale-obtained data, and/or additional tests to perform responsive to the scale-obtained data. The specific service, in other aspects, includes diagnosis by a physician, prescriptions, social groups based on the scale-obtained data, and/or participating in studies/experiments. In other specific aspects, the different services include different levels of social groupings, such as a general consumer level, a physiological scale-based level, and a professional physiological level.

The above discussion/summary is not intended to describe each embodiment or every implementation of the present disclosure. The figures and detailed description that follow also exemplify various embodiments.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Various example embodiments may be more completely understood in consideration of the following detailed description in connection with the accompanying drawings, in which:

FIG. 1a shows an apparatus consistent with aspects of the present disclosure;

FIG. 1b shows an example of a performing an initialization process using an apparatus consistent with aspects of the present disclosure;

FIG. 1c shows an example of process for displaying data using a FUI consistent with aspects of the present disclosure;

FIG. 1d shows an example of various displays of data using a FUI of a scale consistent with aspects of the present disclosure;

FIG. 1e shows an example process for titrating for a condition and/or treatment of a user using scale-obtained data, consistent with various aspects of the present disclosure;

FIG. 1f shows an example process for titrating a prescription drug, consistent with various aspects of the present disclosure;
FIG. 1g shows an example process for authorizing communication between a scale and another device, consistent with various aspects of the present disclosure;

FIG. 1h shows an example process for correlating and analyzing data from a scale and another device, consistent with various aspects of the present disclosure;

FIG. 1i shows an example process for authorizing multiple different communication modes of a scale, consistent with various aspects of the present disclosure

FIG. 1j shows an example process for correlating and analyzing data from a scale and another device, consistent with various aspects of the present disclosure;

FIG. 1k shows an example apparatus for collecting user data from a plurality of devices, consistent with various aspects of the present disclosure;

FIG. 11 shows an example apparatus for collecting user data from a plurality of different sources, consistent with various aspects of the present disclosure;

FIG. 1m shows an example apparatus for collecting user data from a plurality of scales, consistent with various aspects of the present disclosure;

FIG. 1n shows an example process for providing a hierarchy of services to scale users, consistent with various aspects of the present disclosure;

FIG. 1o-lp show examples of different subscription levels for providing a hierarchy of services, consistent with various aspects of the present disclosure;

FIG. 1q shows current paths through the body for the IPG trigger pulse and Foot IPG, consistent with various aspects of the present disclosure;

FIG. 1r is a flow chart illustrating an example manner in which a user-specific physiologic meter/scale may be programmed to provide features consistent with aspects of the present disclosure;

FIG. 2a shows an example of the insensitivity to foot placement on scale electrodes with multiple excitation and sensing current paths, consistent with various aspects of the present disclosure;

FIGs. 2b-2e show top views of a number of multifunction scale displays, consistent with various aspects of the present disclosure;

FIGs. 2f-2g show examples of electrode configurations, consistent with various aspects of the disclosure;

FIGs. 3a-3b show example block diagrams depicting circuitry for sensing and measuring the cardiovascular time-varying IPG raw signals and steps to obtain a filtered IPG waveform, consistent with various aspects of the present disclosure;
FIG. 3c depicts an example block diagram of circuitry for operating core circuits and modules, including for example those of FIGs. 3a-3b, used in various specific embodiments of the present disclosure;

FIG. 3d shows an exemplary block diagram depicting the circuitry for interpreting signals received from electrodes.

FIG. 4 shows an example block diagram depicting signal processing steps to obtain fiducial references from the individual Leg IPG "beats," which are subsequently used to obtain fiducials in the Foot IPG, consistent with various aspects of the present disclosure;

FIG. 5 shows an example flowchart depicting signal processing to segment individual Foot IPG "beats" to produce an averaged IPG waveform of improved SNR, which is subsequently used to determine the fiducial of the averaged Foot IPG, consistent with various aspects of the present disclosure;

FIG. 6a shows examples of the Leg IPG signal with fiducials; the segmented Leg IPG into beats; and the ensemble-averaged Leg IPG beat with fiducials and calculated SNR, for an exemplary high-quality recording, consistent with various aspects of the present disclosure;

FIG. 6b shows examples of the Foot IPG signal with fiducials derived from the Leg IPG fiducials; the segmented Foot IPG into beats; and the ensemble-averaged Foot IPG beat with fiducials and calculated SNR, for an exemplary high-quality recording, consistent with various aspects of the present disclosure;

FIG. 7a shows examples of the Leg IPG signal with fiducials; the segmented Leg IPG into beats; and the ensemble averaged Leg IPG beat with fiducials and calculated SNR, for an exemplary low-quality recording, consistent with various aspects of the present disclosure;

FIG. 7b shows examples of the Foot IPG signal with fiducials derived from the Leg IPG fiducials; the segmented Foot IPG into beats; and the ensemble-averaged Foot IPG beat with fiducials and calculated SNR, for an exemplary low-quality recording, consistent with various aspects of the present disclosure;

FIG. 8 shows an example correlation plot for the reliability in obtaining the low SNR Foot IPG pulse for a 30-second recording, using the first impedance signal as the trigger pulse, from a study including 61 test subjects with various heart rates, consistent with various aspects of the present disclosure;
FIGs. 9a-b show an example configuration to obtain the pulse transit time (PTT), using the first IPG as the triggering pulse for the Foot IPG and ballistocardiogram (BCG), consistent with various aspects of the present disclosure;

FIG. 10 shows nomenclature and relationships of various cardiovascular timings, consistent with various aspects of the present disclosure;

FIG. 11 shows an example graph of PTT correlations for two detection methods (white dots) Foot IPG only, and (black dots) Dual-IPG method, consistent with various aspects of the present disclosure;

FIG. 12 shows an example graph of pulse wave velocity (PWV) obtained from the present disclosure compared to the ages of 61 human test subjects, consistent with various aspects of the present disclosure;

FIG. 13 shows another example of a scale with interleaved foot electrodes to inject and sense current from one foot to another foot, and within one foot, consistent with various aspects of the present disclosure;

FIG. 14a shows another example of a scale with interleaved foot electrodes to inject and sense current from one foot to another foot, and measure Foot IPG signals in both feet, consistent with various aspects of the present disclosure;

FIG. 14b shows another example of a scale with interleaved foot electrodes to inject and sense current from one foot to another foot, and measure Foot IPG signals in both feet, consistent with various aspects of the present disclosure;

FIG. 14c shows another example approach to floating current sources is the use of transformer-coupled current sources, consistent with various aspects of the present disclosure;

FIGs. 15a-d show an example breakdown of a scale with interleaved foot electrodes to inject and sense current from one foot to another foot, and within one foot, consistent with various aspects of the present disclosure;

FIG. 16 shows an example block diagram of circuit-based building blocks, consistent with various aspects of the present disclosure;

FIG. 17 shows an example flow diagram, consistent with various aspects of the present disclosure;

FIG. 18 shows an example scale communicatively coupled to a wireless device, consistent with various aspects of the present disclosure;

FIGs. 19a-c show example impedance as measured through different parts of the foot based on the foot position, consistent with various aspects of the present disclosure.
While various embodiments discussed herein are amenable to modifications and alternative forms, aspects thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit the disclosure to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the scope of the disclosure including aspects defined in the claims. In addition, the term "example" as used throughout this application is only by way of illustration, and not limitation.

DETAILED DESCRIPTION

Aspects of the present disclosure are believed to be applicable to a variety of different types of apparatuses, systems, and methods involving acquiring and assessing physiologic parameters of a user using a scale. In certain implementations, aspects of the present disclosure have been shown to be beneficial when used in the context of a weighing scale with electrodes configured for engaging with the user and generating cardio-related physiologic data, such as data indicative of a BCG or ECG of a user. In some embodiments, a scale acquires physiological data responsive to instructing a user to have a specific posture. For example, the scale displays an instruction to the user directing the user to remain still with their eyes focused in a particular direction until an alert is provided and physiological data is collected prior to providing the alert. These and other aspects can be implemented to address challenged, including those discussed in the background above. While not necessarily so limited, various aspects may be appreciated through a discussion of examples using such exemplary contexts.

Accordingly, in the following description various specific details are set forth to describe specific examples presented herein. It should be apparent to one skilled in the art, however, that one or more other examples and/or variations of these examples may be practiced without all the specific details given below. In other instances, well known features have not been described in detail so as not to obscure the description of the examples herein. For ease of illustration, the same reference numerals may be used in different diagrams to refer to the same elements or additional instances of the same element.

Also, although aspects and features may in some cases be described in individual figures, it will be appreciated that features from one figure or embodiment can be combined with features of another figure or embodiment even though the combination is not explicitly shown or explicitly described as a combination.
In accordance with a number of embodiments, physiologic parameter data is collected using an apparatus, such as a weighing scale or other platform that the user stands on. The user (e.g., co-workers, friends, roommates, colleagues), may use the apparatus in the home, office, doctors office, or other such venue on a regular and frequent basis, the present disclosure is directed to a substantially-enclosed apparatus, as would be a weighing scale, wherein the apparatus includes a platform which is part of a housing or enclosure and a user display to output user-specific information for the user while the user is standing on the platform. The platform includes a surface area with electrodes that are integrated and configured and arranged for engaging a user as he or she steps onto the platform. Within the housing is processing circuitry that includes a CPU (e.g., one or more computer processor circuits) and a memory circuit with user-corresponding data stored in the memory circuit. The platform, over which the electrodes are integrated, is integrated and communicatively connected with the processing circuitry. The processing circuitry is programmed with modules as a set of integrated circuitry which is configured and arranged for automatically obtaining a plurality of measurement signals (e.g., signals indicative of cardio-physiological measurements) from the plurality of electrodes. The processing circuitry generates, from the signals, cardio-related physiologic data manifested as user data.

A stationary posture of a user's body with a particular position of their head, while the user is standing on the platform, increases the accuracy signals/physiological data collected. The signals/physiological data collected can be effected by the user's posture. For example, if the user is moving and/or not standing up straight while standing on the platform, the physiological data collected maybe inaccurate and/or have signal noise. In a number of embodiments, the user display of the scale is located on the platform and/or near the user's feet when the user is standing on the platform. As such, the user may direct their attention, repetitively, down to their feet to view the user display, resulting in posture and/or movement that effects the physiological data collected. In accordance with various embodiments, the processing circuitry operates in an initialization mode upon the user standing on the platform and/or approaching the platform in order to encourage the user to have appropriate posture. For example, the processing circuitry displays an instruction to the user that directs the user to hold their head still, hold their head up (e.g., "look forward"), focus their eyes in a particular direction (e.g., "look straight ahead"), and/or stand still until an alert is provided. The scale collects physiological data responsive to the instruction, provides the alert to the user that indicates the user may move, and displays user-specific information using the user display. By providing an instruction and alert to the user, the user
is instructed to stand such that accurate physiological data is collected and the user better understands when they can move.

In accordance with various embodiments, the user data is acquired by a scale based on sensing, detection, and quantification of at least two simultaneously acquired impedance-based signals. The simultaneously acquired impedance-based signals are associated with quasi-periodic electro-mechanical cardiovascular functions, and simultaneous cardiovascular signals measured by the impedance sensors, due to the beating of an individual’s heart, where the measured signals are used to determine at least one cardiovascular related characteristic of the user for determining the heart activity, health, or abnormality associated with the user's cardiovascular system. The sensors can be embedded in a user platform, such as a weighing scale-based platform, where the user stands stationary on the platform, with the user's feet in contact with the platform, where the impedance measurements are obtained where the user is standing with bare feet.

In certain embodiments, the plurality of impedance-measurement signals includes at least two impedance-measurement signals between the one foot and the other location. Furthermore, in certain embodiments, a signal is obtained, based on the timing reference, which is indicative of synchronous information and that corresponds to information in a BCG. Additionally, the methods can include conveying modulated current between selected ones of the electrodes. The plurality of impedance-measurement signals may, for example, be carried out in response to current conveyed between selected ones of the electrodes. Additionally, the methods, consistent with various aspects of the present disclosure, include a step of providing an IPG measurement within the one foot. Additionally, in certain embodiments, the two electrodes contacting one foot of the user are configured in an inter-digitated pattern of positions over a base unit that contains circuitry communicatively coupled to the inter-digitated pattern. As discussed further herein, and further described in U.S. Patent Application 14/338,266 filed on October 7, 2015, which is herein fully incorporated by reference for its specific teaching of inter-digitated pattern and general teaching of sensor circuitry, the circuitry can obtain the physiological data in a number of manners.

In medical (and security) applications, for example, the impedance measurements obtained from the plurality of integrated electrodes can then be used to provide various cardio-related information that is user-specific including, as non-limiting examples, synchronous information obtained from the user and that corresponds to information in a ballistocardiogram (BCG) and an impedance plethysmography (IPG) measurements. By
ensuring that the user, for whom such data was obtained, matches other bio-metric data as obtained concurrently for the same user, medical (and security) personnel can then assess, diagnose and/or identify with high degrees of confidence and accuracy. Physiologic parameters, such as diagnosis, conditions, and/or treatments, PWV, cardiac output, pre-ejection period and stroke volume by processing the data from the scale.

Various embodiments are directed to a scale apparatus that provide various features using a FUI located at a platform of the scale apparatus. The scale apparatus, such as a body weight scale, can provide (e.g., displays) the FUI using a user display. In other embodiments, the FUI is provided using computer-generated voice messages via a speaker component of the scale. The FUI allows the user to interact with the scale using foot-based user inputs and/or interactions with the FUI. The FUI can be used to provide (e.g., display and/or via sound) alerts correlated to scale-obtained data of the users. Such alerts can include notifications of social groupings available for the user that is tailored to the scale-obtained data, additional information regarding social groupings and/or health information, and/or an indication that additional information is available for the user on a standalone CPU in communication with the scale, such as a smartphone, tablet and/or computing device. The additional information includes various advertisements, such as products and services available and correlated with the scale-obtained data, generic health information, updates on the social groupings, available diagnosis information from a physician, requests for participation in studies by a physician and/or other research, among other data.

The scale, using the FUI, additionally provides such features as discerning an amount and location of data to provide (e.g., display) between the FUI and a graphical user interface of another device based on user demographic information, the data to display, and/or prior user use of the scale. In various aspects, the user can configure the scale to operate in different communication modes using the FUI, registers different biometrics, and/or the FUI displays data using color coding that is indicative of data measured and used to abbreviate more complex information.

For ease of reference, the following disclosure refers to the FUI as displaying data and using a user display. However, embodiments in accordance with the present disclosure are not so limited. For example, the FUI can provide data via computer generated voice messages, haptic responses, and/or other sounds. In various embodiments, the scale includes one or more speaker components to provide the data to the user. Thereby, the FUI can include a projection of sound via the speaker components. In other embodiments, the scale includes a user interface other than or in addition to a FUI. A user interface includes or
refers to interactive components of a device (e.g., the scale) and circuitry configured to allow interaction of a user with the scale (e.g., hardware input/output components, such as a screen, speaker components, keyboard, touchscreen, etc., and circuitry to process the inputs). A user display includes an output surface (e.g., screen) that shows text and/or graphical images as an output from a device to a user (e.g., cathode ray tube, liquid crystal display, light-emitting diode, organic light-emitting diode, gas plasma, touch screens, etc.) The user interface can be and/or include a GUI, a FUI, and/or voice based input/output circuitry which is integrated with the platform of the scale (e.g., internal to the scale) or is integrated with external circuitry that is not located or integrated with the platform of the scale, as further described herein. Further, the user interface can include multiple user interfaces, one of which is integrated with the scale and one that is not, as further described herein.

The instruction, in various embodiments, directs the user to remain still and/or look forward (e.g., "hold your head up and look forward"). In response to the instruction, the scale collects physiologic data from the user. And, in response to the collection of physiological data and/or verification that the user has a specific/current posture, the processing circuitry, and the user display and/or a speaker, provide an alert to the user. The alert indicates that the user may lower their head, such as indicating that the user can look at the user display of the apparatus, and/or the user may move.

In various embodiments, the user display of the scale displays the user interface (e.g., FUI or GUI) including data through the platform. For example, the data is displayed through at least a portion of the platform whereon the user stands. The user interacts with the scale by foot-based user interaction using a FUI. A FUI is a user interface that allows for the user to interact with the scale via inputs using their foot and/or via graphic icons or visual indicators near the user’s foot while standing on the platform. The user interaction can include the user moving their foot relative to the FUI, the user contacting a specific portion of the user display, the user shifting their weight, etc. In some embodiments, the user display includes a touch screen and the user interaction includes the user selecting an icon, an item in a list, a virtual keyboard, among other selections, using a portion of their foot. For example, the FUI can display various tests and/or functions that can be performed and the user can select one of the test or functions by contacting their toe with an icon of the respective test or function. In response to the selection, the scale performs the test or function. Alternatively and/or in addition, the scale is configured with a haptic, capacitive or flexible pressure-sensing upper surface, the (upper surface/tapping) touching from or by the user is sensed in the region of the surface and processed according to conventional X - Y
grid. Signal processing in the logic circuitry/CPU that is within the scale. By using one or more of the accelerometers located within the scale at its corners, such user data entry is sensed by each such accelerometer so long as the user's toe, heel or foot pressure associated with each tap provides sufficient force. In some embodiments, the user display is integrated with motion sense circuitry. The user interaction, in such embodiments, include the user moving their foot (with or without touching the user display). In various embodiments, the control of the FUI can be provided to a separate user device, such a user device that has previously been or is paired with the scale and that is detected by the scale. As a specific example, the scale provides a cellphone with control functions to control the display of the FUI in response to detecting the cellphone is within a threshold distance.

In some embodiments of the present disclosure, a display of a multifunction scale is touch-responsive or tilt-responsive. The user interface (e.g., FUI or GUI) may portray simple menus that can be controlled by the user's feet/toes. A user's feet are sensed via touch sensors on the screen or display and the scale can identify the outline of a user's feet (or hands or other body part). The user's feet may provide user input for functional or aesthetic feedback via the user display such as producing animated graphics around the user's feet (e.g., simulated lapping surf videos that interact with the user's feet; glowing around the user's feet; fish nibbling at the toes, etc.). In some embodiments, the graphics and/or text convey videos, simulations of motion of solids or liquids, of animals and/or water encompassing the user's feet, thereby helping to relax or relate the user.

In yet other specific embodiments, the graphics and/or text are interactive so that while the user stands on the platform, the displays shows information for the user's foot-limited field of view, thereby permitting the user to view relevant portions of graphics and/or text for discernible communication from the display to the user (e.g., displaying information to encourage the user eat healthier, slow-down the rate of breathing, exercise more, relax with a relaxing display such as moving clouds and/or simply relay other information such as weather, news and traffic data). For example, specific information (e.g., that is important) can display in areas of the display that are not covered by the user's feet. A user may also change posture, shifting the weight distribution over the scale's load cells to provide user input. In specific embodiments, the graphics or text are displayed prior to the user standing on the scale using the entire user display and when the user stands on the platform, the graphics or text move to locations of the user display that are not covered by the user's feet. The movement of the graphics or text can be similar to liquid flowing (e.g., flowing from the
first location that is centered on the user display to locations that are not covered by the
user's feet).

In certain other embodiments, the graphics and/or text are interactive so that while
the user stands on the platform, the displays shows information/advertisements that are
relevant to user data stored in the scale's internal (or externally coupled, such as a handheld
device) memory circuit. The interactivity of the user, e.g., tapping the scale with the user's
foot as an input, can be tracked and relayed for further correlation in the memory circuit and
to provide other related information in response. As non-limiting examples, this (other)
information can be responsive to the user's weight or indications of heart-related parameters
(such as cholesterol and/or arterial stiffness) via 360-degree interactivity from the user as
measured on the scale, to displayed user data while the user is standing on the scale, and to
the memory circuit and/or an Internet server whereby correlation and tracking to user data
can be tracked and scored. Information from such an Internet server (as operated by a third
party) can also be accessed and displayed as part of a medical/fitness-related suggestion.

Examples include displaying information to the effect of: exercise moderately each day for a
week and return to scale periodically for a report on your progress; and as it appears that you
have symptoms consistent with cholesterol and/or arterial stiffness, ask your doctor if you
should be taking medication known as [medication name]. Such information, in some
embodiments, is displayed responsive to the user stepping off the scale and displayed in
larger font and/or using a larger portion of the user display so that user may view the text
while standing.

The user provided feedback allows for the selection of menu options, test selection,
browsing information or articles presented on the display, or the input of test relevant user
data such as age, medical conditions, etc. In various embodiments, the FUI indicates to scale
the location of a user's feet relative to a plurality of electrodes located across a top
surface of the multifunction scale.

In further, more specific, embodiments of the present disclosure, a multifunction
scale is communicatively coupled with a user's portable electronic devices, an internet
router, or other home electronic devices. The scale then communicates and exchanges data
with these devices for display and control by a user (e.g. using physiologic data to improve a
fitness or health condition). In various embodiments, the user interface (e.g., FUI or GUI)
displays data using a color coding to abbreviate more complex information, such as scale-
obtained data. As an example, a green color indicates a good value, a yellow color indicates
an okay value, and a red color indicates a bad value. Such values include physiologic
parameters, weight, weight increase or decrease, recovery parameters, among other information. The scale communicates the user data with other electronic devices, including the color coding, such that the more complex information is displayed on the other electronic device using the same color coding. The electronic communications between the multifunction scale and the various devices may take the form of either wireless or wired communications. Further, a multifunction large display scale can be used to communicate with other scale users either using the same scale unit or another scale in the home or other wireless or personal electronic devices (e.g. leaving someone a message or note or confirming a meeting or appointment; and/or incorporating the digital communication and haptic feedback system from a smart watch to make selections related to scale functionality).

The physiologic data collected, in various embodiments, is indicative of a physiological status of the user and is used for assessment of a condition or treatment of the user that corresponds with the physiologic status. The physiologic data, in various embodiments, includes signals obtained using the electrodes, force sensor circuitry, and the processing circuitry. In other embodiments and/or in addition, the physiologic data includes an ECG, BCG, PWV, heartrate, balance, tremors, respiration, among other parameters and/or a combination thereof. For example, the physiologic data is processed by the processing circuitry, and therefrom, the processing circuitry derives and outputs derivation data indicative of the physiological status of the user. Example derivation data includes time-stamped raw signals obtained using the electrodes, physiological parameters determined using the physiological parameter data, and/or time-stamped physiological parameters, among other data that is correlated with various user-corresponding data. Example user-corresponding data includes age, weight, height, gender, exercise habits, cholesterol levels, etc. The processing circuitry stores, in response to the derivation data, additional data in the memory circuit to supplement the user-corresponding data with information corresponding to the physiological parameter data obtained while the user is standing on the platform. The additional data can include physiologic data, additional user-corresponding data (e.g., age, weight, height, gender, cholesterol level), and/or other data.

In accordance with various embodiments, the processing circuitry and/or an external circuitry determines physiologic data of the user using the derivation data and assesses the physiologic data of the user for a treatment or condition. The processing and/or external circuitry correlates the user with a condition or treatment by comparing the physiologic data of the user to reference information. The reference information can include look up tables, rules, indexes, graphs, and/or a plurality of operations. For example, the reference
information includes a range of values for the physiologic parameter(s) of other users having corresponding condition or treatment indications and that have a similar demographic background of the user. In various embodiments, the processing and/or external circuitry determines the reference information, such as from a plurality of reference information, based on the user-corresponding data. The user-corresponding data is indicative of the demographic background of the user. In a number of embodiments, the assessed condition or treatment is sent to external circuitry. By assessing a condition or treatment of the user remotely from the scale and/or outputting the condition or treatment to the external circuitry, the appropriate personal, such as a physician, can view the condition or treatment assessment prior to the user and verify the accuracy of the condition or treatment. The physician can prescribe medication and/or use the assessed condition or treatment to advise the user and/or further evaluate the user. In various embodiments, the user data is compared against historical user data for the same user and used to analyze if the user’s condition/treatment and risk is getting better or worse over time.

In various specific embodiments, the scale can be used to enable prescription drug titration. Drug titration include identifying a dose (or amount) of the drug that controls or mitigates symptoms for a user. In some embodiments, scale can be used to perform drug titration based on and/or considering a dose of the drug that controls or effects optimization of symptoms and side effect minimization. For example, the dosage can be controlled to effect or mitigate symptoms with the fewest side effects. For example, a user can be given an initial dosage of a prescription drug and various physiological parameters are tracked over a period of time using the scale. The tracked physiological parameters are used to determine symptoms (or signs) the user is experiencing and/or side effects. The dosage is adjusted, depending on the results, and the physiological parameters are tracked to determine if the adjusted dosage is better (controls symptoms or mitigates side effects) than the initial dosage. The scale can be used as a feedback to determine the dose for the user that controls or mitigates symptoms with the fewest side effects. Such feedback can be particularly useful with user on multiple prescription drugs for different symptoms and prescription drugs that may interact.

In various embodiments, the scale performs a dual-authorization process to authorize communication between the scale and another device. The activation of communication can include enabling pairing between the two devices, which includes bi-directional communication between the scale and the remote user-physiologic device. The dual authorization include verifying a scale-based biometric is associated with a user and
verifying authorization data from the other device is also associated with the user. The other
device, in specific implementations, includes a remote user-physiologic device. In order to
output the data, the scale receives both authorization from the scale, e.g., biometric, and
authorization from the remote user-physiologic device, e.g., authorization data, such that
health data is only communicated when both devices are authorized. The remote user-
physiologic device and/or the scale uses the user data obtained by the scale and various
cardio-related physiologic data generated by the remote user-physiologic device to determine
additional cardio-health related information. By authorizing communication between the
scale and the other device responsive to a scale-based biometric in addition to authorization
data from the other device, user sensitive data such as health data is only communicated
when both devices are authorized and/or in response to the scale verifying both devices are
being used by the same user. In some specific embodiments, a wearable device, such as a
ring, wristband, and/or ankle bracelet can be used to positively identify a user, with or
without biometrics.

The remote user-physiologic device also includes sensor circuitry and collects signals
from the user indicative of the user's identity and cardio-physiological measurements, but at
a different biological point of the user than the scale. For example, a smartphone or
smartwatch is located near the user's hand and the scale is located near the user's feet.
Thereby, data obtained by the scale and the remote user-physiologic device is correlated
and/or combined and used to determine various cardio-related data that is of a higher quality
(e.g., more accurate, less noise, more information) and/or more detail than data from one of
the respective devices (e.g., combine accelerometer signals from cellphone in hand and from
scale).

In accordance with various embodiments, the remote user-physiologic device and/or
the scale correlates the user data from the scale with signals collected by the remote user-
physiologic device. The correlation includes mapping the user data/signals such that the two
data sets correlate to one another. For example, in some specific embodiments, the cardio-
physiologic measurements output as user data by the scale includes data indicative of a BCG
of the user and the cardio-physiologic measurements generated by the remote user-
physiologic device includes data indicative of an ECG of the user. The correlation can
include correcting the data to get true phase change between the BCG and ECG. In other
embodiments, the scale can collect an ECG from a different location than an ECG collected
by the remote user-physiologic device. The correlation includes placing the ECG data from
the scale in phase with the ECG data from the remote user-physiologic device, such that the
two cardiogram waveforms correspond to one another. In other embodiments, the data includes time stamps and the correlation includes mapping the two data sets based on the time stamps. In various embodiments, the correlated user data and collected signals are stored within a user profile corresponding to the user. The user profile is stored on the memory circuit of the remote user-physiologic device, the scale, and/or is stored on external circuitry, such as using a cloud system.

In a number of specific embodiments, the remote user-physiologic device, scale and/or other external circuitry provides clinical indications by processing the data from the scale and the remote user-physiologic device. The clinical indication includes physiologic parameters, diagnosis, conditions, and/or treatments such as PWV, cardiac output, pre-ejection period and stroke volume, among other data. The clinical indications, in various embodiments, are stored in the user profile corresponding with the user. The remote user-physiologic device, scale, and/or other external circuitry controls access to the user profile by allowing access to clinical indications and other data to a physician and not allowing access to the clinical indications to the users. In various embodiments, the remote user-physiologic device and/or other external circuitry allows access to other data to the user that is not regulated by an agency, without a prescription. For example, the remote user-physiologic device, scale, and/or other external circuitry allows access by granting access to the respective profile or portions of the data in the profile and/or by sending the respective data to the scale (or another user device) for display or displaying the data on a user display of the remote user-physiologic device. Example data that is non-regulated by an agency and is provided to the user without a prescription includes body weight, body mass index, heart rate, body-fat percentage, and cardiovascular age. By controlling access to the clinical indications, that includes Rx health information, the scale and remote user-physiologic device provides the advanced functions of determining the clinical indications while being sold over-the-counter and the user can access this data through their physician. The clinical indications can be used by the physician for further analysis and the resulting analysis can be provided as a service and/or to remotely provide health services.

In other specific embodiments, the user stands on the scale. The scale may attempt to establish communication with another remote user-physiologic device. However, the communication is not activated until authorization data is obtained by the scale from the user and from the remote user-physiologic device. For example, the scale collects signals using the data-procurement circuitry. From the collected signals, the scale identifies a scale-based biometric corresponding with the user and validates the various user data generated as
corresponding to the specific user and associated with a user profile. The remote user-physiologic device, at the same time, before or after, collects signals from the user. For example, while the user is standing on the platform, the user turns their cellphone from a sleep mode to on, and in the process provides a password or a biometric, such as a fingerprint to the cellphone. Subsequently or prior to the cellphone entering a sleep mode, the user accesses an application that is configured to generate cardio-physiologic measurements using collected signals from the user. The application, upon activation, directs the cellphone to output the password or biometric to the scale or the scale outputs a signal to the cellphone requesting the password or biometric. Alternatively, other authorization data is collected by the remote user-physiologic device in response to the user accessing the application, and, in response, the authorization data is sent to the scale. In response to the scale receiving both the scale-based biometric and the authorization data from the remote user-physiologic device, the scale activates communication between the device.

In various embodiments, the remote user-physiologic device collects signals using electrodes that are integrated with and/or within the remote user-physiologic device, such as electrodes added as a cover to the cellphone and that are in communication with the cellphone. The remote user-physiologic device, using the collected signals, generates cardio-physiologic measurements. The data obtained by the scale and the remote-user physiologic device is correlated and/or combined to provide additional information to the user and/or to track progress of the user, among other features.

In various embodiments, one of the scale and/or the remote user-physiologic device correlates the cardio-data from the scale and the remote user-physiologic device and performs additional processing of the cardio-data. The additional processing optionally includes determining physiological parameters of the user, medically assessing the user, such as identifying clinical indications that the user has or is at risk for a disease or condition, updating a medical file of the user, providing generic health information that is tailored to the user, and/or providing alerts in response to the physiological parameter indicating a potential emergency. By using the correlated data from both devices, the data used for additional processing is of a higher quality (e.g., more accurate, less noise, more information) and/or more detail than data from one device.

In accordance with various specific embodiments, the remote user-physiologic device and/or the scale correlates the user data from the scale with signals collected by the remote user-physiologic device. For example, the signals collected by the scale and the signals collected by the remote user-physiologic device are collected at the same time,
similar times and/or different times. The correlation can include mapping the user
data/signals such that the two data sets correlate to one another. For example, in some
specific embodiments, the cardio-physiologic measurements output as user data by the scale
includes data indicative of a BCG of the user and the cardio-physiologic measurements
generated by the remote user-physiologic device includes data indicative of an ECG of the
user. The remote user-physiologic device can correlate the data indicative of the BCG with
the data indicative of the ECG of the user such that the BCG and the ECG are in phase with
one another and/or correlate to a same time of a wave-phase. In other embodiments, the data
can include time stamps and the correlation includes mapping the two data sets based on the
time stamps. In various embodiments, the correlated user data and collected signals are
stored within a user profile corresponding to the user. The user profile is stored on the
memory circuit of the remote user-physiologic device, the scale, and/or can be stored on
external circuitry, such as using a cloud system. As further described herein, the data can be
collected by both the scale and the remote user-physiologic device after performing time
(phase) synchronization.

In a number of specific embodiment, the remote user-physiologic device, scale and/or other external circuitry provides clinical indication data by processing the data from
the scale and the remote user-physiologic device. The clinical indication data can include
physiologic parameters, diagnosis, conditions, and/or treatments such as PWV, cardiac
output, pre-ejection period and stroke volume. The clinical indication data can be stored in
the user profile corresponding with the user. The remote user-physiologic device, scale, and/or other external circuitry controls access to the user profile by allowing access to
clinical indication data and other data to a physician and not allowing access to the clinical
indications to the users. In various embodiments, the remote user-physiologic device and/or
other external circuitry allows access to other data to the user, without a prescription.

In various related aspects, the remote user-physiologic device, scale, and/or other external
circuitry provides various additional health information to the user in response
various user inputs and/or the user data. The additional health information, in various
embodiments, includes tables, information, and/or correlates to the cardio-related data that is
determined using data from the scale and data from the remote user-physiologic device. In
various embodiments, the cardio-related information may indicate the user has and/or is at
risk for a disorder, disease, and/or has a particular symptom. The additional health
information is provided to the user that includes generic information for the disorder,
disease, and/or particular symptom without specific information about the user and/or
particular indication that the user has and/or is at risk for the disorder, disease, and/or symptom. In a number of embodiments, the generic information is based on and/or correlated to specific user inputs, such as a category of interest (e.g., demographic of interest, disorder/disease of interest), among other inputs. For example, while, after and/or before taking the various impedance measurements, the user is asked a number of questions using the remote user-physiologic device. The remote user-physiologic device or the scale display the questions and/or ask the questions using a natural language interface (e.g., a speaker component of the device asks the user questions using computer generated sounds). In some embodiments, the scale instructs the remote user-physiologic device to ask the questions, and in response to the user's input, the remote user-physiologic device provides the responses to the scale and/or other external circuitry. Based on the inputs, categories of interest for the user are determined and used to generate additional health information.

Various embodiments of the present disclosure are directed to a scale apparatus that authorizes various communication modes of the scale apparatus responsive to verifying or not verifying one or more biometrics. The scale apparatus, such as a scale, provides various features, such as authorizing various communication modes of the scale apparatus in response to verifying or not verifying one or more biometrics of the user from the collected signals. The communication modes of the scale apparatus can provide tiered communication of scale-obtained data from the scale apparatus to other circuitry that is responsive to identifying or not identifying different biometrics to communicate user data of different sensitivity levels. The different biometrics, in various embodiments, verify identification of the user to a different degree. For example, the tiered communication enables user-sensitive data of different degrees to be communicated based on user settings and a degree of identification of the user.

The scale, in various embodiments, includes an output circuit that outputs various data to external circuitry. For example, using the output circuit, the scale outputs user data to external circuitry, such as a smartphone, a smartwatch, a tablet, an external server and/or processor, and/or other circuitry and devices. The external circuitry is used to store the data, present the data to the user or another person associated with the user (e.g., a doctor), and/or perform additional processing on the user data. In some embodiments, the external circuitry is remote user-physiologic device that includes sensor circuitry and collects signals from the user indicative of the user’s identity and cardio-physiological measurements, but at a different biological point than the scale. Data obtained by the scale and the external circuitry is correlated and/or combined, as previously described. However, the user data can include
sensitive user information (e.g., health data) that the user does not want compromised, accessed by others, and/or otherwise manipulated by other people. Embodiments in accordance with the present disclosure control the output of user data from the scale to external sources based on biometrics measured from a user using the scale. For example, in response to no identified scale-based biometric, the scale operates in a default communication mode in which no (or little) data is communicated to external circuitry. In the default communication mode, data measured and/or otherwise determined by the scale is output to the user using the user display of the scale. In response to the one or more scale-based biometrics, the scale operates in a user verified communication mode and outputs user data to an external circuitry.

Biometrics, as used herein, are metrics related to human characteristics and used as a form of identification and access control. Scale-based biometrics includes biometrics that are obtained using signals collected by the data-procurement circuitry of the scale (e.g., using electrodes and/or force sensors). Example scale-based biometrics include foot length, foot width, weight, voice recognition, facial recognition, a passcode tapped and/or picture drawn with a foot of the user on the FUI/GUI of the user display, among other biometrics. In some specific embodiments, a scale-based biometric includes a toe-print (e.g., similar to a fingerprint) that is recognized using a toe-print reader on the FUI/GUI of the scale. The toe print can be used as a secure identification of the user. In other embodiments, the scale-based biometric includes a fingerprint captured using external circuitry in communication with the scale (e.g., a cellphone or tablet having fingerprint recognition technology).

In accordance with various specific embodiments, the user verified communication mode includes a tiered communication that is based on the specific biometric and/or the amount of biometrics identified. For example, the scale-based biometrics can include a high security biometric and a low security biometric. An example high security biometric can include an ECG-to-BCG timing relationship in addition to (or on its own) one or more of a foot shape, toe tapped password and/or a toe print. A low security biometric can include a user weight, a foot size, and a body-mass-index. In response to identifying the low security biometric, the scale operates in a low verified communication mode. In response to identifying the high security biometric (or the high security biometric in addition to the low security biometric), the scale operates in a high verified communication mode. In the low verified communication mode, the scale outputs portions of the user data to the external circuitry. For example, the scale outputs lower security information such as user weight (or other information which can be set by the user). In the high verified communication mode,
the scale outputs additional user data as compared to the low verified communication mode to the external circuitry. For example, the scale outputs higher security information such as the user's location, date of birth, and/or health condition. By using tiered communications that are enabled using different biometrics, the scale communicates user data that is sensitive to the user based on user settings and responsive to different levels of verification of the identity of the user.

In various specific embodiments, the scale, that identifies the biometrics, reminds the user how to use the scale with or without the higher security biometric. For example, the higher security biometric may not be identified by the scale if the user is wearing foot coverings (e.g., thick socks and/or shoes). When wearing foot coverings, the scale can identify the low security biometric and output portions of the user data to external circuitry. In order for the external circuitry to accurately track the user data and/or perform various additional processing, the external circuitry may require user data that has not been sent. The scale tracks when and what types of user data are output to the external circuitry and instructs the user on how to use the scale. For example, the scale identifies that the user has not operated the scale in the high verified communication mode in a threshold period of time (e.g., a few days). The scale, based on user settings in the user profile, identifies user preferences, such as goals and/or parameters to track. For example, in order to determine and/or otherwise track particular user preferences, user data that is only communicated in the high verified communication mode is used to analyze the parameters or goals in the user preferences. The scale can instruct the user on using the scale with or without foot coverings in order to determine or track the user goals and/or parameters. For example, the scale displays or otherwise provides a message on the user display indicating the last time the high verified communication mode occurred and instructing the user to remove their foot coverings to retake measurements and/or to not wear foot coverings during the next measurement.

Alternatively and/or in addition, the next time the user stands on the platform, an alarm (e.g., sound) is provided and a message displayed that asks if the user is standing or wearing (or not wearing) what the user should be to obtain the one or more scale-based biometrics.

In a number of a specific embodiments, the user stands on the scale and the scale attempts to establish communication with external circuitry, such as a remote device. However, the communication is not activated until scale-based biometrics obtained by the scale from the user are identified. The scale collects signals using the data-procurement circuitry. From the collected signals, the scale identifies one or more scale-based biometrics corresponding with the user and validates the user data generated as corresponding to the
specific user and associated with a user profile. Responsive to identifying a first, lower
security, biometric, the scale operates in a low verified communication mode and outputs a
first portion of the user data to external circuitry. Responsive to the scale identifying a
second, higher security, biometric, the scale operates in a high verified communication and
outputs a second portion of the user data to the external circuitry. The second portion
includes a greater portion of the user data than the first portion and/or user data of a higher
security than the data in the first portion.

Aspects of the present disclosure are directed to a scale apparatus that provides
various features including communicating with other user devices to aggregate and
communicate user data that is sensitive. The scale apparatus, such as a scale, collects scale-
obtained data from a user while the user is standing on the scale, aggregates user data from a
plurality of other user devices with the scale-obtained data, and outputs the aggregated user
data to external circuitry using a secure connection to a server. The aggregated (sensitive)
user data can be output in response to verifying a scale-based biometric from the user. The
scale can includes a hardware security component, such as a hardware token that provides a
hardware key to provide additional security. The user data is provided to the scale from the
user devices in response to secure access to the scale via a scale-based biometric and is
output to the external circuitry, such as a standalone CPU and/or a server CPU, in response
to the scale-based biometric. In various embodiments, different levels of verification of the
user and/or encryption of the data is performed based on the sensitivity of the data sent
and/or the circuitry the data is sent to. For example, the levels of verification include
different levels of scale-base biometrics, dual authorization of the scale and the external
circuitry, hardware key, software key, and/or types of coding. The scale may not accessed
by external sources and outputs data to external circuitry, and is thereby a secure-source to
use as a hub for aggregating and outputting user data based on authorization by the user.

Security measures performed by the scale, in a number of embodiments, are
dependent on the user-sensitivity of the data. For example, the scale has a hierarchy of user
identity verifications to authorize the communications and/or security measures used on the
user data depending on the sensitivity of the user data being output. In various
embodiments, the hierarchy includes a plurality of different scale-based biometrics, data
encryption, hardware token key, software token key, among other security measures. For
example, the different levels of user-sensitive data are authorized for communication based
on different levels of biometrics. In various specific embodiments, the scale outputs a first
(lower-sensitivity) set of user data to the external circuitry in response to identifying a lower
level biometric and outputs a second (greater and/or higher sensitivity) set of user data in
response to identifying a higher level biometric, such that higher security data is only
communicated when a higher level biometric is verified.

In a number of embodiments, the scale acts as a hub to collect data from a variety of
sources. The sources includes the above-noted user devices. The scale can incorporate a
web server (URL) that allows secure, remote access to the collected data. For example, the
secure access can be used to provide further analysis and/or services to the user.

Various aspects of the present disclosure are directed to a user-specific scale-based
enterprise system. The user-specific scale-based enterprise system includes at least one
scale, the Internet (e.g., world-wide-web), a standalone user CPU, and one or more user
devices, such as a smartwatch, fitness tracking device, smartphone, smartbed, among other
devices. The scale collects highly user-sensitive data, as previously described. The user
devices can include devices that collect various user-sensitive data, such as exercise data,
food intake or liquid intake data, sleep data, cardiogram data, among other information. The
standalone user CPU includes a user device having processing circuitry and/or a user display
that is easier for the user to view data than the scale or other user devices. In some
embodiments, the standalone user CPU includes a personal computer, a laptop, a tablet,
and/or a smartphone.

The scale, in various embodiments, includes input/output circuitry that receives data
from other user devices and outputs various data to other external circuitry, such as a
standalone user CPU and/or a server CPU (e.g., at a datacenter). For example, using the
input/output circuitry, the scale receives various user data from one or more user devices.
One or more of the user devices also include sensor circuitry and collects signals from the
user indicative of the user's identity and cardio-physiological measurements, but at a
different biological point of the user than the scale. For example, a smartphone or
smartwatch is located near the user's hand and the scale is located near the user's feet.
Further, the other user devices, in some embodiments, are used more often than the scale
and/or used to collect data that the scale cannot, such as exercise logging and sleep habits.
The data obtained by the scale and the user device is aggregated and/or combined and used
to determine various cardio-related data that is of a higher quality and/or more detail than
data from one of the respective devices.

Various embodiments are directed to providing a hierarchy of services using scale-
based user data. The scale, in various embodiments, collects various data indicative of
cardio-related information of the user and communicates data to an external circuitry. In
various embodiments, the external circuitry, such as a server CPU, receives user data from a plurality of scales and pools the user data to provide various services to the users and/or to other personnel. The user data is compared to other user data and/or various reference health information to determine correlations for the users. The correlations can include potential risks for conditions, such as disorders or diseases, and/or social groupings of users with similar patterns of user data (e.g., demographic, conditions, scale-obtained data, user goals and/or lifestyle). A hierarchy of services includes different services enabled in response to user selection and activation of subscription levels. The subscription levels have different weighted values that activate the subscription level and each subscription level is associated with one or more services.

As a specific example, a system includes three subscription levels. The first subscription level does not have a weighted value (e.g., weighted value is zero), the second subscription level has a first weighted value, and the third subscription level has a second weighted value, which is greater than the first weighted value. The first subscription level is provided to any user with a scale. The user stands on the scale, the scale collects user data, and the scale prompts the user to access a first service of the first subscription level. As an example, the first service includes providing the user with generic health information that is tailored based on the scale-obtained data, such as cardio-data, user goals, diagnosis/health history, demographic information, among other data. The user selects the prompt, using the user interface of the scale and/or another user interface, and is provided the first service. In response to the providing the user with the first service, the scale and/or other user display, provides another prompt for a second service of the second subscription level. As an example, the second service includes providing the user access to a social grouping of users with similar physiological data. In response to the user selecting the prompt and activating the second service level based on the first weighted value, the user is provided with the second service.

In response to the user not selecting a prompt and/or not activating one of the service levels, the scale, in some embodiments, provides a prompt for a service of a service level that is activated for the specific users. For example, various other services includes advertisements for products and/or services, physician-provided advice over a longer period of time, participation in a study and/or experiment, social groupings based on professional (e.g., physician lead and/or participation by physician in the social grouping), among other services.
The weighted values of the subscription levels, in some embodiments, is based on the value of the service or corresponding data to the user, the user-sensitivity and/or regulation of the corresponding data, the value of the corresponding data to the service provider/provider of the scales, and the value of the corresponding data to the requester. In various embodiments, the value of the service and/or corresponding data is determined based on a level of security of the data, a level of technical detail of the data, and/or a likelihood of diagnosing the user based on the data. The requester of the data provided by the service, in various embodiments, includes a third party, such as a researcher, physician, government entity, and/or other entity. The different subscription levels have different weighted values that, in some embodiments, increase with the levels of subscription. Alternatively and/or in addition, the weighted values are provided to activate the different levels by different parties. For example, in some embodiments, one or more of the subscription levels are activated by the user selecting the prompt and a third party providing the weighted value, such as a researcher. As a specific example, a gym may offer gym subscriptions whose cost decreases as fitness of the user increases, which is determined using scale-obtained data. The cost maybe offset by insurance companies (e.g., health insurance) which offer contributions to a gym subscription if the user goes a threshold number of times in a month and/or based on other health factors.

In various specific embodiments, the hierarchy of services includes providing a subset of the (securely) pooled user data to a requester, such as a physician and/or other researcher, and/or using the scales to participate in a study and/or experiment. The subset of user data provided to a requester is provided, in various embodiments, based on analysis parameters and security parameters. The analysis parameters are input by the requester for the data, and include parameters such as demographics of users, conditions or diseases, parameter values, lifestyle, and/or pseudo-random selection. The security parameters include restrictions on the user data output to protect the identity of the users and the user data, which include sensitive data.

Aspects of the present disclosure are directed to securely pooling user data from scales. The pooled data is securely and anonymously communicated to requestors based on analysis parameters and security parameters. The security and anonymity is accomplished in various embodiments by replacing an identifier that indicates an identity of the scale and the user with an alias ID and restricting access to specific data. Scales, in various embodiments, communicate with external circuitry for various processing of user data. The external circuitry securely pools user data and identifies potential correlations or patterns of risks for
conditions or diseases of users. To securely communicate the data, the scale removes portions of the scale-obtained data that identifies the user and adds an identifier to the scale-obtained data to identify that the user-data corresponds to one user. The scale, optionally, secures the user data by encrypting all and/or portions of the user data, such as the identifier. The scale outputs the secure data to the external circuitry. Alternatively and/or in addition, the identifier is encrypted that identifies the user and the scale, and the external circuitry replaces the identifier with an alias ID. The external circuitry stores the user data with the alias ID in a first database and stores the identification of the scale and user that corresponds to the alias ID in a second database. In this manner, the user data stored in the first database does not identify the user. Further, by storing the user data in a separate database from the identification of the alias ID and scale/user, preferably at a separate location, the pooled user data has a lower risk of being inappropriately accessed such that an external entity and/or source, such as a security hacker, identifies the respective user corresponding to the user data. Thereby, the user data is more secure and the user’s identity remains unknown.

The pooled user data is used for various analytics. For example, various sources/entities request access to the user data. The requester for the securely pooled user data can include a researcher intending to perform research on the user data. Example sources/entities include government entities for research or census studies, environment groups, scientific research groups, including both private, academic, and public source, among other entities. The research is performed on existing user data and/or the requester requests for specific data that is consequently obtained. For example, in response to analytics performed and/or prior to, the researcher requests the external circuitry contact particular users to perform an experiment. Various users are contacted based on the analysis parameters. The users are contacted through the user display of the scale and asked if they are interested in participating in a study. In some embodiments, a portion of the users are used as a control group and the remaining portion as an experimental group. The scale, in some embodiments, is used to perform the study and/or encourage the user to actively participate.

In other embodiments, the requester for the securely pooled user data includes a user of one of the plurality of scales. For example, the user may be interested in learning about a particular disorder. The user may know that they have a disorder/condition or have a goal or may be interested in learning more for someone they know. The user provides the various analysis parameters using their scale and/or another user device. The scale communicates with the external circuitry to authorize the communication and outputs data to the scale. The
scale can output the user data to user circuitry such that the user can more easily view the
data but the communication with the external circuitry is through the scale and responsive to
identification of the user.

The external circuitry identifies the various user data to output to the requester based
on the analysis parameters and the security parameters. In various embodiments, the
analysis parameters identify various types of user data, such as demographics of users,
conditions/disorders, lifestyle, user goals, etc., that the requester is interested in. The
analysis parameters may establish various bias parameters and/or request for pseudo-random
selection to provide analytics on a statistically random sample population. The analysis
parameters further include sample size (e.g., number of users) and/or data of the data
obtained. In other embodiments, the analysis parameters identify various parameters,
conditions or goals the requester is interested in learning about and potential failures,
successes, and/or correlated diagnosis. The external circuitry scans the pool of user-specific
knowledge to identify various securely pooled user data related to the analysis parameters
and collects the respective securely pooled user data.

Based on the security parameters, the external circuitry removes portions of the
respective user data and/or does not include the portions in the collected securely pooled user
data. Thereby, the security parameters restrict access to the securely pooled user data. User
data sets corresponding to each user includes data that is unrelated to the analysis parameters
and/or otherwise not used for the purpose of analysis as requested. Such data is not provided
to the requester. The security parameters include specific data that cannot be accessed by
requesters, combinations of data, and/or a threshold sensitivity value of the user data. The
identification is based on the risk of the data, such as location data and/or date of birth. The
user data can have a sensitivity value that identifies a security risk of the data. The
sensitivity values are set by the external circuitry and/or the users of the scales. User data
types with a sensitivity value above a threshold value (e.g., a threshold sensitivity value of
the user data) may not be provided to requesters. Alternatively, data is provided based on a
security of the requester. For example, if the requester has a high amount of security
measures in place, a greater amount of data and/or data with higher sensitivity values are
provided. If the requester has a low amount of security in place, a lower amount of data
and/or only data with lower sensitivity values are provided.

In various related embodiments, the security parameters include a set of rules
restricting combinations of user data provided. For example, a particular requester is
provided user data of particular combinations. The rules may include “can receive 2 out of
the three: height, date of birth, and location data.” The set of rules mitigate the risk of the requester being able to identify the user's identities. Further, the external circuitry, in some embodiments, changes the alias IDs each time a requester requests user data to prevent the requester from correlating a first data set with a second data set and obtaining the combination of user data that the set of rules are designed to prevent.

The securely pooled user data can include biases. For example, the user of the scale may include health conscious users and/or unhealthy or sick users. The bias can result in the pooled user data not representing a random sample census of user data from a population.

The external circuitry, optionally, identifies what the bias is. The external circuitry provides the identified bias to the requester such that the requester can correct for the bias by adjusting the selection of user data and/or the external circuitry adjusts the selection of user data to correct for the bias.

In accordance with a number of embodiments, the hierarchy of services is based on a grouping of users. For example, one or more services of one or more subscription levels includes providing access to a social group of users. For example, in some embodiments, the access is to a forum, blog, webpage, and/or application. Alternatively and/or in addition, the access is to reports and/or dashboards of scale-obtained data from the users of the social group over a period of time, such as changes in physiological parameters and/or weights and potential causes of the changes (e.g., treatments, exercise, lifestyle changes). A social group, as used herein, includes grouping of a set of scale users based on scale-obtained data. The forum, blog, webpage, and/or application provided as the service includes automatically linking the uses of the group and providing the users access. In various embodiments, the forum, blog, webpage and/or application is automatically populated with reports of the user, such as rankings, progress of the users, new observation, and/or other information. In a number of embodiments, users in the social group remain anonymous and are identified by their alias ID and/or another ID selected by the user. The social groups can be intra scale or inter scale.

In a number of specific embodiments, social groupings are provided as services in a plurality of different subscription levels. For example, in a first subscription level, a user is provided access to a social group based on exercise interest and/or goals or other general consumer related interests. The social group at the first level can include a consumer based social group. A consumer based social group includes or refers to a social group based on consumer interests and/or facts. At a second subscription level, a user is provided access to a physiological social group, which is based on scale-obtained data and/or diagnosis of the
scale-obtained data by a physician. At a third subscription level, a user is provided access to a (more) professional social group. For example, a physician participated in the professional social group with other users and/or actively tracks the progress of the user. Alternatively and/or in addition, the physician uses the professional social group to perform a study and/or experiment.

Turning now to the figures, FIG. 1a shows an apparatus consistent with aspects of the present disclosure. The apparatus includes a platform 101 and a user display 102. The user, as illustrated by FIG. 1a is standing on the platform 101 of the apparatus. The user display 102 is arranged with the platform 101. As illustrated by the dashed-lines of FIG. 1a, the apparatus further includes processing circuitry 104, (optionally) data-procurement circuitry 116, and physiologic sensors 118. That is, the dashed-lines illustrate a closer view of components of the apparatus.

The physiologic sensors 118, in various embodiments, include a plurality of electrodes integrated with the platform 101. The electrodes and corresponding force sensor circuitry 117 are configured to engage the user with electrical signals and to collect signals indicative of the user's identity and cardio-physiological measurements while the user is standing on the platform 101. The physiological sensors 118 further include a plurality of force sensors, such as strain gauges, as discussed further herein. Accordingly, although the embodiment of FIG. 1a illustrates the force sensor circuitry 117 as separate from the physiological sensors 118, one of skill in the art may appreciate that the force sensor circuitry 117 are physiological sensors. The signals collected are indicative of physiologic parameters of the user and/or are indicative of or include physiologic data, such as data indicative of a BCG or ECG and/or actual body weight or heart rate data, among other data. As discussed further below, the signals can be force signals. The user display 102 is arranged with the platform 101 and the electrodes to output user-specific information for the user while the user is standing on the platform 101. The processing circuitry 104 includes CPU and a memory circuit with user-corresponding data 103 stored in the memory circuit. The processing circuitry 104 is arranged under the platform 101 upon which the user stands, and is electrically integrated with the force sensor circuitry 117 and the plurality of electrodes (e.g., the physiologic sensors 118). The data indicative of the identity of the user includes, in various embodiments, user-corresponding data, biometric data obtained using the electrodes and/or force sensor circuitry (or external circuitry), voice recognition data, images of the user, input from a user's device, and/or a combination thereof and as discussed
in further detail herein. For example, the scale can capture voice sounds from the user speaking, and the user data indicative of the identity includes the voice sounds captured.

The user-corresponding data includes information about the user that may or may not be obtained using the physiologic sensors 118 and/or force sensor circuitry 117, such as demographic information or historical information. Example user-corresponding data includes height, gender, age, ethnicity, exercise habits, eating habits, cholesterol levels, previous health conditions or treatments, family medical history, and/or a historical record of variations in one or more of the listed data. The user-corresponding data can be obtained directly from the user (e.g., the user inputs to the scale) and/or from another circuit (e.g., a smart device, such a cellular telephone, smart watch and/or fitness device, cloud system, etc.).

In various embodiments, the processing circuitry 104 is electrically integrated with the force sensor circuitry 117 and the plurality of electrodes and configured to process data obtained by the data-procurement circuitry 116 while the user is standing on the platform 101. The processing circuitry 104 can generate cardio-related physiologic data corresponding to the collected signals and that is manifested as user data. Further, the processing circuitry 104 generates data indicative of the identity of the user, such as a user ID and/or other user identification metadata. The user ID can be generated in response to confirming identification of the user using the collected signals indicative of the user's identity.

The physiologic data collected by the scale, in accordance with various embodiments, includes force signals, PWV, weight, heartrate, BCG, balance, tremors, respiration, data indicative of one or more of the proceeding data, and/or a combination thereof. In some embodiments, the physiologic parameter data includes the raw force signals and additional physiologic parameter data is determined using external circuitry. Alternatively, the physiologic data can include physiologic parameters such as the PWV, BCG, IPG, ECG that are determined using the force signals from the electrodes and the external circuitry (or the processing circuitry 104 of the scale) can determine additional physiologic parameters (such as determining the PWV using the BCG) and/or assess the user for a condition or treatment using the physiologic parameter. Although the present examples embodiments provided above are in reference to processing circuitry performing the determination, embodiments in accordance with the present disclosure are not so limited. For example, the external circuitry can determine the physiologic data. An algorithm to determine the physiologic data from raw signals can be located on the scale, on another
device (e.g., external circuitry, cellphone), and on a Cloud system. For example, the Cloud system can learn to optimize the determination and program the scale to subsequently perform the determination locally. The Cloud system can perform the optimization and programming for each user of the scale.

In some embodiments, the scale collects physiologic data from other devices, such as medical devices, user devices, wearable devices, and/or remote-physiological devices. The data can include glucose measurements, blood pressure, ECG or other cardio-related data, body temperature, among other physiologic data.

The user data and/or physiologic data, in some embodiments, can include the raw signals, body weight, body mass index, heart rate, body-fat percentage, cardiovascular age, among other data. In various embodiments, the processing circuitry 104, with the user display 102, displays at least a portion of the user data to the user. For example, user data is displayed to the user, such as user weight. Alternatively and/or in addition, the user data is stored. For example, the user data is stored on the memory circuit of the processing circuitry (e.g., such as the physiologic data stored on the physiological data database 107 illustrated by FIG. 1a). The processing circuitry 104, in various embodiments, correlates the collected user data (e.g., physiologic user-data) with user-corresponding data, such as storing identification metadata that identifies the user with the respective data.

In a number of embodiments, the scale includes an output circuit 106. The output circuit 106 receives the user data and, in response, sends the user data, including the data indicative of the user's identity and the generated cardio-related physiologic data, from the scale for reception by assessment circuitry 187 and to provide to the user via a user interface. The user interface, as previous described, is or includes a graphical user interface (GUI), a foot-controlled user interface (FUI), and/or voice input/output circuitry. The user interface can be integrated with the platform 101 (e.g., internal to the scale) and/or can be integrated with external circuitry that is not located under the platform 101. In some embodiments, the user interface is a plurality of user interfaces, in which at least one user interface is integrated with the platform 101 and at least one user interface is not integrated with the platform 101. Example user interfaces include input/output devices, such as display screens, touch screens, microphones, etc.

A FUI is a user interface that allows for the user to interact with the scale via inputs using their foot and/or via graphic icons or visual indicators near the user's foot while standing on the platform. In specific aspects, the FUI receives inputs from the user's foot (e.g., via the platform) to allow the user to interact with the scale. The user interaction
includes the user moving their foot relative to the FUI, the user contacting a specific portion of the user display, etc.

A GUI is a user interface that allows the user to interact with the scale through graphical icons and visual indicators. As an example, the external circuitry includes a GUI, processing circuitry, and output circuitry to communicate with the processing circuitry of the scale. The communication can include a wireless or wired communication. Example external circuitry can include a wired or wireless tablet, a cellphone (e.g., with an application), a smartwatch or fitness band, smart glasses, a laptop computer, among other devices. In other examples, the scale includes a GUI and voice input/output circuitry (as further described below) integrated in the platform 101. The user interact with the scale via graphical icons and visual indicators provided via the GUI and voice commands from the user to the scale.

Voice input/output circuitry (also sometimes referred to as speech input/output) can include a speaker, a microphone, processing circuitry, and other optional circuitry. The speaker outputs computer-generated speech (e.g., synthetic speech, instructions, and messages) and/or other sounds (e.g., alerts, noise, recordings, etc.) The computer-generated speech can be predetermined, such as recorded messages, and/or can be based on a text-to-speech synthesis that generates speech from computer data. The microphone captures audio, such a voice commands from the user and produces a computer-readable signal from the audio. For example, the voice input/output circuitry can include an analog-to-digital converter (ADC) that translates the analog waves captured by the microphone (from voice sounds) to digital data. The digital data can be filtered using filter circuitry to remove unwanted noise and/or normalize the captured audio. The processing circuitry (which can include or be a component of the processing circuitry 104) translates the digital data to computer commands using various speech recognition techniques (e.g., pattern matching, pattern and feature matching, language modeling and statistical analysis, and artificial neural networks, among other techniques).

In specific embodiments, the output circuitry 106 provides the user data to the user display 102 for display by a FUI 108 of the scale. The FUI 108 is arranged with the platform 101 and the data-procurement circuitry 116. The FUI 108 outputs user-specific information to the user while the user is standing on the platform. The FUI 108 allows the user to interact with the scale. For instance, to interact with the scale, the user moves their foot, contacts the user display 102 with their toe, and/or shifts their weight to interact with the scale, among other interaction. The interaction causes the FUI 108 to change and/or
causes the scale to perform an action. As the user is standing on the scale, the FUI 108 allows the user to interact with the scale without getting off the scale and/or changing their posture significantly.

The user display 102 can be configured to display the FUI 108 including data through at least a portion of the platform 101 whereon the user stands. The FUI 108 receives inputs from the user's foot to allow the user to interact with the scale apparatus. The interaction can include the user moving their foot, the user contacting a specific portion of the user display with their foot, the user shifting weight, and a combination thereof. In some embodiments, the user display 102 includes a touch screen. In response to the user touching the screen with their foot, the FUI 108 undergoes a change in appearance. Alternatively and/or in addition, the user display can be integrated with motion sense circuitry and/or accelerometers. In some embodiments, the scale is configured with a haptic, capacitive or flexible pressure-sensing upper surface, the (upper surface/tapping) touching from or by the user is sensed in the region of the surface and processed according to conventional X-Y grid. Signal processing in the logic circuitry/CPU that is within the scale. By using one or more of the accelerometers located within the scale at its corners, such user data entry is sensed by each such accelerometer so long as the user's toe, heel or foot pressure associated with each tap provides sufficient force. In such embodiments, the interaction includes the user moving their foot, such as swiping their foot across the user display. The user may or may not touch the screen and the scale senses the movement as input. In a specific example, when the user stands on the platform of the scale, and the scale detects touching of the toe, the scale can reject the toe touch (or tap) as a foot signal (e.g., similar to wrist rejection for capacitive tablets with stylus).

In specific embodiments, the FUI 108 (or GUI) displays a variety of text or images for the user to interact with the scale. For example, a variety of icons, a virtual keyboard, a listing of items, etc., can be displayed. The FUI 108 can receive a user input in response to the user moving their foot to select the icon or item listed that is displayed using the FUI 108. The FUI 108 displays, for example, a variety of icons that each represent a function (e.g., a test, a parameter, an action) that the scale can perform (e.g., as further illustrated by FIG. 2e). In response to the user touching one of the icons with their foot, such as with their toe, the FUI 108 is revised to verify the selection. For example, the FUI 108 displays text asking "Did you want to perform test A?" and include two icons listing "yes" or "no". In response to the user selecting yes, the scale performs the test or other function.
to the user selecting no, the scale redisplay the variety of icons for the user to re-select on the FUI.

In other related embodiments, the FUI 108 receives a user input in response to the user moving their foot on a virtual keyboard is displayed using the FUI 108 on the user display 102. The user may type a command or an answer to a question to the scale, as discussed further herein.

The output circuit 106 can send a subset of the user data to the FUI 108. The subset of user data is indicative of a portion of available health information that is specific to the user and is based on the cardio-related physiologic data. Further, the subset of user data includes an indication that the user data is available. In specific embodiments, the subset of user data displayed on the FUI 108 includes weight and a synopsis of available user data. The indication of available user data includes an icon for the user to select on the FUI 108 (using their foot) to view the user data. The output circuit 106 can send the user data to assessment circuitry 187 that is integrated with the scale or is not integrated with the scale in response to a user input to the FUI 108 that is indicative of a user selecting to view the user data. The user data includes additional data from the subset of user data.

The assessment circuitry 187 is configured to receive and further assess the user data (as further described herein). The assessment circuitry 187, based on the assessment, can provide data for review. The assessment circuitry 187 can be integrated with external circuitry (e.g., a server CPU and/or standalone CPU) and/or can be integrated with the processing circuitry 104 of the scale. The external circuitry is remotely located from the weighing scale and can include output circuitry, processing circuitry, and memory circuitry. In various embodiments, the output circuit 106 displays on the FUI 108 the user's weight and the data indicative of the user's identity and/or the generated cardio-related physiologic data corresponding the collected signals. The external circuitry is at a remote location from the scale and is not integrated with the scale. The communication, in various embodiments, includes a wireless communication and/or utilizes a cloud system.

The scale can perform an initialization process in response to a user standing on the scale. For example, the processing circuitry can include initialization mode logic configured and arranged to direct the apparatus to operate in the initialization mode. In a number of embodiments, the processing circuitry 104, and the electrodes, provides (e.g., displays or otherwise) an instruction 111 to the user in response to the user standing on the platform 101 and/or approaching the platform 101 using the user interface (e.g., internal or external GUI, FUI 108, and/or voice input/output circuitry). The processing circuitry 104 may determine
the user is standing on the platform 101 using the physiologic sensors 118 (e.g., in response to a force signal from the force sensors) and/or may determine the user is approaching using signal-sense circuitry and/or motion sensing-circuitry. Specifically, the instruction directs the user to have a particular posture until an alert is provided. In response to the instruction (e.g., after), the processing circuitry 104 collects physiological data from the user while the user is standing on the platform and using signals obtained by the plurality of electrodes and force sensors.

The instruction 111 provided (e.g., displayed), in some embodiments, directs the user to remain still (e.g., avoid motion/stand still) until an alert is provided. The instruction, in various embodiments, directs the user to remain still and/or look forward (e.g., "hold your head up and look forward"). For example, the instruction 111 directs the user to posture to render the body of the user stationary with a particular position of the head until an alert is provided in response to the user standing on the platform. As noted above, it has been discovered that the posture of the user and the position of the user's head can impact the accuracy of the physiological data collected by the scale. Alternatively and/or in addition, the instruction 111 directs the user to hold their head still, to continue to hold their head still, direct their eyes in a particular direction, and/or hold their head in a certain way (e.g., hold your head up or look forward) until the alert is provided. The instruction 111, in various embodiments, includes a visual display on the user display 102 (e.g., visual instruction), an audio display (e.g., audio instruction), and/or an instruction sent to a user device (e.g., a mobile phone the user is holding). In some embodiments, the apparatus includes an electroacoustic transducer circuit, such as a speaker, to provide the audio instruction. The processing circuitry and the electroacoustic transducer circuit provide the display, in such embodiments, by providing an audio instruction to the user. The audio instruction can include a pre-recorded instruction, an instruction obtained from an external source (e.g., external server or device), and/or a computer-generated voice instruction generated by the processing circuitry 104.

In response to the instruction, the scale collects physiologic data from the user. For example, responsive to the instruction and/or a period of time after the instruction 111, the processing circuitry 104 and the electrodes collect physiologic data 112 from the user while the user is standing on the platform 101. The physiological data 112 collected, in various embodiments, is stored a physiological data database 107.

In in response to the collection of physiological data and/or verification that the user has a specific/current posture, the processing circuitry, and the user display and/or a speaker,
provide an alert to the user. The alert indicates that the user may lower their head, such as indicating that the user can look at the user display of the apparatus, and/or the user may move. For example, after the physiologic data is collected, the processing circuitry 104 provides the alert 113 to the user and user-specific information is displayed 114 using a user interface, which can include the user display 102 and/or a speaker component. The alert 113, in various embodiments, indicates that the user can lower their head and/or move. Further, the alert, in some embodiments, indicates that the user can look at the user display 102. The alert, similarly to the instruction, can be provided by displaying a visual indication on the user display 102 and/or using an electroacoustic transducer circuit of the apparatus to provide an audio alert to the user. In some embodiments, the alert includes a vibration on the platform 101 provided while the user is standing on the platform 101 and using the electrodes, and/or a combination of the visual indication, audio alert, and/or vibration.

In specific embodiments, the processing circuitry 104 verifies accuracy of the physiological data collected. For example, the processing circuitry 104 verifies that the user has a specific/correct posture using the physiologic data collected 112. If the user is moving and/or looking down, the physiologic data collected 112 may include a high signal-to-noise value and/or data that is indicative of the movement and/or incorrect posture. The verification can include verifying the accuracy of the physiologic data collected. In some instances, the processing circuitry 104 compares the physiologic data collected 112 from individual electrodes to determine potential movement, compares a signal-to-noise value to a threshold value, and/or compares the physiological data or determined physiological parameters to a threshold value. For example, large differences between electrodes at the same time and/or in a series of time can indicate movement. Alternatively and/or in addition, the signal-to-noise and/or data being outside a threshold value indicates movement and/or incorrect posture. If the scale has previously been used by the user, the scale can compare prior measurements to determine if the user is standing incorrectly.

In response to verifying the accuracy, the processing circuitry 104 provides the alert to the user indicating they can move. Further, the processing circuitry and output circuit 106 can provide user-specific cardio data to the user using the user interface (e.g., GUI, FUI 108, and/or voice input/output circuitry) and the collected physiologic data. The user-specific cardio data can include the verified physiological data and/or portions thereof. In other embodiments, the user-specific cardio data can include a summary of the physiologic data and/or an indication of available physiologic data, and a prompt to authorize communicating the data to another source and/or displaying on the scale. In response to the processing
circuitry 104 being unable to verify the user has the correct/specific posture, the processing circuitry 104 provides an additional instruction to the user indicating incorrect posture is identified and redirecting the user to stand with their head up, with a particular posture, and/or remain still. The processing circuitry 104, and the electrodes, in response to the further instruction, re-collect physiological data 112 from the user.

In various embodiments, the instruction is provided by the scale and/or includes use of projection circuitry and/or a light source which may be embedded in the platform of the scale. The projection circuitry includes one or more light sources and is configured to project light or an image onto a surface. The one or more light sources include circuitry and/or hardware configured to provide light, such as light-emitting diodes (LEDs), an incandescent light bulb, a fluorescent light bulb, compact fluorescent lamp, a laser, among other sources of light. For example, the projection circuitry is a digital light processing (DLP) projector that includes an LED and a Digital Micromirror Device (DMD), a Liquid Crystal Display (LCD) projection that includes a prism or series of dichroic filters, and/or a Liquid Crystal on Silicon (LCOS) that includes a liquid crystal layer on top of silicon backplane, such as a pico projector, among other projection circuitry. In other embodiments and/or in addition, the projection circuitry includes a laser embedded in the scale. For example, the scale provides the instruction by projecting a mark on an external surface (e.g., a wall in a bathroom) using a light source. The laser projects a mark on the wall (e.g., a dot, a smiley face, a good/bad indication) that indicates where to look and, optionally, indicates a steadiness of the user to engage with the user. In other embodiments, the projection circuitry can include two or more embedded lasers to project (through a holographic filter) the good/bad indication of steadiness onto an external surface (e.g., the wall).

In related embodiments, the projection circuitry includes a laser projector engine to project content onto an external surface. The laser projector engine includes circuitry and two or more light beams to project the indication. The projection circuitry and/or light source can include various commercially available projection circuitry and/or light sources, such as a laser pointer, pico projector, LEDs, and other light sources. For more specific and general information on commercially available projection circuitry and/or light sources, reference is made to http://www.sony.net/Products/SC-HP/picopro/, which is fully incorporated herein. The light source can include a strobing light (e.g., an LED) when the user is moving too much, to prompt the user to be steadying. The strobing can indicate how the user is moving. For example, the amount of time between flashes of the strobing light
can change based on the amount of movement (e.g., faster strobing in response to greater amount of user movement as compared to a steady user).

The projection circuitry and/or light source can be used in addition to an instruction displayed on the user display and/or a computer-generated voice message. The projection circuitry can be used to assist the user is standing with the correct posture and encourage improvements in steadiness. As a specific example, the projection circuitry may cycle colors (e.g., red, orange, yellow, repeat) when measurements are being made and then project green when the user may move and/or look down. In other embodiments, the projection circuitry tracks the movement of the user's eyes to simulate activity. As further examples, a location of the laser may move to a particular location and/or may flash (e.g., strobe) when the user may move and/or look down, the strobing light may become a solid light (e.g., stop strobing) or turn off (e.g., no light) when the user may move and/or look down, and/or an image is projected that indicates the user may move and/or look down (e.g., a smiley face or a thumbs up).

In accordance with various embodiments, although not illustrated by FIG. 1a, the apparatus includes an additional sensor circuitry that is external to the scale. The additional sensor circuitry can include a communication circuit and is configured and arranged to engage the user with electrical signals and collect therefrom signals indicative of an ECG of the user. The sensor circuitry, which may include and/or be correlated with processing circuitry configured to derive an ECG from the collected signals. The sensor circuitry communicates the ECG to the external circuitry 125 and/or assessment circuitry 135 and the scale can communicate aBCGto the external circuitry 125 and/or assessment circuitry 187.

The scale and the external circuitry 125 and/or assessment circuitry 187 can be used to provide additional health information to the user. The scale, for example, outputs user input data that provides an indication that the user is interested in additional (non-Rx) health information and various categories of interest, as further described herein. In various specific embodiments, the user data is user for correlating and titrating the user for condition and/or treatment assessment, at 119, as further described herein.

FIG. 1b shows an example of a performing an initialization process using an apparatus consistent with aspects of the present disclosure. The apparatus illustrated by FIG. 1b can include the apparatus, including the platform 101 and user display 102, as previously illustrated and discussed with regard to FIG. 1a. As illustrated, the apparatus include a platform in which a plurality of electrodes and force sensor circuitry (e.g., the physiologic sensors) are integrated, a user display configured and arranged with the platform and the
plurality of electrodes and/or force sensor circuitry to output user-specific information for the user while the user is standing on the platform, and processing circuitry. The processing circuitry includes a CPU and a memory circuit with user-corresponding data 103 stored in the memory circuit.

The initialization process and/or mode, in accordance with a number of embodiments, includes identifying the user is approaching/standing on the platform, confirming identification of the user, obtaining the user-corresponding data from the user, providing the instruction, collecting physiologic data, providing the alert, and a combination thereof. For example, as illustrated by FIG. 1b, during the initialization mode, the apparatus at block 121 waits for a user to stand and/or approach the platform. In response to the user standing and/or approaching the platform, the apparatus obtains identification data to identify the user. Example identification data, as discuss further herein with regard to FIG. 2a, includes the time of day, length of foot, spoken words from the user, weight, height, facial features, and/or other biometrics, such as cardio-wave characteristics. As illustrated, at block 122, the apparatus confirms identification of the user when the user is standing on the platform and/or as the user approaches the platform. The identification, in various embodiments, is based on the identification data and/or user-corresponding data 103. For example, the processing circuitry of the scale can compare the identification data (e.g., obtained signals) to stored user data 103 (e.g., stored biometrics) to confirm identification of the user. The user-corresponding data 103, in a number of embodiments, is obtained prior to the user standing on the platform. Further, in some embodiments, additional user-corresponding data is obtained in response to the user standing on/approaching the platform.

In various embodiments, in response to the user standing on/approaching the platform and/or confirmation of the identity of the user, the processing circuitry instructs the user via a user interface and, optionally a user display. As previously described, the user interface can be or include a FUI that allows for the user to interact with the scale via inputs using their foot. The instruction, in various embodiments, directs the user to remain still and/or look forward (e.g., "hold your head up and look forward"). In response to the instruction, at block 123, the processing circuitry, using the electrodes and force sensors, collects physiologic data from the user. And, in response to the collection of physiological data and/or verification that the user has a specific/current posture, the processing circuitry, and the user display and/or a speaker, provide an alert to the user. The alert indicates that the user may lower their head, such as indicating that the user can look at the user display of the apparatus, and/or the user may move.
At block 124, the processing circuitry processes the physiologic data. The processing, in various embodiments, occurs using the processing circuitry and/or external circuitry. For example, the processing circuitry can determine a cardiogram, ECG, PWV, BCG, and/or other physiological parameter of the user using the physiological data, which can be output to external circuitry. The external circuitry can be located at a remote location from the platform and/or can be located on the user (e.g., a mobile cellular phone located in the user's pocket). Alternatively, the processing circuitry outputs the collected physiologic data to the external circuitry. In such embodiments, the external circuitry determines the cardiogram, BCG, and/or other physiological parameter of the user using the collected physiologic data and can send determined data back to the processing circuitry. In both embodiments, the processing circuitry includes an output circuit configured to output data to the external circuitry.

In various embodiments, the scale is used to collect data from a variety of sources, such as a user device and/or the external circuitry, as previously described. The scale and user device (or external circuitry) can pair and/or otherwise communicate in response to a verification or authorization of the communication, which can be based on confirming identification of the user device, that the same user is using the user device and the scale, and/or a scale-based biometric that is recognized. As a specific example, the user may be holding a cellphone in their hand while standing on the scale. The scale, using the processing circuitry and output circuit, outputs a command to the phone to vibrate. The scale detects the vibration frequency and timing (phase). This detected vibration frequency and timing can be used to securely identify the cellphone and/or to time synchronize the scale and the user device, as further described herein.

At block 126, user-specific information is displayed using the user display and in response to the collected physiologic data. The user-specific information, in some embodiments, includes the collected physiologic data, data indicative of physiological parameters, the determined physiologic parameters, among other information, such as bodyweight. In a number of embodiments, the physiologic parameters are not displayed to the user. For example, the physiologic parameters are sent to external circuitry for further processing. In various embodiments, the user-specific information may not include the physiologic parameters but may include suggestions for the user that are determined and/or based on the physiologic parameters, such as health advice. At block 128, the apparatus updates the memory circuit of the processing circuitry by storing the collected physiologic data and/or user data.
The scale can be used by multiple different users. The scale can recognize each of the respective user using scale-based biometrics. For example, the user display and the FUI (or other user interface, in various embodiments) are used to verify the user's identity. For instance, the processing circuitry validates the user data as concerning a user associated with a specific user profile using the data indicative of the user's identity. The validation, in some embodiments, includes comparing user data to a user profile. In various embodiments, the data indicative of the user’s identity is a user ID and/or is associated with the user ID (e.g., is mapped to and/or otherwise correlated to). In response to the identification, the processing circuitry outputs the identification to the output circuit for display on the user display. The FUI displays data to confirm identification of the user and, in response to a user input, outputs the confirmation to the processing circuitry to authorize identification of the user. For example, the FUI displays the identification of the user and asks the user to verify the identification. In response to the verification by the user by a foot-based user interaction with the FUI, the output circuit outputs the verification to the processing circuitry 104.

In various embodiments, the identification is based on a scale-obtained biometric. The scale-obtained biometric is learned by the scale, in some embodiments, during a registration (or initialization) mode of the scale. For example, in various embodiments, a user is correlated with a user profile stored on the scale and/or otherwise accessible by the scale. The user profile is set up during the registration mode and/or includes an indication of a scale-based biometric. For example, a user without a user profile set-up steps onto the scale. The scale is unable to identify the user using collected signals as the user does not have an indication of a scale-obtained biometric stored and/or accessible by the scale. The scale operates in a default mode by displaying the user's body mass and/or weight using the user interface (e.g., FUI) and does not output user data to any external circuitry. The scale, in various embodiments, displays a prompt (e.g., an icon) on the user interface (e.g., FUI) indicating the user can establish a user profile. In response to the user selecting the prompt, the scale, using the user interface, enters a registration mode. During the registration mode, the scale asks the users various questions, such as identification of external circuitry to send data to, identification information of the first user, and/or demographics of the user. The user provides inputs using the user interface to establish scale-based biometrics to enable one or more communication modes that are associated with the user profile. The scale further collects user data to identify the scale-based biometrics and stores an indication of the scale-based biometric in the user profile such that during subsequent measurements, the scale recognizes the user and authorizes a particular communication mode. Alternatively, the user
provides inputs using another device that is external to the scale and is in communication
with the scale (e.g., a cellphone).

In various embodiments, the scale is configured to collect data for two or more users
and correlates the user data with respective user profiles. As previously discussed, the scale
recognizes each of the two or more users based on a scale-based biometric. In various
embodiments, the user profiles are associated with a hierarchy of different levels of
biometrics that enable different data to be communicated and/or to different sources, as
discussed further herein.

The user profile stores historical user data, including generated cardio-related
physiologic data. Further, the user profile includes various stored user preferences. For
example, the user interface (e.g., FUI), in response to verification of the user's identity, is
revised based on user preferences of the user associated with the user profile. The user
preferences include text or image size, data to display using the user interface, commonly
access test or features, specific parameters to track, among other settings.

In a number of embodiments, the user interaction changes the view of the user
interface (e.g., the GUI and/or FUI). The change can include, for example, changing user
preferences stored in the user profile and/or based on user interaction. For example, the user
may be unable to read the data displayed using the FUI. The user, using their foot, revises
the size of the data. For example, the FUI displays an icon on the side of the user display
that the user can select to increase or decrease text or image size. The icon may include
a sliding bar that the user contacts with their foot and moves. Alternatively, the user can tap
their foot on the FUI to change the text or image size.

The font size and/or configuration, in various embodiments, of text and/or images
displayed using the FUI (or GUI) is automatically configured based on user demographic
information and/or the data to be displayed. In some embodiments, the scale includes a
display configuration filter (e.g., circuitry and/or computer readable medium) configured to
discern the data to display to the user. The display configuration filter discerns which
portions of the user data, clinical indications, and/or other information to display to the user
using the FUI of the scale based on various user demographic information (e.g., age, gender,
height, diagnosis) and the amount of data. For example, the data may include an amount of
data that if all the data is displayed on the FUI, the data is difficult for a person to read
and/or uses multiple display screens.

The display configuration filter discerns portions of the data to display using the FUI,
or otherwise provided using a different type of user interface, based on the data and the
demographic information, and discerns other portions of the data to display on another user device. The other user device is selected by the scale (e.g., the filter) based on various communications settings. The communication settings include settings such as user settings (e.g., the user identifying user devices to output data to), scale-based biometrics (e.g., user configures scale, or default settings, to output data to user devices in response to identifying scale-based biometrics), and/or proximity of the user device (e.g., the scale outputs data to the closest user device among a plurality of user devices and/or in response to the user device being within a threshold distance from the scale), among other settings. For example, the scale determines which portions of the information to output to the other particular user device based on user settings/communication authorization (e.g., what user devices are authorized by the user to receive particular user data from the scale), and proximity of the user device to the scale. The determination of which portions to output is based on what type of data is being displayed, how much data is available, and the various user demographic information (e.g., an eighteen year old is able to see better than a fifty year old).

In some specific embodiments, the scale operates in different modes of data security and communication, as further discussed herein. The different modes of data security and communication are enabled in response to biometrics identified by the user and using the user interface (e.g., FUI).

The scale can be used in different settings and/or modes, such as a consumer mode, a professional mode, and a combination mode. A consumer mode includes a scale as used and/or operated in a consumer setting, such as a dwelling. As a specific example, a scale is located in a dwelling with five different people. Each of the five different people use the scale, and three of the five people have previously provided inputs to initialize with the scale and set up user profiles.

In other instances, the scale is used in a professional setting, such as a medical office, and/or in a professional mode. A professional mode includes an operation of the scale as used and/or operated in a professional setting, such as a doctor’s office, exercise facility, nursing home, etc. In a professional mode, the scale is used by different users that may not be familiar with one another. The different users may have services with the professional to track and/or aggregate data from a user device and/or to provide health information. The user device is not integrated within the scale and can communicate with the scale via a wired or wireless connection. In some instances, a user can be provided additional health information as service while waiting for the professional, such as while waiting to see a doctor. The scale receives the additional health information from the external circuitry and either
displays the additional health information using a user interface of the scale and/or via direct communication (e.g., WiFi, Bluetooth, NFC) with a user device (e.g., cellphone, tablet) that is within a threshold distance of the scale. Similar to the consumer mode, the scale can selectively provide the services by verifying the identity of the user using a scale-based biometric. The identification can include a higher-level biometric and/or identification than the consumer mode. As a specific professional mode example, a scale is located at a doctor's office and is used to obtain data from multiple patients (e.g., 10 in a day, 500 in a year). When a patient checks-in, they stand on the scale and the scale-obtained data is output to external circuitry for document retention and/or other purposes. A subset (or all) of the patients have activated a service with doctor that corresponds with and/or includes providing additional health information while the user is waiting. For example, a user indicates an interest in learning more about atrial fibrillation (AFIB), which the scale outputs to external circuitry along with user data obtained by the scale. The external circuitry generates additional health information correlated with AFIB and the user data. For example, the additional health information includes various risk factors for AFIB and identifies lifestyle changes that can reduce the risk factors. The external circuitry communicates the additional health information to the scale via an Internet (or direct communication) connection and the scale outputs the additional health information to a cellphone of the user via an NFC or Bluetooth communication. The scale, in the professional mode, may be used to obtain data from more users than a scale used in a consumer setting.

The scale can also be in a combination consumer/professional mode. A combination consumer/professional mode includes a scale as used and/or operated in a consumer setting for purposes and/or uses by a professional, and/or in a professional setting for purposes and/or uses by the consumer (e.g., use by the consumer outside of the professional setting and/or in addition to). As a specific example, a scale is located at a user's dwelling and used by multiple family members. A first user of the family is diagnosed with a heart-related condition and the doctor may offer a service to review data from the scale (and optionally another user device) of the first user. When the other family members stand on the scale, the scale operates in the consumer mode. The other family members may or may not have the service activated for the doctor to review data and the scale operates via the consumer mode. When the first user that is diagnosed with heart-related condition stands on the scale, the scale recognizes the user and operates in a professional mode or a combination mode. For example, the scale outputs aggregated data from the scale to external circuitry that is accessible by the doctor of the first user.
Data provided to the user and/or the professional can default to be displayed on the user interface of the scale, the GUI of the user device, and/or a GUI of other external circuitry depending on the use of the scale. In a consumer mode and/or combination consumer/professional mode, data can default to display on the user interface of the scale.

The defaulted display of data can be revised by the user providing inputs to display the data on the GUI of a user device or a GUI of another external circuitry (e.g., a standalone CPU) and/or automatically by the scale based on past scale-based actions of the user. As a specific example, a first user provided a user input to the scale to display data on the GUI of the user device multiple times (e.g., more than a threshold number of times, such as five times). In response, the scale adjusts the defaulted display and output data to the GUI of the user device. The display on the user interface of the scale and/or GUI of the user device (or other external circuitry) can include an indication of available additional health information, requests for categories of interest, and/or the additional health information, among other displays. In a professional mode, the scale is not owned by the user. The user may be uninterested in synchronizing their user device with the professional's scale. The display may default to the GUI of the user device to display an option to synchronize, and/or to override the synchrony. Alternatively, the display may default to the user interface of the scale to display an option to synchronize and, responsive to user verification or authority to synchronize, defaults to display on the GUI of the user device. During the combination consumer/professional mode, portions of scale-obtained data for a particular user may default to display on external circuitry, such as a standalone or server CPU that is accessible by the professional.

FIG. 1c shows an example of process for displaying data using a FUI consistent with aspects of the present disclosure. The apparatus illustrated by FIG. 1b can include the apparatus, including the platform 101 and user display 102, as previously illustrated and discussed with regard to FIG. 1a. As illustrated, the apparatus includes a platform, a user display, data-procurement circuitry, and processing circuitry. The data-procurement circuitry includes force sensor, including circuitry, and a plurality of electrodes (e.g., the physiologic sensors) which are integrated with the data-procurement circuitry. The processing circuitry includes a CPU and a memory circuit with user-corresponding data stored in the memory circuit. As previously discussed, the user display displays a FUI within at least a portion of the platform.

The FUI, as previously described, allows for the user to interact with the scale and displays data, such as an alert of available data, to the user. For example, as illustrated by
FIG. IB, the scale at block 132 is in a reduced power-consumption mode of operation and is waiting for a user to stand on the platform. In various embodiments, in response to the user standing on and/or approaching the scale, the scale transitions from the reduced power-consumption mode of operation to at least one higher power-consumption mode of operation at block 133. The higher power-consumption mode can include activating the FUI. In some embodiments, the FUI is already activated during the reduced power-consumption mode of operation, but may be displaying a "screen saver." The activation of the FUI, as used herein, includes displaying the FUI including data through at least a portion of the platform whereon the user stands and/or is about to stand. The display, upon the transition, can be used to verify identity of the user and/or an associated user profile, and/or to identify various measurements, or features to perform. For example, the scale may be associated with a limited number of users (e.g., three people living in a home) and the display can include icons with each of the number of users.

Optionally, the display (which can be before or after collected signals) includes a list and/or icons containing the various measurements, features, or test to perform. The FUI, in some embodiments, displays a plurality of icons of a list that includes the plurality of measurements, test, and/or features. In response to user input to the FUI selecting one of the icons or item, the scale performs the selected measurement, test, or features. For example, in response to the user placing their foot on one of the plurality of measurements, tests, or features in the list, the scale performs the selection. In some related embodiments, the displayed measurements, tests, and/or features can be tailored to the specific user. The scale can identify the user (using signals collected from the user and/or in response to user input) and identifies recently selected measurements, test, and/or features and/or user preferences that include measurements, test, and/or features.

At block 134, the scale engages the user with electrical signals, using the data-procurement circuitry, and collects signals indicative of the user's identity and/or cardio-physiological measurements (e.g., physiologic data) while the user is standing on the platform. The processing circuitry, at block 124, processes the signals to generate cardio-related physiologic data manifested as user data. In various embodiments, prior to collecting the signals, the FUI is used to display an instruction to the user to hold still during the engagement of the user with the electrical signals and the collection of signals, as previously described in connection with FIGs. la- lb. The instruction can indicate to stay still until an alert is provided, which is provided after collecting the signals.
At block 136, the apparatus, using the processing circuitry, optionally confirms identification of the user when the user is standing on the platform. The identification can be based on the signals indicative of the user's identity, such as a biometric collected using the scale, and/or user data. For example, the processing circuitry compares the scale-obtained biometric to stored user-corresponding data to confirm identification of the user. In some embodiments, the FUI is used to additionally verify the identity using a display. For example, in response to the verification using the collected signals, user input is received using the FUI and from the user's foot. The FUI, in some embodiments, displays the identity determined using the collected signals and the user input verifies the identity is correct. Responsive the user input, the scale validates the user data, including data indicative of the user's identity and the generated cardio-related physiologic data, as concerning a specific user associated with a user profile. The FUI can display verification data to the user and in response to a user input to the scale can validate the user data. The validated user data, at block 137, is used to update the user profile. For example the user data is stored within the user profile.

At block 138, data is displayed using the FUI. For example, the user's weight is displayed to the user. Additionally, the generated cardio-related physiologic data and/or other health information can be displayed. The scale, in various embodiments, discems what data and/or amount of data to display. For example, the scale discems what data to display based on user demographic information, what type of data is being display, and/or user-specific use of the scale. User-specific use of the scale includes data such as frequency of use, time of use (e.g., time of day) features used and/or enabled, priority of user data, among other information. In specific aspects, the time of day can be useful for obtaining PWV and heart rate. For example, the scale records user data and can prompt the user at set times. In various embodiments, a subset of the data, such as a synopsis of the data is displayed using the FUI and an indication that further information is available on another electronic device. The full data is sent to the other electronic device, such as a smartphone or other standalone CPU, and displayed using the other electronic device's user display. In some embodiments, the user-specific use of the scale includes previous data that the user accessed and how the user viewed the data.

The scale can include a FUI or other user interface that has limited space. Based on the amount of data, the height of the user, and/or past user responses, the scale discerns whether to display the data on the FUI and/or output the data to another electronic device. For example, the scale displays a synopsis, a subset of the total data, and/or an indication of
a data on the user display of the scale which includes an icon for the user to select to view more information. In response to the user selecting the icon, the scale outputs the data to the other electronic device, such as the user's smartphone and/or displays the advertisement on the user display. Alternatively, in response to the user selecting the icon, the scale displays another one or more icons for the user to select which device to display the data on. Based on the user inputs to the FUI overtime, the scale automatically displays data based on how the user responds in the past and/or over time. For example, if the user continuously displays the data on their smartphone, the scale outputs the data to the user's smartphone. By contrast, if the user does not indicate an interest in particular data, such as advertisements, the scale does not display the advertisements. The scale displays or outputs the data in response to verifying a scale-based biometric, in various embodiments.

Priority of user data, as used herein, includes an importance of the user and/or the user data. In various embodiments, the importance of the user is based on parameter values identified and/or user goals, such as the user is an athlete and/or is using the scale to assist in training for an event (e.g., marathon) or is using the scale for other user goals (e.g., a weight loss program). Further, the importance of the user data is based on parameters values and/or user input data indicating a diagnosis of a condition or disease and/or a risk of the user having the condition or disease based on the scale-obtained data. For example, the scale-obtained data of a first user indicates that the user is overweight, recently had an increase in weight, and has a risk of having atrial fibrillation. The first user is identified as a user corresponding with priority user data. A second user of the scale has scale-obtained data indicating a decrease in recovery parameters (e.g., time to return to baseline parameters) and the user inputs an indication that they are training for a marathon. The second user is also identified as a user corresponding with priority user data. The scale displays indications to the user with the priority user data, in some embodiments, on how to use the scale to communicate the user data to external circuitry for further processing, correlation, and/or other features, such as social network connections. Further, the scale, in response to the priority, displays various feedback to the user, such as user-targeted advertisements and/or suggestions, directly on the FUI and/or another electronic device. In some embodiments, only users with priority user data have data output to the external circuitry to determine risks, although embodiments in accordance with the present disclosure are not so limited.

In various embodiments, the scale displays identification of other circuitry that the scale apparatus is configured to communicate with. The other circuitry may be identified by the output circuit and the FUI displays the identification. Responsive to an input from the
user's foot selecting one of the identified other circuitry (e.g., electronic device), user data is output to the selected other circuitry using the output circuit. The output may be, for example, only in response to verifying identification of the user, such as using a biometric obtained using the scale. In this manner, the user can output data to another device and can control the output to prevent accidental disclosure of personal data.

As the FUI includes a limited amount of space to display data, in various embodiments, the FUI displays portions and/or subsets of data using a color coding to abbreviate more complex information, such as cardiac-information. As an example, a green color indicates a good value, a yellow color indicates an okay value, and a red color indicates a bad value. Such values include physiologic parameters, weight, weight increase or decrease, recovery parameters, among other information. In a specific example, the FUI displays a simple display of "weight" with the color coding corresponding to the user's weight change. If the user has a goal to lose weight and has lost weight, the scale displays "weight" with a green coding. If the user has not lost weight or gained weight, the scale displays "weight" with a yellow coding. If the user gained weight, the scale displays "weight" with a red coding. A user without a weight loss goal (or with a muscle gain goal) may have different color codings. For example, if the user lost weight or has not lost weight, "weight" with a green coding is displayed. If the user gained an amount of weight that is below a threshold, "weight" with a yellow coding is displayed. If the user gained an amount of weight that is above the threshold, "weight" with a red coding is displayed.

The various thresholds, settings, color coding or goals can be set by the user and/or determined by the scale based on user input data. Further, multiple different data types with color codings are displayed simultaneously and/or sequentially, such as weight, body-mass-index, heart rate, heart age, PWV, PTT, among other parameters. The scale communicates the information with other electronic devices, including the color coding and additional information about the values and color coding. In a number of embodiments, the additional information is displayed on the other device using the same color coding so that the data corresponds between the scale and other devices.

In accordance with a number of embodiments, the scale performs a question and answer session. For example, the FUI can display a plurality of questions using the user display. Using user interaction by the user's foot, the FUI receives user inputs (e.g., answers) to each of the questions and, using the output circuit, stores the user inputs within a user profile associated with the user. For example, the FUI provides a number of questions in a question and answer session to identify symptoms, health or fitness goals, categories of
interest, demographic information, and/or other data from the user. As previously described, the scale can (alternatively and/or in addition to a FUI or GUI) have a voice input/output circuitry that can obtain user's answers to questions via voice comments and inputs user information in response (e.g., a speaker component to capture voice sounds from the user and processing circuitry to recognize the voice commands and/or speech).

In various embodiments, the scale and/or other external circuitry further processes the user data. For example, the scale and/or external circuitry or the scale determines additional health data such as at least one physiologic parameter, clinical indications, and/or additional health information using the user data. Clinical indication data is data indicative of physical state of the user, such as a disease, disorder, and/or risk for a disease or disorder and can be used for assessment of a condition or treatment of the user. The clinical indication data, in various embodiments, includes information that is regulated by a government agency, such as the Food and Drug Administration (FDA), and/or otherwise requires a prescription from a physician for the user to obtain. Example clinical indication data includes physiological parameters, risk factors, and/or other indicators that the user has a condition or could use a treatment. For example, the user can be correlated with the condition or treatment by comparing the cardio-related data to reference information. The reference information can include a range of values of the user data (e.g., physiologic data) for other users having the corresponding condition or treatment indicators. The other user are of a demographic background of the user, such that the reference information includes statistical data of a sample census. For example, the clinical indication data can be derived, that is indicative of a physiologic status of the user, and for assessment of a condition or treatment of the user and using the cardio-related data and/or historical cardio-related data within a user profile corresponding with the user. The condition or treatment can correspond to the physiologic status.

The additional health information, includes derived measurements and/or generic health information that may be "non-regulated" by agencies, such as the FDA. In various embodiments, the additional health information can be indicative of the clinical indication data and/or can correlate to categories of interest provided by the user. For example, the additional health information can include non-prescription health information such as generic health information including disease or disorder symptoms, risk, or advice, generic health information related to categories of interest provided by the user, and/or generic health information that correlated to the cardio-related data. In some embodiments, the additional health information is based on historical data. For example, the additional health
information (e.g., a table) provided can include a correlation to the categories of interest and the user data over time. The categories of interest, in number of embodiments, include demographics of interest, symptoms of interest, disorders of interest, diseases of interest, drugs of interest, treatments of interest, etc.

In various related embodiments, the scale is used to perform a question and answer session. For example, the scale can display questions using the user display 102 and FUI (or other type of user interface). The user can answer the questions by the FUI displaying preset answers as icons or in a list and/or using a virtual keyboard displayed using the FUI. The questions are used to identify symptoms and/or reasons why the user is visiting the physician. The answers input by the user are used to update the user profile. The update, for instance, includes populating the data in the specific user profile. In various embodiments, the scale and/or other external circuitry uses the input data to determine clinical indication data and/or to further refine stored clinical indication data, as discussed further herein.

As a specific embodiment, the scale engages the user with electrical signals and generates cardio-related physiologic data therefrom. The cardio-related physiologic data indicates that the user may have a heart condition. In response, the FUI displays a plurality of questions to the user. The plurality of questions include various symptoms associated with the heart condition. For each question, the FUI displays a set of icons or a list that contain answers to the questions. One of the icons or items in the list includes "answer not displayed". If the user selects "answer not displayed" with their foot, a virtual keyboard is displayed for the user to type their answer using their foot. In response to the user providing an answer to the questions, the answers are stored within the user profile.

In various embodiments, the categories of interest include a set of demographics, disorders, diseases, and/or symptom, drugs, treatments that the user is interested, and/or other topics. In some embodiments, the scale provides the user input to external circuitry and the external circuitry derives additional health information for the user. The additional health information can include a table that corresponds to the categories of interest and/or corresponds to the physiological parameter and/or clinical indications determined without providing any specific values and/or indication related to the physiological parameter. The user is provided the additional health information by the external circuitry outputting the information to the scale and/or another user-device, and the scale and/or other user-device displays the information. The information can printed by the user. In various related-aspects, the scale using the processing circuitry 104 generates the additional health information instead of the external circuitry.
In some instances, a user may not realize they are having a symptom and may not input the symptom unless directly ask. As a specific example, the user may be having shortness of breath when exercising or difficulty sleeping. The user may not identity that the shortness of breath or difficulty sleeping is a symptom for a condition or may forget that they are experiencing such a symptom. In response to identifying the user may have condition that is associated with the symptom of shortness of breath or difficulty sleeping, the scale asks the user if the user is experiencing such a symptom (without directly identifying this as a symptom) and can store the response for use by a physician or to verify the clinical indication data.

The additional health information can be generated by comparing and/or correlating the categories of interest to raw data obtained by the data-procurement circuitry or the user data to historical user data captured over a period of time. In various embodiments, the correlation/comparison include comparing statistical data of a sample census pertinent to the categories of interest and the at least one physiological parameter. The statistical data of a sample census includes data of other users that are correlated to the categories of interest. In such instances, the additional health information includes a comparison of data measured while the user is standing on the platform to sample census data. In other related embodiments, the correlation/comparison includes comparing statistical data of a sample census pertinent to the categories of interest and values of the least one physiological parameter of the sample census. In such instances, the additional health information includes average physiological parameter values of the sample census that is set by the user, via the categories of interest, and may not include actual values corresponding to the user.

For example, if the categories of interest are demographic categories, the additional health information can include various physiological parameter values of average users in the demographic categories and/or values of average users with a clinical indication that correlates to a physiological parameter of the user. Alternatively and/or in addition, the additional health information can include general medical insights related to the categories of interest. For example, "Did you know if you are over the age of 55 and have gained 15 pounds, you are at risk for a particular disease/disorder?" The scale can ask the user if the user would like to include this factor or disease in their categories of interest to dynamically update the categories of interest of the user. The physician of the user can be notified of the user's interest and/or can be provided a copy of the additional health information. For example, the physician may go over the additional health information with the user during an appointment to provide further clarity.
Various categories of interest, in accordance with the present disclosure, include demographics of the user, disorders, diseases, symptoms, prescription or non-prescription drugs, treatments, past medical history, family medical history, genetics, life style (e.g., exercise habits, eating habits, work environment), among other categories and combinations thereof. In a number of embodiments, various physiological factors can be an indicator for a disease and/or disorder. For example, an increase in weight, along with other factors, can indicate an increased risk of atrial fibrillation. Further, atrial fibrillation is more common in men. However, symptoms of various disorders or disease can be different depending on categories of interest (e.g., atrial fibrillation symptoms can be different between men and women). For example, in women, systolic blood pressure is associated with atrial fibrillation. In other instances, sleep apnea may be assessed via an ECG and can be correlated to weight of the user. Furthermore, various cardiac conditions can be assessed using an ECG. For example, atrial fibrillation can be characterized and/or identified in response to a user having indistinguishable or fibrillating p-waves, and indistinguishable baseline/inconsistent beat fluctuations. Atrial flutter, by contrast, can be characterized by having indistinguishable p-wave, variable heart rate, having QRS complexes, and a generally regular rhythm. Ventricular tachycardia (VT) can be characterized by a rate of greater than 120 beats per minute, and short or broad QRS complexes (depending on the type of VT). Atrio-Ventricular (AV) block can be characterized by PR intervals that are greater than normal (e.g., a normal range for an adult is generally 0.12 to 0.20 seconds), normal-waves, QRS complexes can be normal or prolong shaped, and the pulse can be regular (but slow at 20-40 beats per minute). For more specific and general information regarding atrial fibrillation and sleep apnea, reference is made herein to https://www.clevelandclinicmeded.com/medicalpubs/diseasemanagement/cardiology/atrial-fibrillation/ and http://circ.ahajournals.org/content/118/10/1080.full, which are fully incorporated herein for their specific and general teachings. Further, other data and demographics that are known and/or developed can be added and used to derive additional health information.

For example, the categories of interest for a particular user can include a change in weight, age 45-55, and female. The scale obtains raw data using the data-procurement circuitry and the categories of interest from the user using the FUI and/or a GUI of another user device in communication with the scale. The scale outputs the raw data and categories of interest to the external circuitry and the external circuitry correlates the categories of interest to the raw data and derives additional health information therefrom. The external
circuitry, over time, can collect and correlate the categories of interest of the user and data from the data-procurement circuitry using the specific patient profile of the user. The external circuitry, in various embodiments, sends the data to a physician and/or additional health information to the user (to print and/or otherwise view).

FIG. 1d shows an example of various displays of data using a FUI of a scale consistent with aspects of the present disclosure. More specifically, FIG. 1d shows an isometric view of a multifunction scale 100 with a large-area display (beneath platform 115). In this particular embodiment, the scale 100 has a primarily rectangular shape with a support structure 110 around the perimeter of the scale that transfers the weight of a user on the platform 15 through load cells in each corner of the support structure 110. In other implementations, the scale has rounded corners, is elliptical or shaped to be circular or circularly elongated. In embodiments in which the shape of the scale does not indicate the intended orientation of the user's feet (e.g., circular or circularly elongated), the scale recognizes (as described herein) where the feet are located and orients the information to be displayed accordingly as though the intended orientation of the user's feet is however/wherever the user's feet are oriented on the scale.

It is to be understood that the aesthetic design of the scale 100 may take on a plurality of shapes and sizes (based on the needs of the users, e.g., weight requirements, their aesthetic preferences, etc.). A feature of the multifunction scale 110 is the large-area display that makes up the majority of the top surface of the scale. The display may present the user with a myriad of information, such as the results of physiological and biometric test results conducted by the scale, entertainment information (while the scale is conducting tests or a weight measurement), and aesthetic screen savers.

As illustrated by FIG. 1d, the user interact with the scale using a FUI displayed on the user display 115. For example, the user can provide various inputs using the FUI using their foot. In some embodiments, the user selects an icon or item from a list to cause the scale to perform a particular features, measurement, and/or test. The FUI, in response to various measurements, displays a user weight, other cardio-related data, and/or other health data and/or non-health data. Further, the FUI displays a variety of questions and the user can answer using foot-based user inputs. Such questions can be used to identity symptoms, goals, and/or other information from the user. The user, in some embodiments, provides inputs via their foot contacting a virtual keyboard display using the FUI. Furthermore, the FUI can display other circuitry that the scale can communicate with. In response to user
input selecting one of the other circuitry, data is output from the scale to the other circuitry and/or from the other circuitry to the scale.

In accordance with various embodiments, access to data displayed on the FUI and/or an external GUI can optionally be controlled. For example, the scale and/or the external circuitry optionally controls access to the user profile. The controlled access includes not allowing access to portions of the user data that is prescription level data and/or otherwise regulated by a government entity until the data is reviewed by a licensed physician and/or a prescription for the data is received.

The controlled access, in accordance with a number of embodiments, includes a filter associated with the external circuitry (and/or the scale). For example, the user is not allowed to access the scale-obtained data that includes health information regulated by a government agency by way of a filter that disables scale-obtained physiological data, where such (FDA regulated) scale-obtained physiological data is blocked when it correlates with cardio-based diagnostic data stored in the user profile, whether obtained directly by the scale or provide externally by a physician and/or third-party device or entity. The filter, as used herein, includes circuitry and/or computer-readable medium (e.g., a module) that blocks access to the user if the data is scale-obtained physiological data and the user has not diagnosed or otherwise prescribed access to the data, for example. Scale-obtained physiological data includes the clinical indications determined using the scale-obtained data. For example, the filter includes and/or accesses a list of the scale-obtained physiological data that includes physiologic parameters (such as PWV, BCG, respiration, arterial stiffness, cardiac output, pre-ejection period, stroke volume), diagnosis, conditions, risk factors, among other health information that is regulated by the FDA. In some embodiments, the filter includes an AND gate, such as a three-way AND gate that blocks access to the data if the user wants access to the data, the data is scale-obtained physiological data, and the user is not diagnosed with a condition associated with the data or prescribed to access the data.

In various embodiments, the filter is achievable as follows. The user requests access to data in the profile. A determination is made as to whether the requested data falls into the category of scale-obtained physiological data. In response to determining the requested data is not scale-obtained physiological data, the user is provided access to the data. In response to determining the requested data is scale-obtained physiological data, a determination is made as to whether the user has been diagnosed with a condition associated with the requested data and/or if the user has been prescribed access to the requested data by a physician. If the user has not been diagnosed or prescribed access, the user is not allowed to
access the requested data. In response to determining the user has been diagnosed or prescribed access, the user is provided access to the requested data. A condition associated with the request data includes, for instance, a condition that results in the scale-obtained physiological data and/or the scale-obtained physiological data is otherwise indicative of the condition. The diagnosis is obtained by the scale (e.g., stored in a user profile), and/or provided externally by a physician and/or third-party device/entity. For example, the profile is associated with a diagnosis and used to access the requested data.

In various embodiments, the user data is collected and determined but the user is not allowed access to the features (and the related information is not displayed/displayable to the user), such as access to the user data or service related to the user data until government clearance is obtained. For example, the scale collects and stores the user data but does not display or otherwise allow the user access to the user data until clearance is obtained for each feature, which retrospectively enables the feature and/or service, at which time the features are accessible and the related information is displayed/displayable to the user (the display is unblocked thereby retrospectively enabling access). Alternatively and/or in addition, the feature and/or service is not provided until a weighted value is received (e.g., payment).

In other embodiments, the filter is achievable as follows. The user requests access to data in the profile. A determination is made as to whether the user has been diagnosed with a condition associated with the requested data and/or if the user has been prescribed access to the requested data by a physician. In response to determining the user has been diagnosed or prescribed access, the user is provided access to the requested data. If the user has not been diagnosed or prescribed access, a determination is made as to whether the requested data falls into the category of scale-obtained physiological data. In response to determining the requested data is not scale-obtained physiological data, the user is provided access to the data. In response to determining the requested data is scale-obtained physiological data, the user is not allowed to access the requested data. Further, embodiments in accordance with the present disclosure are not limited to the examples provided and the filter blocks access to the requested data in a variety of manners. For example, the filter allows and/or blocks access to requested data based on a determination of physician approval (e.g., diagnosis or prescription) and categorization of the requested data as scale-obtained physiological data.

In various embodiments, the clinical indication is provided as an additional service. For example, the user can obtain the information and/or have their physician interpret the information for a service fee. The service fee can include a one-time fee for a single interpretation, a monthly or yearly service fee, and/or can be a portion of a healthcare
insurance fee (e.g., the user can purchase a health care plan that includes the service). In such embodiments, the physician corresponding to the user can access the clinical indications and/or other user data in response to verification that the user has enabled the service and verification of the identity of the physician.

FIG. 1e shows an example process for titrating for a condition and/or treatment of a user using scale-obtained data, consistent with various aspects of the present disclosure. The scale as illustrated by FIG. 1e includes the scale illustrated by FIG. 1a and/or FIG. 1b. During the processing of signals obtained by the electrodes and forces sensors, the scale can be in a comparison state. In a number of embodiments, the processing circuitry includes logic, such as the comparison state logic, that is executed to perform one or more of the operations and/or activities regarding the derivation data, and/or assessment.

The comparison state logic can be used to assess a condition or treatment correspond to the user. The comparison state, in accordance with a number of embodiments, includes identifying the user is standing on the platform, confirming identification of the user, obtaining user-corresponding data (e.g., user-corresponding data database 103) from the user and/or memory circuit, collecting physiologic parameter data (e.g., the physiologic data database 107), processing the user-corresponding data with the physiologic parameter data, and assessing the user for a condition or treatment. The processing can include correlating the collected physiologic data with user-corresponding data. The processing circuitry (e.g., the cardio-based physiologic logic circuit) derives and outputs, therefrom, derivation data indicative of a physiologic status of the user for assessment of a condition or treatment of the user that corresponds with the physiologic status. A physiologic status, as used herein, is status of cardio-health of the user, and can include risk factors and/or indicators.

Using the signals obtain, the processing circuit derives derivation data. Example derivation data includes time-stamped raw signals obtained using the electrodes, physiological parameters determined using the physiological parameter data, and/or time-stamped physiological parameters, among other data that is correlated with various user-corresponding data. The processing circuitry (and/or external circuitry that received the derivation data) assesses the user for a condition or treatment, in various embodiments. For example, the processing circuit correlates the user with the condition or treatment by comparing the physiological parameter data and/or the additional physiological parameter data of the user to reference information. Reference information includes a range of values of the physiological parameter data for other users having corresponding condition or treatment indicators and wherein the other users are of a demographic background of the
user. A demographic background includes similar age, gender, exercise habits, weight, height, diet, cultural-norm, etc., and/or various combinations thereof. Example reference information includes a lookup table, rules, an index, a graph, a plurality of operations, and a combination thereof. The indicators, in some embodiments, include values of the physiological parameter, diagnosis, changes in demographic information (change in weight), etc.

The respective reference information can be determined and/or identified using user-corresponding data that is indicative of the demographic background of the user. For example, the external circuitry and/or the processing circuitry of the scale include or has access to a database with a plurality of reference information. The user data, such as the data processed with the physiologic data and/or including the derivation data, can be used to select and/or determine the respective reference information by identifying the demographic background of the user (e.g., and identifying reference information using the demographic background and associated with physiological parameter data). In some embodiments, the external circuitry receives the user-corresponding data from the processing circuitry, from the user, and/or from another circuitry corresponding to the user (e.g., the user's mobile cellular telephone).

As a specific example, the correlation of the user with the condition or treatment includes using a PWV of the user as an indicator for arterial stiffness by referring to the reference information that reveals an appropriate range of arterial stiffness for other users having corresponding arterial-stiffness indicators. Another specific example includes using a PWV of the user as an indicator for fluid retention levels by referring to the reference table that reveals an appropriate range of fluid retention level for other users having corresponding fluid retention level indicators.

In some embodiments, the scale is used as a feedback for prescription drug titration. For example, the output derivation data can include physiological parameters related to a symptom the user is being treated for with a prescription drug or side effects of the prescription drug. Drug titration can include identifying a dose (or amount) of the drug that controls or effects optimization of symptoms and side effect minimization. For example, the dosage can be controlled to effect or mitigate symptoms with the fewest side effects. In some embodiments, drug titration can consider dosage that controls or mitigate symptoms with the fewest side effects. Using the output derivation data, the scale or external circuitry determines an adjusted dose for the prescription drug, as described further herein.
For example, a user can be given an initial dose of a prescription drug and various physiologic parameters are tracked over a period of time using the scale. Prior to the initial dose, the scale tracks the same physiological parameter to establish a pre-drug baseline. The user stands on the scale periodically (e.g., at the same time in the morning, multiple times throughout the day, among other times) and the scale measures physiologic data. The scale may prompt the user with audio from the scale and/or via a paired cellphone or other user device (e.g., via audio, an alert, a text or email) at periodic times to remind the user to stand on the scale. The user may stand on the scale hourly to determine the effect of the drug over time. For instance, the prescription drug dose may be effective during the first three hours and become ineffective after. Such information can be useful to determine how often to give the user the prescription drug. Such tracked physiologic parameters can include weight, PWV, heartrate, BCG, tremors, balance, respiratory, among other parameters. The tracked physiological parameters are used to determine symptoms the user is experiencing and/or side effects. The dosage can be adjusted, depending on the results, and the same physiologic parameters can be tracked to determine if the adjusted dosage is better (controls symptoms or mitigates side effects) than the initial dosage. For example, if the initial dose indicates the user is experiencing the symptoms, the dose is increased and the physiological parameters are measured to determine if the increase dosage is controlling the symptoms and/or causing side effects. The scale can used as a feedback to determine the dose for the user that controls or mitigates symptoms with the fewest side effects.

In a number of embodiments, the user (e.g., a patient) may adjust the dose or provide a recommendation to adjust the dosage. The user may be experiencing unwanted side effects or unwanted symptoms (or signs) and provides the recommendation or adjustment based on the same. As a specific example, a user with Parkinson may adjust the dosage to control Parkinson tremor.

Although the present examples embodiments provided above are in reference to processing circuitry of the scale performing the assessment, embodiments in accordance with the present disclosure are not so limited. For example, the external circuitry can determine the condition or treatment on based on the user-corresponding data and/or physiologic parameter data obtained while the user is standing on the platform. Specifically, the external circuitry can determine the physiologic parameter data of the user using the derivation data and correlate the user with a condition or treatment by comparing the physiologic parameter data of the user to reference information. Further, in such
embodiments, the external circuitry optionally determines the reference information from a plurality of reference information using the user-corresponding data.

As a specific example, during the comparison, the apparatus at block 139 waits for a user to stand on the platform apparatus. User-corresponding data (e.g., the user-corresponding data database 103) can be input and/or received prior to the user standing on the platform apparatus and/or in response to. In response to the user standing on the apparatus, the apparatus obtains the physiologic parameter data (e.g., the physiologic data database).

The processing circuitry 104, at block 124, processes the user-corresponding data with the physiologic data, and derives and outputs therefrom derivation data. The output can be to the external circuitry and/or to the memory circuit of the processing circuitry 104. The derivation data is indicative of a physiological status of the user. In various embodiments, the processing includes adding (and later storing) data with a time stamp indicating a time at about when the physiologic parameter data is obtained.

As illustrated, at block 145, the derivation data and/or additional physiologic data determined is compared to reference information. The comparison, as previous discussed, can occur using the processing circuitry and/or external circuitry. Further, in response to the comparison, assessment data is generated and output that is indicative of the condition or treatment at 147. The output can be to the external circuitry, the memory circuit of the processing circuitry, and/or a memory circuit of the external circuitry for later access and/or further assessment. In various embodiments, the condition and/or treatment is used to update the memory circuit of the processing circuitry at 149. The update can include an indication of the treatment or condition, or symptoms or side effects, which may be displayed to the user on the user display, and/or generic information or advice to provide the user that is indicative of a person with the physiologic status corresponding to the treatment or condition.

In various embodiments, based on the comparison of the user data to the reference information, the scale and/or external circuitry can determine various advice. Such advice can include suggested treatments, prescriptions, and life-style changes (e.g., diet, exercise, sleeping habits). The advice may be provided to the user and/or stored. For example, in some embodiments, the advice may be provided to a physician associated with the user for further medical assessment and for potential treatment purposes.

In various embodiment, the comparison state can include repeated acts of processing the user-corresponding data and physiologic parameter data. For example, the processing
circuity of the scale, as discussed above, can process the user-corresponding data and store, in response to the derived derivation data, additional data with a time stamp indicating a time at about when the physiological parameter data is obtained. Further, the processing circuitry repeats the acts of processing the user-corresponding data and storing, in response to the derived derivation data at another subsequent time, and therefrom generate a refined set of derived derivation data to further supplement the user-corresponding data with information corresponding to the physiologic parameter data. Alternatively and/or in addition, the processing circuitry can determine the condition or treatment of the user based on at least one of an updated measurement associated with the physiologic data obtained while the user is standing on the platform, wherein the updated measurement is updated relative to a previous measurement corresponding to and/or stored with the user-corresponding data.

FIG. If shows an example process for titrating a prescription drug, consistent with various aspects of the present disclosure. Drug titration includes or refers to a process of identifying a dose (e.g., amount) and/or type of drug that controls or effects optimization of symptoms with side-effect minimization. In specific embodiments, the drug titration can be used to mitigate symptoms (or signs) for a user while minimizing or controlling side-effects. In some embodiments, the apparatus includes a scale 127 and external circuitry 125. The scale 127 and external circuitry 125 can be used to perform drug titration based on and/or considering a dose of the drug that controls or mitigates symptoms with the fewest side effects. A symptom (e.g., felt or observed by the user) includes or refers to a subjective or objective sign or evidence of a disease or health condition. Example symptoms include anxiety, lower back pain, fatigue, skin rash, headache, blood cell counts, blood pressure, fever, weight loss, clubbing of fingers, bruising, skin color (e.g., yellowing of skin), anemic, among others. A side effect includes or refers to a secondary or peripheral effect of a drug.

Side effects can be adverse or an undesirable secondary effect of a drug and/or treatment. Example side effects include fatigue, vomiting, decreased blood counts, hair loss, mouth sores, etc. Side effects can be mitigated or avoided by adjusting the dosage of the drug, changing drugs, adding a secondary drug to control or mitigate the side effects, dietary and/or other lifestyle changes, among other changes. The scale 127 is used to provide feedback to the external circuitry 125 for prescription drug titration.

As illustrated by FIG. If, the user is given an initial dose of a prescription drug at 128. The initial dose can be set by a physician and based on demographics of the user (e.g., user weight, sex, height, age). Prior to the initial dose and/or prior to taking the initial dose, the scale is used to obtain pre-drug baseline values. For example, the scale monitors various
physiological parameters to establish the pre-drug baselines. In response to the initial dose, the scale 127 is used to monitor various physiologic parameters, and other data, over a period of time at 151. The scale 127 can be located at a dwelling of the user and/or at another location that the user can periodically access. Such tracked physiological parameters can include weight, PWV, heart rate, BCG, tremors, balance, respiratory, among other parameters. Using the monitored physiologic data, the scale 127 can derive derivation data at 152. The derivation data is indicative of a physiological status of the user for assessment of a condition or treatment of the user that corresponds with the physiologic status. A physiologic status is or refers to a status of cardio-health of the user, and can include risk factors and/or indicators. In various embodiments, the scale 127 obtains the user-corresponding data by querying the user using a user interface of the scale 127 and/or an external user interface (e.g., a GUI of another device) that is in communication with the scale 127. For example, the output derivation data can include physiological parameters related to a symptom the user is being treated for with a prescription drug or side effects of the prescription drug.

As previously discussed, drug titration includes identifying a dose (or amount) of the drug that controls or mitigate symptoms for a user. The scale 127 outputs the physiologic data and/or derivation data to external circuitry 125, at 153. The external circuitry 125, using reference information, identifies if the user is experiencing symptoms at 154. The identification can include identifying particular symptoms and/or comparing to a threshold and can be based on the pre-drug baseline parameters. For example, certain medical conditions and/or diseases are associated with causing headaches and stomachaches. The scale queries the user to identify if the user is experiencing headaches and/or stomachaches. In response to the user indicating they are experience one or both symptoms, the scale can (optionally) query the user to identify a rating (e.g., 1-10, with 1 being a low value and 10 being high) indicative of the severity of the symptoms. In other embodiments, the symptoms are a part of the derivation data. For example, the physiologic data may indicate that the user is shaking (e.g., has higher balance movement and/or tremors as compared to pre-drug baseline balance movement and/or tremors) and/or has an increased heart rate (as compared to pre-drug baseline heart rate). A symptom of the medical condition and/or disease may include tremors and/or causes heart issues. The scale may be used to verify the symptom by querying the user. In response to determining the user is experiencing symptoms, the external circuitry provides a message to adjust the dosage, at 156. The message can be provided via a portal that is accessible by the physician and/or other healthcare staff. The
adjustment can include a suggestion to increase the dosage and/or change prescriptions to a new prescription drug. Although not illustrated, the scale 127 may continue to monitor after the provided message. For example, a physician may view the message and, in response, contact the user to adjust the dosage. In other embodiments, the user may contact the physician and/or output a message suggesting to adjust the dosage to the physician, as previously described.

In response to determining the user is not experiencing symptoms (and/or experiencing below a threshold value) and/or after providing a message to adjust the dosage (at 156), the external circuitry 125 may determine if the user is experiencing side-effects at 157. The identification can include identifying particular side-effects and/or comparing the experience of the side-effect to a threshold. For example, certain medication are associated with causing headaches and stomachaches. The scale queries the user to identify if the user is experiencing headaches and/or stomachaches. In response to the user indicating they are experience one or both symptoms, the scale can (optionally) query the user to identify a rating (e.g., 1-10, with 1 being a low value and 10 being high) indicative of the severity of the side effect. In other embodiments, the presents of the side effect is a part of the derivation data. For example, the physiologic data may indicate that the user is shaking (e.g., has higher balance movement and/or tremors) and/or has an increased heart rate. A side effect of the drug may include tremors and causes heart issues. The scale 127 may be used to verify the side effect by querying the user. In response to determining the user is experiencing side effect, the external circuitry provides a message to adjust the dosage, at 158, as previously described. The adjustment can include a suggestion to decrease the dosage, change prescriptions to anew prescription drug, and/or add a secondary prescription to control and/or mitigate the side effects.

In response to determining the derivation data is indicative of the user not experiencing side effects and/or experiencing side effects below a threshold, the external circuitry 125 can output a message, as feedback, to the scale 127 to query the user for potential side effects and/or a severity of the side effects at 159. As described above, some side effects may be subjective and/or may otherwise not be measured using the scale 127. Using the headaches and/or stomachaches as an example, physiological data obtained by the scale (alone) does not indicate the present of the side effect. The external circuitry 125 may include or otherwise have access to a database containing reference information, which includes expected side effects of drugs. The scale 127 is used to query the user to identify the presents or not of the side effect and/or to qualify the severity of the side effect. The
scale 127 outputs the user's responses to the query to the external circuitry 125 and the external circuitry 125, at 161, can again determine if the user is experiencing side effects and/or if the experience of one or more side effects is above a threshold. In response, at 158 and as described above, the external circuitry provides a message to adjust the dosage. In response to the adjustment and/or no identified side effects (or below threshold level), the scale 127 continues to monitor the user over time.

Although the present example illustrates titration of a single prescription drug, in various embodiments, the process and apparatus can be used to titrate a plurality of prescription drugs and/or identify side effects due to drug interactions between two or more of the plurality of drugs. For example, certain diseases and/or health conditions can require a user to be prescribed multiple drugs. As a particular example, a user may have a heart condition and be on dialysis. The drugs used for dialysis may impact the user's heart and/or vice versa, and/or the combination may cause new side effects, such as confusion and disorientation. The apparatus and process described can be used to titrate multiple prescription drugs and potential identifying interactions between respective drugs. In various embodiments, the external circuitry can be used for research purposes such as to identify new side effects of one more drugs and/or between multiple drugs. Such side effects may not be detrimental to a user's health and can be used to identify new uses for drugs. For example, a first drug that is used for the above-describe heart condition may have a beneficial impacts on the user's kidney functions (e.g., dialysis related).

FIG. 1g shows an example process for authorizing communication between a scale and another device, consistent with various aspects of the present disclosure. The scale can include the scale as previously described in connection with FIG. 1a, and including the processing circuitry 104. The scale can communicate with other devices, such as a remote user-physiologic device 109. The scale and remote user-physiologic device 109, in various embodiments, communicate various cardio-related data in response to activation of communication using a dual-authorization. The dual-authorization includes a scale-based biometric and a remote user-physiologic device-based authorization data that both are validated as corresponding to the user. The dual-authorization increases security of sensitive user data and prevent unintended disclosure as compared to a single authorization.

As previously described, the processing circuitry 104 of the scale collects physiologic data, which can be stored as user data in a user profile corresponding to a particular user. The scale recognizes the particular user, and respective user profile, in various embodiments using data indicative of the user identity that is collected while the user
is standing on the platform of the scale. The data indicative of the identity of the user includes, in various embodiments, user-corresponding data, biometric data obtained using the electrodes and/or force sensor circuitry, voice recognition data, images of the user, input from a user's device, and/or a combination thereof and as discussed in further detail herein. The user profile includes scale-obtained data and user-corresponding data. The user-corresponding data includes information about the user (that is or is not obtained using the physiologic sensors) such as demographic information or historical information.

In specific embodiments, the processing circuitry 104 generates data indicative of the identity of the user, such as a scale-based biometric, a user ID and/or other user identification metadata. The user ID is identified, for example, in response to confirming identification of the user using the collected signals indicative of the user's identity (e.g., a scale-based biometric). Specifically, the processing circuitry 104 can identify a scale-based biometric of the user using the collected signals. For example, the scale-based biometric includes foot length, foot width, weight, voice recognition, facial recognition, toe print, and a combination thereof. In various embodiments, the scale-based biometric corresponds to a user ID and is used to verify identity of the user. Using the scale-based biometric, the user data is validated as concerning the user associated with the scale-based biometric. The user data includes data indicative of the user's identity and the generated physiologic data.

The remote user-physiologic device 109, as illustrated, is not integrated within the scale and, in various embodiments, includes a cellphone, a smartwatch, other smart devices, a tablet, a (photo) plethysmogram a two terminal ECG sensor, and a combination thereof. The remote user-physiologic device 109 includes sensor circuitry, processing circuitry 120, and an output circuit. The remote user-physiologic device 109 is configured to collect various signals. For example, the remote user-physiologic device 109 collects signals indicative of the user's identity. The collected signals indicative of the user's identity include the authorization data to be sent to the scale to authorize communication. The remote user-physiologic device 109 can identify the authorization data of the user using the collected signals indicative of the user's identity and, therefrom, validate the collected signals as concerning the user associated with the authorization data and/or a user profile.

Example authorization data includes data selected from the group consisting of a password, a passcode, a biometric, a cellphone ID, and a combination thereof. A remote user-physiologic device-based biometric, in various embodiments, includes biometrics selected from the group consisting of: a fingerprint, voice recognition, facial recognition, DNA, iris recognition, typing rhythm, and a combination thereof, in various embodiments.
Responsive to collecting the authorization data and/or verifying the authorization data as corresponding to the user, the remote user-physiologic device outputs the authorization data to the scale. The authorization data is collected, in various embodiments, prior to, during, and/or after, the scale collects various signals.

In various specific embodiments, the authorization of both devices includes biometrics of the user. For example, the scale-based biometric includes foot length, foot width, weight, voice recognition, facial recognition, toe print, and a combination thereof. The remote user-physiologic device-based biometric includes a finger print, voice recognition, facial recognition, DNA, iris recognition, typing rhythm, and a combination thereof. Alternatively and/or in addition, the authorization data from the remote user-physiologic device includes a password or other passcode, a device ID, and/or a combination of a biometric and a password, passcode, or device ID.

The scale can receives the authorization data and, in response to both the authorization data and the scale-based biometric corresponding to the user, activates communication between the scale and the remote user-physiologic device. For example, the scale includes communication activation circuitry to activate the communication. The communication activation circuitry, in some embodiments, includes an AND gate to activate the communication in response to receiving both the identified scale-based biometric and the authorization data that correspond to the same user. Although embodiments are not so limited and the communication activation circuitry can include various circuit components and/or processing circuitry to activate the communication and/or verify both the scale-based biometric and the authorization data correspond to the specific user.

In response to the activation, an output circuit of the scale can send user data to the remote user-physiologic device and/or an output circuit of the remote user-physiologic device 109 can send data to the scale. For example, the output circuit 106 receives the user data from the processing circuitry 104 and, in response to the user data and the activation of the communication, sends the user data to the remote user-physiologic device. In various embodiments, the output circuit 106 displays on the user display 102 the user's weight and the data indicative of the user's identity and/or the generated cardio-related physiologic data corresponding the collected signals. Alternatively and/or in addition, the remote user-physiologic device, including an output circuit, sends signals indicative of cardio-physiologic data to the scale. The communication, in various embodiments, includes a wireless communication and/or utilizes a cloud system.
The remote user-physiologic device 109 and/or the scale receives the user data and validates the user data as concerning a specific user associated with a user profile (based on the communication activation and/or a user ID within the user data). The remote user-physiologic device, using the sensor circuitry and the processing circuitry 120, collects signals indicative of cardio-physiological data. For example, the sensor circuitry, includes electrodes and/or other circuitry configured and arranged to collect the signals. The signals include recordings of electrical activity of the user's heart over a period of time and that are collected by placing electrodes on the user's body. The electrodes detect electrical changes on the skin and/or other surface that arise from the heart muscle depolarizing during each heartbeat. That is, the signals are indicative, in various embodiments, of an ECG of the user.

The processing circuitry 120 of the remote user-physiologic device 109 receives the collected signals, and, therefrom generates the physiologic data (e.g., the ECG). Thereby, the remote user-physiologic device 109 includes a two-terminal ECG sensor and/or a plethysmogram sensor, in various embodiments.

In various embodiments, the remote user-physiologic device and/or the scale correlates the physiologic data obtained by the scale with the physiologic data obtained by the remote user-physiologic device. The correlation includes placing the data in phase, in the same and/or similar time range, in the same and/or similar time scale, and/or other correlation. For example, the physiologic data from the scale, in a number of embodiments, includes data indicative of a BCG and the physiologic data from the remote user-physiologic device includes data indicative of an ECG. The correlation can include correcting the data to get true phase change between the BCG and ECG. In other embodiments, the scale can collect an ECG from a different location than an ECG collected by the remote user-physiologic device. The correlation includes placing the ECG data from the scale in phase with the ECG data from the remote user-physiologic device, such that the two cardiogram waveforms correspond to one another. Alternatively and/or in addition, the BCG and ECG data includes time stamps and the correlation includes matching the data based on the time stamps. The correlated data is stored in a user profile corresponding with the user, such as a user profile stored on the remote user-physiologic device, scale, and/or an external circuitry.

In accordance with various embodiments, a communication is activated and/or enabled in response to a dual-authorization, one from the scale and the other from the remote user-physiologic device. In many instances, the scale (or the remote user-physiologic device) are used by multiple people. For instance, the scale may be located in a home, a working environment, a fitness center, a physician office, among other locations. When the
scale is located at a public locations, many people may use the scale and users’ may not want their cardio-related data and/or weight information to be output to other users. The scale outputs specific user data to a remote user-physiologic device in response to the authorization from both the scale and the remote user-physiologic device that corresponds to the specific user. In other instances, the scale may be located at private location and may track user data for one or more persons living in the private location. The scale outputs specific user data, similarly to the private location as previously discussed, in response to the dual-authorization. Further, in some instances, the scale may correspond to only one user. However, other people visiting the user may stand on the scale as a scale is a common house hold item. Data is communicated to the remote user-physiologic device (which a visiting person may have or be using) or the scale in response to the dual-authorization. The dual-authorization thereby prevents user data corresponding to the user from being communicated to nearby remote user-physiologic devices that the particular user is not using and/or to a remote user-physiologic device when the particular user is not standing on the scale.

In specific examples, as illustrated by FIG. 1g, the scale waits for a user to stand on the platform. User-corresponding data, in various embodiments, is input and/or received prior to the user standing on the scale and/or in response to. In response to the user standing on the scale, the scale transitions from a reduced power-consumption mode of operation to at least one higher power-consumption mode of operation. At block 173, the scale collects signals indicative of an identity of the user and cardio-physiological measurements (e.g., force signals) by engaging the user with electrical signals and, therefrom, collecting the signals. At block 173, the processing circuitry 104, processes the signals obtained by the data-procurement circuitry while the user is standing on the platform and generates, therefrom, cardio-related physiologic data corresponding to the collected signals.

At block 171, the processing circuitry 104 identifies a scale-based biometric of the user using the collected signals and validates the user data, which includes the data indicative of the users identity and the generated cardio-related physiologic data, as concerning the user associated with the scale-based biometric. At block 170, the scale waits for dual-authorization. The dual-authorization includes the communication activation circuit of the scale receiving a scale-based biometric corresponding to a specific user and authorization data from the remote user-physiologic device 109 corresponding to the same specific user.

The remote user-physiologic device 109, as previously discussed, includes a device, including processing circuitry, configured to collect various signals from the user. In various
embodiments, the remote-physiologic device 109 is configured to operate in multiple modes. For example, the remote user-physiologic device 109, at block 129, waits for user authorization data from the user. The user authorization data, as previously discussed, includes the user entering a password or fingerprint to transition the remote user-physiologic device 109 from a reduced-power mode of operation to a higher-power mode of operation. Alternatively and/or in addition, the user authorization data includes a password, pass code, and/or biometric data obtained in response to the user accessing the specific functionality (e.g., an application) of the remote user-physiologic device 109 capable of generating physiologic data.

In response to the authorization data, at block 160, the remote user-physiologic device 109 collects signals indicative of the physiologic data and generates therefrom the cardio-physiologic data. Further, at block 163, the remote user-physiologic device 109 activates the communication by outputting the authorization data to the scale. The authorization data is output concurrently, during, and/or after the collection of signals indicative of the physiologic data by the remote user-physiologic device 109.

At block 170, in response to the identified scale-based biometric and receiving the authorization data from the remote user-physiologic device 109 corresponding to the same user, the scale activates the communication between the scale and the remote user-physiologic device 109. As illustrated by FIG. 1g, the activation includes pairing the scale and the remote user-physiologic device 109, at 169, in a number of embodiments. Further, the scale, in various embodiments, displays the user’s weight on the display of the scale. And, in response to activation, the scale sends the user data from the scale to the remote user-physiologic device 109 and/or the remote user-physiologic device 109 sends signals indicative of physiologic data to the scale. At block 167, the scale and/or remote user-physiologic device 109, further processes and analyzes the physiologic data from the scale and from the remote user-physiologic device 109.

In various embodiments, the processing circuitry of the scale and/or the remote user-physiologic device 109 correlates and stores the user data and the data obtained by the remote user-physiologic device 109 with a user profile of the user. In some embodiments, the scale and/or remote user-physiologic device 109 correlates the physiologic data generated by the scale with the physiologic data generated by the remote user-physiologic device 109. The scale and/or remote user-physiologic device 109 uses the correlated data to derive cardio-related data that may be of a higher quality and/or have more information than the data individually.
The correlated user data and data from the remote user-physiologic device can be further processed and/or analyzed. In various embodiments, the scale and/or the remote user-physiologic device 109 determines additional health information and provides the additional health information for display to the user. The additional health information is indicative of the clinical indication data and correlates to the categories of interest provided by the user. The categories of interest are provided at a different time, the same time and/or from the scale. In various embodiments, the additional health information is based on historical user-data, as previously described. As further previously described, the scale and/or the remote user-physiologic device 109 controls access to data within the user profile.

In accordance with various embodiments, although not illustrated by FIG. 1g, the apparatus includes an additional sensor circuitry that is external to the scale and the remote user-physiologic device 109. The additional sensor circuitry includes a communication circuit and is configured and arranged to engage the user with electrical signals and collect therefrom signals indicative of an ECG of the user. The sensor circuitry, which may include and/or be correlated with processing circuitry configured to derive an ECG from the collected signals. The sensor circuitry communicates the ECG to the remote user-physiologic device 109 and the scale communicates a BCG to the remote user-physiologic device 109. The additional sensor circuitry can be located at a different location of the user than the remote user-physiologic device 109 and the scale (e.g., on the wrist, head, or ankle).

In various embodiments, the apparatus includes additional remote user-physiologic devices and/or other body accessories. For example, the scale receives data from a plurality of remote user-physiologic devices and/or other body accessories. The remote user-physiologic device 109 and/or scale receives data from the plurality of remote user-physiologic devices or other body accessories and calibrate the data from each of the remote user-physiologic devices /body accessories. In this way, the scale is used as a hub for collecting and correlating data corresponding to a user. For example, the data can include fitness data, cardio-related data, user input data (e.g., calorie counts/food intake, drug dosage, treatment, sleep schedule), sleep schedule (e.g., directly input from a smartbed and/or other body accessory), among other data. The scale collects the various data and correlates the data with a user profile corresponding with the user. In various embodiments, the data from one of the remote user-physiologic devices may conflict with data obtained by the scale. In such instances, the data obtained by the scale is used and the data from the remote user-physiologic device is discarded. That is, the data from the scale is the default
data as the scale may include greater processing resources and/or obtain higher quality signals than the remote user-physiologic device.

Although the present embodiments illustrates the remote user-physiologic device 109 or the scale performing the various additional processing, embodiments are not so limited. For example, external circuitry can perform the processing and update the user profile, which may be stored on the external circuitry, the remote user-physiologic device 109, or the scale. The user profile can be accessed by the scale, the remote user-physiologic device 109, or the external circuitry, in response to authorization. The authorization can, in some embodiments, include dual-authorization. In response to the authorization, various data is displayed to the user, such as on a user display of the remote user-physiologic device 109 or the scale. The user, in various embodiments, can establish where to display data, based on user preferences stored in the user profile.

In some embodiments, the scale-based biometric and the authentication data are received at different times. In such embodiments, the communication activation circuitry may activate the communication in response to receiving each of the scale-based biometric and the authentication data within a threshold period of time (e.g., 60 seconds, 5 minutes, 10 minutes). In response to receiving one of the scale-based biometric and the authentication data outside the threshold period of time, the scale may not activate the communication and/or triggers each device to resend the scale-based biometric and the authentication data.

The scale can time synchronize with the remote user-physiologic device prior to the scale and remote user-physiologic device (or other user devices) obtaining the user data, in various specific embodiments. When using data from both the scale and another device, time-based (e.g., phase) inaccuracies between user data sets from the other device and the scale can impact assimilation and/or combined use of the two sets of user data. For example, lack of time synchrony can cause issues such as cardiac parameters from each device not coordinating, and/or being inaccurate, and/or not identifying the correct data to output. For example, a user exercises while wearing a remote user-physiologic device (e.g., a wearable device) that monitors one or more physiological parameters, and the remote user-physiologic device outputs the physiological parameters to a scale for further processing. The time (e.g., phase) used by the remote user-physiologic device can cause a resulting physiological parameter (e.g., waveform) to be inaccurate. The scale and the remote user-physiologic device (or other user devices) can be time-synchronized based on the frequency and/or timing (e.g., phase) of signals or waveforms. Time-synchronizing includes or refers to synchronizing two waveforms (e.g., signals from the scale and the user device) based on a
frequency and a timing, sometimes referred to as "a phase angle". In specific embodiment, time-synchronized waveforms have the same frequency and same phase angle with each cycle and/or share repeating sequences of phase angles over consecutive cycles.

The following is a specific example of a remote user-physiologic device or other user devices time-synchronizing with a scale prior to obtaining user data. While the user is standing on the scale, the scale recognizes a nearby remote user-physiologic device (e.g., within a threshold) and prompts the user to pair the remote user-physiologic device and scale. The user authorizes the pairing (e.g., selects an icon on the FUI or otherwise provides an indication of an interest) by providing an indication of interest to the scale (e.g., select an icon, provide a voice command, or perform an action). In specific embodiments, the user device and scale can be time-synchronized by tapping the user device, such as a remote user-physiologic device, a wearable device, cellphone, and/or tablet to the scale. The scale synchronizes via strain gauges of the scale and accelerometer of the user device, as previously described. In other specific embodiments, the scale provides a command to the user device, which is placed on the scale and/or tapped on the scale, the scale detects the vibration frequency and timing (e.g., phase). This can be used to give secure identification and time synchronization, as previously described.

In a number of specific embodiments, the user activates a time-synchronization service/feature of the scale. For example, the user stands on the scale and identifies the user device, such as a remote user-physiologic device, including how to synchronize the two devices, using a user interface (e.g., FUI of the scale, external GUI in communication, etc.) The scale authorizes the communication and/or the synchronization by recognizing the user using a scale-based biometric and based on authorization data from the user device, in some specific embodiments. In response to the synchronization, the scale outputs a message requesting a time value from the user device. The user device, in response to the message, outputs a response message with an indication of the time value. The response message can include the user device vibrating (at a respective frequency and timing). The scale detects the vibration at a frequency and timing, and can determine the vibration frequency and timing. The determined vibration frequency and timing can be used to time-synchronize the scale with the user device based on a time difference. A time difference between the scale and the user device can include a difference in relative time (e.g., phase) according to the scale and relative time (e.g., phase) according to the user device. The scale can time-synchronize by outputting a message to the user device to adjust its timing based on the time difference and/or to match the timing of the scale.
As previously described, the time-synchronization can occur responsive to a user dropping and/or tapping the user device on the scale. The user device may include a built-in accelerometer and the user dropping or tapping the user device on the platform of the scale (with or without standing on the scale) can activate the time-synchrony. In various embodiments, the time-synchrony is activated in response to the user device being within a threshold distance from the scale. In other embodiments, the user is standing on the scale and/or within a threshold distance, and the scale outputs a messaged to the user device to vibrate to trigger the time-synchronization, as previous discussed. Further, via NFC, Bluetooth, and/or wireless communication, the time-synchrony can occur through direct communication between the scale and the user device. In some specific embodiments, the time-synchrony occurs in response to verification that the user device (and/or the scale) has recognized the user within a threshold period of time. The verification can be used to mitigate or prevent accidental synchronization and can be used in combination with a user dropping or tapping the user device on the scale and/or the user device being within a threshold distance from the scale.

In other specific embodiments, the scale time-synchronizes with the user device by docking the user device with the scale and/or via acoustic sounds. For example, the user device may be a remote user-physiologic device that includes a photoplethysmograph. The photoplethysmography can be time-synchronized by docking (e.g., placing on the platform and/or connecting) the remote user-physiologic device with the scale and using a light source of the scale to flash a pattern to calibrate the photoplethysmography (e.g., flashing LED lights via one or more LEDs embedded in the platform of the scale). Further, the user device can be acoustically calibrated by outputting sounds from the platform (e.g., "pips" and "chirps").

The scale can include a mechanical mass that can be triggered by the user device to calibrate the system. In response to a command from the user device, for example, a mechanical input is input to circuitry of the scale using the mechanical mass. The scale can pick apart the mechanical input separately from a cardiac parameter (e.g., BCG) and use the mechanical input to measure a phase latency of the system.

FIG. 1h shows an example process for correlating and analyzing data from a scale and another device, consistent with various aspects of the present disclosure. The other device can include a remote user-physiological device 109. As previously described, the scale can activate communication between the scale and the remote user-physiological
device 109 in response to validating that authorization data received from the remote user-physiological device 109 and the scale-based biometric correspond to the same user.

In response to the activation, the scale and/or remote user-physiological device 109 output physiologic data obtained to the other. For example, the scale outputs scale-obtained physiological data to the remote user-physiological device 109 and/or the remote user-physiological device 109 outputs physiological data to the scale. In various embodiments, the remote user-physiologic device and/or the scale correlates the cardio-related physiologic data obtained by the scale with the cardio-related physiologic data obtained by the remote user-physiologic device. The correlation includes placing the data in phase, in the same and/or similar time range, in the same and/or similar time scale, and/or other correlating. For example, the cardio-related physiologic data from the scale can include data indicative of a BCG and the cardio-related physiologic data from the remote user-physiologic device includes data indicative of an ECG. The correlation can include correcting the data to get true phase change between the BCG and ECG. In other embodiments, the scale can collect an ECG from a different location than an ECG collected by the remote user-physiologic device. The correlation includes placing the ECG data from the scale in phase with the ECG data from the remote user-physiologic device, such that the two cardiogram waveforms correspond to one another. Alternatively and/or in addition, the BCG and ECG data can include time stamps and the correlation can include matching the data based on the time stamps. In other related embodiments, the correlation included revising a time range and/or scale of one of the data sets such that both data sets correspond to the same time range and/or time scale. The correlated data is stored in a user profile corresponding to the user, such as a user profile stored on the remote user-physiologic device, scale, and/or an external circuitry.

A communication is activated and/or enabled in response to a dual-authorization, one from the scale and the other from the remote user-physiologic device. In many instances, the scale (or the remote user-physiologic device) is used by multiple people. As previously described, the dual-authorization can prevent user data corresponding to the user from being communicated to nearby remote user-physiologic devices or to the scale that the particular user is not using and/or to a remote user-physiologic device when the particular user is not standing on the scale. In various instances, the remote user-physiologic device (e.g., a handheld or worn device) can be time-synchronized to or phase corrected to the scale (e.g., tapping devices together), as previously described.
In various embodiments, the correlated user data and data from the remote user-physiologic device is further processed and/or analyzed. For example, using the correlated data, the remote user-physiologic device, scale, and/or other external circuitry can medically assess the user, provide clinical indication data, provide generic health information that correlates to the correlated data, and controls access to the various data, among other analysis. For example, using the cardio-related physiologic data from the scale and the remote user-physiologic device, the remote user-physiologic device and/or scale can determine cardio-related data. The cardio-related data can include physiological parameters, such as a cardiac output, a PWV, a BCG or ECG, pre-ejection period, stroke volume, arterial stiffness, respiration, and/or other parameters. Further, using the cardio-related data, the remote user-physiologic device and/or scale can derive clinical indication data. The clinical indication data, as previously described, is indicative of a physiological status of the user and can be used for assessment of a condition or treatment of the user. Example clinical indication data includes physiological parameters, risk factors, and/or other indicators that the user has a condition or could use a treatment. The user can be correlated with the condition or treatment by comparing the cardio-related data to reference information. The reference information include a range of values of the cardio-related data for other users having the corresponding condition or treatment indicators, as previously described.

As a specific example, as illustrated by FIG. 1h, the scale waits for a user to stand on the platform. In response to the user standing on the scale, the scale optionally transitions from a reduced power-consumption mode of operation to a higher power-consumption mode of operation. At block 173, the scale collects signals by engaging the user with electrical signals and, therefrom, collecting the signals. At block 173, the processing circuitry 104, processes the signals obtained by the data-procurement circuitry while the user is standing on the platform and generates, therefrom physiologic data.

At block 171, the processing circuitry 104, identifies a scale-based biometric of the user using the collected signals and validates the user data (e.g., data indicative of the user's identity and the generated cardio-related physiologic data) as concerning the user associated with the scale-based biometric. The scale is configured to collect data for a plurality of users and data for each user is stored in and/or associated with a user profile correlating with the respective user. The identification of the scale-based biometric and validation of the user data, in various embodiments, includes identifying the particular user based on the scale-based biometric matching a biometric stored on the scale and associated with the user profile correlating with the respective user. Each user, in various embodiments, configures the scale
to communicate user data in particular communication modes, including identification of which external circuitry to send data to and/or biometrics that enable the one or more communication modes.

At block 170, the scale waits for dual-authorization, as previously described. For example, the remote user-physiologic device 109, at block 129, waits for user authorization data from the user. The user authorization data, as previously discussed, includes the user entering a password or fingerprint to transition the remote user-physiologic device 109 from a reduced-power mode of operation to a higher-power mode of operation. Alternatively and/or in addition, the user authorization data is obtained in response to the user accessing the specific functionality of the remote user-physiologic device 109 capable of generating physiologic data.

In response to the authorization data, at block 160, the remote user-physiologic device 109 collects signals indicative of the physiologic data and generates therefrom the physiologic data. At block 163, the remote user-physiologic device 109 activates the communication by outputting the authorization data to the scale. In various specific embodiments, the scale and remote user-physiologic device are time-synchronized prior to obtain the physiologic data, as previously described.

At block 170, in response to the identified scale-based biometric and receiving the authorization data from the remote user-physiologic device 109, the scale activates the communication between the scale and the remote user-physiologic device 109. As illustrated by block 169, the activation can include pairing the scale and the remote user-physiologic device 109, which includes bi-directional communication between the scale and the remote user-physiologic device 109. The scale can displays the user's weight on the display of the scale. In response to activation, the scale sends the user data from the scale to the remote user-physiologic device 109 and/or the remote user-physiologic device 109 sends signals indicative of physiologic data to the scale.

In response to the communication, the remote user-physiologic device 109 and/or the scale, further processes and analyzes the physiologic data from the scale and from the remote user-physiologic device 109. The processing can includes determining cardio-related data using the physiologic data collected by the remote physiologic device 109 and the user data collected by the scale at block 177. The cardio-related data includes a physiologic parameter selected from the group consisting of: cardiac output, a PWV, a revised BCG or ECG, pre-ejection period, stroke volume, arterial stiffness, respiration, and a combination thereof.
Further, the processing can include performing additional cardio-related processing of the cardio related data. The additional cardio-related processing, as illustrated by FIG. 1h, can include processing selected from the group consisting of: correlating with and updating a user profile corresponding with the user (e.g., block 178), deriving clinical indication data for medical assessment of the user (e.g., block 179, 180), correlating the user with a condition or treatment to medically assess the user (e.g., block 180), generate non-prescription health information (e.g., block 182), automatically updating a medical profile of the user (e.g., block 181), and generating an alert that provides an indication the user has a condition (e.g., block 165), among other processing.

For example, the remote user-physiologic device 109 or the scale correlates the physiologic data generated by the scale with the physiologic data generated by the remote user-physiologic device 109. The physiologic data can be correlated based on time stamping of each data set, adjustment of time ranges of each data set, adjustment of time scales of each data set, adjustment of a phase of at least of the data sets, and a combination thereof. The remote user-physiologic device 109 or the scale uses the correlated data to derive cardio-related data, at block 177, as previously described.

In various embodiments, the remote user-physiologic device 109 or scale correlates and stores the user data and the data obtained by the remote user-physiologic device 109 with a user profile of the user, at block 178. The user profile, in some instances, can include a medical profile and/or can be used to update a medical profile. For example, the correlation can include automatically updating a user profile corresponding with the user with data, such as the cardio-related data, the physiologic data collected by the remote physiologic device 109, the user data collected by the scale, and/or a combination thereof. Automatically updating a profile, as used herein, includes populating the profile with the data without additional human interaction. In various embodiments, as illustrated by block 181, the user profile can include a medical profile that is automatically updated and/or a user profile and a medical profile can be automatically updated. The medical profile or the user profile, for example, can be accessed by a physician for medical assessment, at block 180. Automatically updating a medical profile, in a number of embodiments, includes populating the cardio-related data and user input data within the medical profile. The user input data can include symptoms the user is having and, in some embodiments, can be obtained by the remote user-physiologic device 109 or scale asking questions to the user.

In a number of embodiments, the remote user-physiologic device 109 and/or the scale provides (e.g., determines) clinical indication data by processing the derived cardio-
related data, at block 179. For example, the clinical indication data can be derived, that is indicative of a physiologic status of the user, and for assessment of a condition or treatment of the user and using the cardio-related data and/or historical cardio-related data within a user profile corresponding with the user. The condition or treatment can correspond to the physiologic status. The remote user-physiologic device 109 and/or the scale provides the clinical indication data, in some embodiments, by updating the user profile of the user with the received user data and/or the clinical indication data.

The various data can be used for medical assessment of the user, at block 180. For example, the medical assessment can include the remote user-physiologic device 109 and/or the scale correlating the user with the condition or treatment by comparing the cardio-related data of the user to reference information. The reference information, as previously described, includes a range of values of the cardio-related data for other users having corresponding condition or treatment indicators and wherein the other users are of a demographic background of the user. Alternatively and/or in addition, the medical assessment includes outputting the clinical indication data to an external circuitry and/or allowing access to the user profile that includes the clinical indication data to a physician for review for medical assessment.

In various related embodiments, the remote user-physiologic device 109 and/or the scale determines additional health information and provides the additional health information for display to the user, at block 182. The additional health information can be indicative of the clinical indication data and/or can correlate to categories of interest provided by the user. For example, the additional health information can include non-prescription health information such as generic health information including disease or disorder symptoms, risk, or advice, generic health information related to categories of interest provided by the user, and/or generic health information that correlated to the cardio-related data. In some embodiments, the additional health information is based on historical data. For example, the additional health information (e.g., a table) provided can include a correlation to the categories of interest and the user data over time.

The remote user-physiologic device 109 and/or the scale can provide a number of questions to the users. The questions can include questions about symptoms the user is experiencing, demographic information of the user, and/or lifestyle questions. In various embodiments, the answers to the questions are used to determine categories of interest of the user, as previously described. Further, the answer to the questions can be correlated with the cardio-related data and used to determine the clinical indication data. For example, symptom
information can be used to determine and/or revise clinical indication data of the user. The user can be correlated with a condition or treatment by comparing the cardio-related data of the user to reference information and providing the number of questions in response to the correlated condition or treatment. The answers can be used to validate the condition or treatment (e.g., verify experiencing expected symptoms) or revised the condition or treatment. The answers to the questions can be used to determine categories of interest, determine a condition or treatment, verify a condition or treatment, and/or otherwise revise various data.

As previously described, in some instances, a user may not realize they are having a symptom and may not input the symptom unless directly ask. As a specific example, the user may be having shortness of breath when exercising or difficulty sleeping. The user may not identity that the shortness of breath or difficulty sleeping is a symptom for a condition or may forget that they are experiencing such a symptom. In response to identifying the user may have condition that is associated with the symptom of shortness of breath or difficulty sleeping, the scale or remote user-physiologic device 109 asks the user if the user is experiencing such a symptom (without directly identifying this as a symptom) and can store the response for use by a physician or to verify the clinical indication data.

The remote user-physiologic device 109 and/or the scale can control access to data within the user profile. As previously described, the control of access includes allowing access to the clinical indication data and the user data to a physician corresponding to the user. Further, the control includes not allowing access to the clinical indication data to the user. The user is allowed to access the user data in the profile and the remote user-physiologic device 109 displays portions of the user data and/or other non-regulated data. Additionally, the remote user-physiologic device 109 and/or the scale may not allow access to the profile and/or any data corresponding to the profile to non-qualified personal, such as other users. In various embodiments, the user is allowed access the clinical indication data in response to interpretation by the physician and a prescription from the physician to access the clinical indications. In some embodiments, a demographic model and/or other report is provided to the user in response to the clinical indication data. For example, the user may not be allowed to view the clinical indication data but is provided generic information corresponding to other users with similar clinical indications. The controlled access, in a number of embodiments, includes a filter associated with the external circuitry (and/or the scale), as previously described.
In various embodiments, the clinical indication data is provided as an additional service. For example, the user can obtain the information and/or have their physician interpret the information for a service fee. The service fee can include a one-time fee for a single interpretation, a monthly or yearly service fee, and/or can be a portion of a healthcare insurance fee (e.g., the user can purchase a health care plan that includes the service). In such embodiments, the physician corresponding to the user can access the clinical indication data and/or other user data in response to verification that the user has enabled the service and verification of the identity of the physician.

FIG. 1i shows an example process for authorizing multiple different communication modes of a scale, consistent with various aspects of the present disclosure. In various embodiments, the scale recognizes and/or distinguishes between users using scale-based biometrics. The scale can communicate with other devices, such as external circuitry 125.

The scale can operate in several communication modes in response to whether or not scale-based biometrics are identified. For example, the processing circuitry 104 identifies one or more scale-based biometrics of the user using the collected signals. In various embodiments, the scale-based biometrics corresponds to a user ID and are used to verify identity of the user. In response to not identifying a scale-based biometric using the collected signals, the scale operates in a default communication mode. By contrast, responsive to identifying one or more scale-based biometrics, the scale operates in a user verified communication mode. In some aspects, at least one of the scale-based biometrics is identified using a force accelerometer within the platform of the scale, and/or the electrodes. For example, a scale-based biometric can be a size of the user's foot that is identified based on engagement of the user with electrical signals (and the signals collected therefrom). Further, a first scale-based biometric can be identified based on tapping by the user's foot and/or movement of the user's foot and a second scale-based biometrics can be identified based on the user's weight. The tapping or movement and the weight can be compared to the user profile.

The default communication mode, as used herein, includes the output circuit of scale displaying user data on the user display. During the default communication mode, the output circuit may not output user data to external circuitry. For example, the user has not been verified and, thereby, communication with external circuitry is not authorized. During the default communication mode, the scale may be unable to validate the user's identity. However, the scale displays user data (e.g., at least a first portion) on the user display and
collects data that is correlated to a generic unknown user (e.g., user 1). Thereby, the scale is able to operate without identifying the user.

The user verified communication mode, as used herein, includes the output circuit outputting at least a portion of the user data (e.g., at least a second portion) from the scale to the external circuitry 125. Further, the output circuit displays the user's weight on the user display (e.g., the FUI, GUI, and/or voice input/output circuitry). That is, during the user verified communication mode, the user data is sent to the external circuitry 125 without manual action by the user (besides the user standing on the scale) and portions are displayed to the user. The display, in various embodiments, includes an indication that user data has been sent to the external circuitry 125. Using the scale-based biometric, the user data is validated as concerning the user associated with a user profile and/or the scale-based biometric. The user data includes data indicative of the user's identity and the generated physiologic data.

In various embodiments, the user verified communication mode includes multiple modes of communication. For example, the scale identifies multiple tiered scale-based biometrics and, in response, operates in the different modes of communication. In a number of embodiments, the one or more scale-based biometrics includes a high security biometric and a low security biometric. The low security biometric is easier to obtain and/or verify than the high security biometric. For example, the low security biometric, in some embodiments, is identified from the user when the user is wearing foot coverings. By contrast, in related embodiments, the high security biometric is not identified from the user when the user is wearing foot coverings. Alternatively and/or in addition, the high security biometric has a greater likelihood of securely identifying the user than the low security biometric. Example high security biometrics include a biometric selected from the group consisting of: a size of the user's foot obtained when the user is not wearing foot coverings, a pass code entered with the user's foot when the user is not wearing foot coverings, a picture drawing with the user's foot when the user is not wearing foot coverings, and a combination thereof. Example low security biometric can include a user weight, heart rate, body mass index, etc.

The user verified communication mode can include the high verified communication mode and the low communication mode responsive to the low security biometric and/or high security biometric. For example, in response to identifying the low security biometric, the scale operates in the low verified communication mode. During the low verified communication mode, the output circuit outputs a first portion of user data to the external
circuitry 125. In response to identifying the high security biometric or both the low and high
security biometrics, the scale operates in the high verified communication mode. During the
high verified communication mode, the output circuit outputs at least a second portion of the
user data to the external circuitry 125. The second portions includes greater portions or
higher security data than data in the first portion. For example, the second portion can
include the first portion and additional data.

In some specific embodiments, the scale instructs the user on using the data in the
different communication modes. One or more scale-based biometrics may be identified
when the user is not wearing foot coverings. For example, the high security biometric is
identified when the user is not wearing foot coverings. The instructions, in such optional
embodiments, includes the scale instructing the user on using the apparatus with or without
foot coverings. For example, the instruction includes how the user should stand or what the
user should be wearing (such as, don't wear foot coverings) the next time measurements are
made using the scale and/or the last time the output circuit operated in the user verified
communication mode (e.g., the high verified communication mode). In various
embodiments, the instruction indicates to the user to remove foot coverings and retake the
measurements to output data to the external circuitry 125. Alternatively and/or in addition,
the next time the user stands on the platform, an alarm (e.g., sound) is provided and a
message displayed that asks if the user is standing or wearing (or not wearing) what the user
should be to obtain the one or more scale-based biometrics.

The scale can identify that user data has not been sent to the external circuitry 125 in
greater than a threshold period of time and instructs the user on how to take measurements
using the scale that results in the user data being output to the external circuitry. The
threshold period of time is predetermined and/or associated with a user profile. In a number
of embodiments, the threshold period of time is dependent on parameters tracked and/or
goals of the user. For example, in order to determine the parameters and/or goals, the
external circuitry 125 receives user data that is only sent in the user verified communication
mode and/or the high verified communication mode. If the scale does not operate in the user
verified communication mode and/or high verified communication mode, such user data is
not sent to the external circuitry 125. Thereby, in response to the scale not operating in the
user verified and/or high verified communication mode in a threshold period of time, the
scale instructs the user on how to use to the scale such that the scale operates in the
respective communication mode. As a specific example, the scale may not be able to
recognize a particular biometric if the user is wearing foot coverings (e.g., socks or shoes)
and the scale reminds the user to not wear the foot coverings for the next measurement and/or to currently take off the foot coverings. In other examples, the particular biometric for the verified communication mode and/or high verified communication mode may not be obtained unless the user stands still (or a threshold level still for a threshold period of time).

As an example, the biometric may be a BCG which cannot be verified and/or obtained if the user is introducing noise via body motion. The scale may remind the user stand still and retake the measurement.

The one or more biometrics can be learned by the processing circuitry 104 over time and/or are updated in response to collected signals. The scale can identify the user's biometrics during a registration mode, as previously described. As an example, during the registration mode, the scale collects signals from the user and verifies the user's identity using a user input (e.g., pass code, user ID, etc.). Based on the collected signals, the processing circuitry 104 stores scale-based biometrics associated with the user within a user profile corresponding to the user and the user input.

Optionally, in some embodiments, the scale outputs the user data to the external circuitry 125 in response to activation of communication between the scale and the external circuitry 125. The activation includes a dual-activation, as previously described, and is in response to a scale-based biometric and authorization data from the external circuitry 125. The external circuitry 125 can include sensor circuitry, processing circuitry, and an output circuit. For example, the external circuitry 125 can be configured to collect various signals, such as signals indicative of the user's identity. The collected signals indicative of the user's identity include the authorization data to be sent to the scale to authorize communication. The external circuitry 125 can identify the authorization data of the user using the collected signals indicative of the user's identity and, therefrom, validate the collected signals as concerning the user associated with the authorization data and/or a user profile. The scale and/or external circuitry 125 can correlate data from both device, as previously described.

As a specific example of a scale operating in multiple communication modes, illustrated by FIG. 11, the scale waits for a user to stand on the platform. In response to the user standing on the scale, the scale transitions from a reduced power-consumption mode of operation 176 to at least one higher power-consumption mode of operation 175. At block 173, the scale collects signals indicative of an identity of the user and cardio-physiological measurements (e.g., force signals) by engaging the user with electrical signals and, therefrom, collecting the signals. Further, at block 173, the processing circuitry 104, processes the signals obtained by the data-procurement circuitry while the user is standing
on the platform and generated, therefrom, cardio-related physiologic data corresponding to the collected signals.

At block 183-1, the processing circuitry 104, the scale operates in a default communication mode in response to no identified scale-based biometric and/or while waiting for a scale-based biometric. During the default communication mode, the output circuitry of the scale displays user data, such as the user's weight, on the user display of the scale. The user data collected can be correlated with a generic (non-identified) user (e.g., user 1, user 2, etc.). Further, user data is not sent to the external circuitry 125 during the default communication mode.

At block 183-2, in response to a low security biometric being identified, the scale transitions from the default communication mode to the low verified communication mode. The low security biometric, for example, authorizes communication of a first portion of the user data. The first portion may include lower security data. The scale, using the processing circuitry 104, identifies a scale-based biometric of the user using the collected signals and validates the user data, which includes the data indicative of the user's identity and the generated cardio-related physiologic data, as concerning the user associated with the scale-based biometric. At block 183-3, in response to identifying the high security biometric, the scale transitions to a high verified communication mode. The high security biometric, for instance, authorizes communication of a second portion of the user data. The second portion includes higher security data (or higher sensitivity) than the first portion. The user data output in the first portion and second portion can be identified by the user in a user profile and/or are otherwise predefined. In various embodiments, the second portion includes the first portion and additional data. Thereby, during the high verified communication mode, the scale outputs the data that is sent in the low verified communication mode.

Alternatively, the scale transitions from the low verified communication mode to the high communication mode, and sends the first portion of the user data followed by the second portion of the user data.

In various embodiments, optionally prior to outputting user data, the scale awaits for dual-authorization, at block 169, as previously discussed. For example, the external circuitry, at block 162, waits for user authorization data from the user. In response to the authorization data, at block 160, the external circuitry 125 optionally collects signals indicative of the physiologic data and generates therefrom the physiologic data. However, embodiments are not so limited and in various embodiments the external circuitry may not
collect physiologic data. At block 163, the external circuitry 125 activates the communication by outputting the authorization data to the scale.

At block 169, responsive the identified one or more scale-based biometrics and receiving the authorization data, the scale activates the communication between the scale and the external circuitry 125. As illustrated by FIG. li, the activation can include pairing the scale and the external circuitry 125. Further, the scale can display the user's weight on the display of the scale. In response to activation, the scale sends the user data from the scale to the external circuitry 125 and/or receives data from the external circuitry 125. The external circuitry 125 and/or the scale can process and analyze the physiologic data from the scale and the external circuitry 125, as previously described.

In various embodiments, the apparatus includes additional user wearable devices and/or other body accessories. For example, the scale receives data from a plurality of user wearable devices and/or other body accessories. The external circuitry 125 and/or scale receive data from the plurality of user wearable devices or other body accessories and calibrates or correlates the data from each of the user wearable devices /body accessories. In this way, data obtained from all devices and other body accessories are relevant to one another. Furthermore, the scale is used as a hub for collecting and correlating data corresponding to a user. For example, the data includes fitness data, cardio-related data, user input data (e.g., calorie counts/food intake, drug dosage, treatment, sleep schedule), sleep schedule (e.g., directly input from a smartbed and/or other body accessory), among other data. The scale collects the various data and correlates the data with a user profile corresponding with the user. In various embodiments, the data from a user wearable device may conflict with data obtained by the scale. The data obtained by the scale can be used and the data from the user wearable device may be discarded. That is, the data from the scale can be the default data as the scale may include greater processing resources and/or obtain higher quality signals than the user wearable device.

Although the present embodiments illustrate the external circuitry 125 or the scale performing the various additional processing, embodiments are not so limited. For example, additional external circuitry can perform the processing and update the user profile, which may be stored on the external circuitry 125 or the scale. The user profile can be accessed by the scale or the external circuitry, in response to authorization.

FIG. lj shows an example an example scale wireless in communication with multiple other devices. The scale can communicate data wirelessly (and/or via the cloud 130) with other devices, such as the remote user-physiologic device 109 and/or the external circuitry.
In a specific embodiment, the remote user-physiologic device 109 outputs authorization data to the scale. In response to the authorization data corresponding to the same user as a scale-based biometric obtain using the scale, the scale outputs scale-based physiological raw data and/or user data. Further, the scale displays a user weight to the user, using the user display of the scale.

The remote user-physiologic device 109 receives the user data from the scale or the scale receives the cardio-related physiologic data from the remote user-physiologic device 109 and correlates the user data with data obtained by the remote user-physiologic device 109. The remote user-physiologic device 109 outputs various cardio-related data to an external circuitry 125 or to the scale. In some embodiments, the external circuitry 125 can include a medical file database and the various cardio-related data is automatically populated in the medical file corresponding to the user and for a physician to review. The external circuitry 125 (and/or the remote user-physiologic device 109) can further analyze the cardio-related data and determine additional health information, such as non-Rx health information to provide to the user.

The remote user-physiologic device 109 or scale can control access to various data, such as the clinical indication data, by storing the parameter in a database corresponding with and/or integrated with the remote user-physiologic device 109. Alternatively and/or in addition (such as, in response to determining the user can access the parameter) the remote user-physiologic device 109 or external circuitry 125 outputs various data, such as the clinical indication data to the scale for display and/or storage.

In a number of embodiments, the scale and the remote user-physiologic device 109 provide additional health information to the user. The remote user-physiologic device 109, for example, receives user input data that provides an indication that the user is interested in additional (non-prescription (Rx)) health information and various categories of interest. The additional health information is derived by the remote user-physiologic device 109 or the scale and provided to the user, as previously described.

As further previously described, the remote user-physiologic device 109, including the processing circuitry, provides a number of questions to the user. The questions can be provided via a speaker component of the remote user-physiologic device 109 outputting computer generated natural voice (via a natural language interface), displaying the questions on the user display of the remote user-physiologic device 109, and/or outputting the questions to another user-device. In various embodiments, the questions include asking the user if the user is interested in additional health information and if the user has particular
categories of interest. In specific embodiments, the questions are provided and/or the answers are obtained using voice input/output circuitry, as previously described.

The additional health information is generated, in various embodiments, by comparing the categories of interest to the cardio-related physiologic data generated by the scale and by the remote user-physiologic device 109. The correlation/comparison can include comparing statistical data of a sample census pertinent to the categories of interest and at least one physiological parameter determined using the cardio-related physiologic data (e.g., data of other users that are correlated to the categories of interest). The additional health information can include a comparison of data measured while the user is standing on the platform 101 and data measured using the remote user-physiologic device 109 to sample census data (e.g., may contain prescription (Rx) information). In other related embodiments, the correlation/comparison includes comparing statistical data of a sample census pertinent to the categories of interest and values of the least one physiological parameter of the sample census, and the additional health information includes average physiological parameter values of the sample census that is set by the user, via the categories of interest, and may not include actual values corresponding to the user (e.g., may not contain Rx information).

As discussed above, the scale can operate in multiple communication modes in response to whether or not scale-based biometrics are identified. For example, in response to not identifying a scale-based biometric corresponding to a user, the scale operates in a default communication mode. During the default communication mode, the output circuit of the scale outputs user data to the user display of the scale and the scale displays the data. In response to identifying one or more scale-based biometrics corresponding to a particular user, the scale operates in a user verified communication mode. During a user verified communication mode, the output circuit of the scale is configured and arranged to output at least a portion of the user data to the external circuitry 125 for further assessment and correlation. Although the different communications are referred to as "modes", one of skill in the art may appreciate that the communications in the different modes may not (or may) include different media and channels. The different communication modes can include different devices communicated to and/or different data that is communicated based on sensitivity of the data and/or security of the devices.

FIG. 1k shows an example apparatus for collecting user data from a plurality of devices, consistent with various aspects of the present disclosure. The apparatus includes a scale and one or more user devices. Example user device include a smartwatch, a smartcup, a smartphone, a standalone CPU, among other devices. The scale and user devices can,
communicate various cardio-related data and other user data that is sensitive. The scale collects and aggregates user data from the scale and the user devices. The scale is used to securely communicate the aggregated user data to external circuitry, such as a standalone CPU and/or server CPU. For example, the scale verifies identification and authorization of the communication using a scale-obtained biometric. The scale can add various security measures to aggregated user data by encrypting, coding, adding a hardware and/or software key, and combinations thereof. Using the scale as a hub to aggregate and communicate user data increases security of communicating the user data as the scale is not accessed by external circuitry and/or applications. The verification of the identity of the user prevents and/or avoids unintended disclosure of the user data as compared to a single authorization.

User data that is sensitive, as used herein, include data obtained by the scale and/or the user device that is related to user health, lifestyle, and/or identification. In various embodiments, both the scale and the user devices collect various user data. For example, both the scale and the user device collect cardio-related data. Alternatively, the user device collects exercise data and/or sleep data, among other data. Combining the user data from the scale and the user devices is beneficial in identifying various risks of the user for conditions, in tracking the user's progress, and/or in making suggestions to the user. However, separately sending the data to a standalone CPU and/or server CPU is time consuming and frustrating for many users. Further, the scale, in various embodiments, verifies identification of the user using a scale-based biometric to increase security of the data communication. As discussed further herein, in various embodiments, the scale has a hierarchy of security measures depending on the sensitivity of the user data. For example, different scale-obtained biometrics are used to authorize communication of different levels of sensitivity of the user data. Further, the user can adjust the settings of the various biometrics and levels of sensitivity of the user data.

The one or more user devices, as illustrated, are not integrated within the scale and, in various embodiments, includes a cellphone, a smartwatch, other smart devices, a tablet, a (photo) plethysmogram a two terminal ECG sensor, and a combination thereof. Each user device includes processing circuitry and an output circuit. Optionally, one or more user device includes sensor circuitry. The user devices are configured to collect various signals. For example, the user device collects signals indicative of the user's identity. The collected signals indicative of the user's identity include the authorization data to authorize use of the user device and, optionally, is sent to the scale to authorize communication.
The scale receives the user data and validates the user data as concerning a specific user associated with a user profile (based on the communication activation and/or a user ID), such as using authorization data and/or other identifying data in the user data. The user data includes data collecting using sensor circuitry, such as accelerometers and/or electrodes, and/or using processing circuitry. For example, a user inputs user data to one or more of the user devices.

In some embodiments, the user device, using the sensor circuitry and the processing circuitry, collects signals indicative of cardio-physiologic data. For example, the sensor circuitry, includes electrodes and/or other circuitry collect the signals. The signals include recordings of electrical activity of the user's heart over a period of time and that are collected by placing electrodes on the user's body. The electrodes detect electrical changes on the skin and/or other surface that arise from the heart muscle depolarizing during each heartbeat. That is, the signals are indicative, in various embodiments, of an ECG of the user. The processing circuitry of the user device receives the collected signals, and, therefrom generates the physiologic data (e.g., the ECG). The user device includes a two-terminal ECG sensor and/or a plethysmogram sensor, in various embodiments.

The scale can aggregate the user data obtained by the scale (e.g., user data) with the user data from the one or more user device. The aggregation includes combining and/or correlating the data. In addition, the scale securely communicates the aggregated user data to external circuitry using a secure connection to a server, by verifying the communication using a scale-obtained biometric, and/or by performing additional security measures on the data. In various embodiments, the scale correlates portions of the user data obtained by the scale with the user data obtained by the user device(s), as previously described.

In a number of embodiments, the scale is configured to collect data from a plurality of users. The scale can differentiate between the different uses based on scale-based biometrics. The scale-obtained data includes health data that is sensitive, such that unintentional disclosure of scale-obtained data is not desired. Differentiating between the two or more users and automatically communicating (e.g., without further user input) user data responsive to scale-obtained biometrics, in various embodiments, provides a user-friendly and simple way to communicate data from a scale while avoiding and/or mitigating unintentional (and/or without user consent) communication.

The scale communicates the aggregated user data, in various embodiments, by authorizing the communication based on the biometric identified and adding various security measures to the user data in response to the authorized communication. For example, in
various embodiments, the user profiles are associated with a hierarchy of different levels of biometrics that enable different data to be communicated and/or to different sources. For example, in response to verifying a first biometric, the scale outputs the user's weight to the user's smartphone or other standalone CPU. In response to verifying a second biometric, the scale outputs additional data to external circuitry and/or that is more sensitive, as discussed further herein. In response to verifying the second biometric, the scale outputs the user data (such as higher-sensitivity user data) from the scale to the smartphone or standalone CPU, from the scale to the smartphone/standalone CPU for sending to a third party, and/or from the scale to the third party.

As an example, for user data, the above described biometrics are used as directed by the user for indicating and defining protocol to permit such data to be exported from the scale to other external circuitry. In more specific embodiments, the scale operates in different modes of data security including, for example: a default mode in which the user's body mass and/or weight is displayed regardless of any biometric which would associate with the specific user standing on the scale; another mode in which complicated data (or data reviewed infrequently) is only exported from the scale under specific manual commands provided to the scale under specific protocols; and another mode or modes in which the user-specific data that is collected from the scale is processed and accessed based on the type of data. Such data categories include categories of different level of importance and/or sensitivities such as the above-discussed high and low level data and other data that might be very specific to a symptom and/or degrees of likelihood for diagnoses. Optionally, the CPU in the scale is also configured to provide encryption of various levels of the user's sensitive data.

In some embodiments, the scale operates in different modes of data security and communication. The different modes of data security and communication are enabled in response to biometrics identified by the user and using the user interface. In some embodiments, the scale is used by multiple users and/or the scale operates in different modes of data security and communication in response to identifying the user and based on biometrics. The different modes of data security and communication include, for example: a first mode (e.g., default mode) in which the user's body mass and/or weight is displayed regardless of any biometric which would associate with the specific user standing on the scale and no data is communicated to external circuitry; a second mode in which complicated/more-sensitive data (or data reviewed infrequently) is only exported from the scale under specific manual commands provided to the scale under specific protocols and in
response to a biometric; and a third mode or modes in which the user-specific data that is
collected from the scale is processed and accessed based on the type of data and in response
to a biometric.

Examples of security measures in place include firewalls, encryption schemes used,
access to the requesters database by external sources, authentication of people when
accessing the data, such as tokens, passwords, finger print, and/or biometrics, among other
security measures.

As previously described, the different modes of data security and communication can
be enabled in response to recognizing a biometric and operating in a particular mode of data
security and communication based on user preferences and/or services activated. The
different modes of operation can include the default mode (as discussed above) in which
certain data (e.g., categories of interest, categories of user data, or historical user data) is not
communicated from the scale to external circuitry, a first communication mode in which data
is communicated to external circuitry as identified in a user profile, a second or more
communication modes in which data is communicated to a different external circuitry for
further processing. The different communication modes are enabled based on biometrics
identified from the user and user settings in a user profile corresponding with each user.

In various embodiments, the scale defines a user data table that defines types of user
data and sensitivity values of each type of user data. In specific embodiments, the FUI
displays the user data table. In other specific embodiments, a user interface of a smartphone,
tablet, and/or other computing device displays the user data table. For example, a wired or
wireless tablet is used, in some embodiments, to display the user data table. The sensitivity
values of each type of user data, in some embodiments, define in which communication
mode(s) the data type is communicated and/or which biometric is used to enable
communication of the data type. A default or pre-set user data table can be displayed and the
user revises the user data table using the user interface (e.g., FUI). The revisions are in
response to user inputs using the user’s foot and/or contacting or moving relative to the FUI.
Although the embodiments are not so limited, the above (and below) described control and
display is provided using a wireless or wired tablet or other computing device as a user
interface. The output to the wireless or wired tablet, as well as additional external circuitry,
is enabled using biometrics. For example, the user is encouraged, in particular embodiments,
to configure the scale with various biometrics. The biometrics include scale-based
biometrics and biometrics from the tablet or other user computing device. The biometrics, in
some embodiments, used to enable output of data to the tablet and/or other external circuitry
includes a higher integrity biometric (e.g., higher likelihood of identifying the user accurately) than a biometric used to identify the user and stored data on the scale.

An example user data table is illustrated below:

<table>
<thead>
<tr>
<th>User-data Type</th>
<th>Weight, local weather</th>
<th>Body Mass Index, user specific news</th>
<th>User-Specific Advertisements</th>
<th>Physician-Provided Diagnosis/Reports</th>
<th>Scale-stored suggestions (symptoms &amp; diagnosis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

The above-displayed table is for illustrative purposes and embodiments in accordance with the present disclosure can include additional user-data types than illustrated, such as cardiogram characteristics, clinical indications, physiological parameters, user goals, demographic information, etc. In various embodiments, the user data table includes additional rows than illustrated. The rows, in specific embodiments, include different data input sources and/or sub-data types (as discussed below). Data input sources include source of the data, such as physician-provided, input from the Internet, user-provided, from the external circuitry. The different data from the data input sources, in some embodiments, is used alone or in combination.

In accordance with various embodiments, the scale uses a cardiogram (on its own or in addition to weight, BCG, ECG, and/or various combinations) of the user and/or other scale-obtained biometrics to differentiate between two or more users. The scale-obtained data includes health data that is user-sensitive, such that unintentional disclosure of scale-obtained data is not desired. Differentiating between the two or more users and automatically communicating (e.g., without further user input) user data responsive to scale-obtained biometrics, in various embodiments, provides a user-friendly and simple way to communicate data from a scale while avoiding and/or mitigating unintentional (and/or without user consent) communication. For example, the scale, such as during an registration mode for each of the two or more users and as previously discussed, collects user data to identify the scale-based biometrics and stores an indication of the scale-based biometrics in a user profile corresponding with the respective user. During subsequent measurements, the scale recognizes the particular user by comparing collected signals to the indication of the scale-based biometrics in the user profile. The scale, for example, compares the collected
signals to each user profile of the two or more users and identifies a match between the collected signals and the indication of the scale-based biometrics. A match, in various embodiments, is within a range of values of the indication stored. Further, in response to verifying the scale-based biometric(s), a particular communication mode is authorized.

In accordance with a number of embodiments, the scale identifies one or more of the multiple users of the scale that have priority user data, as previously described. The scale displays indications to a user with the priority user data, in some embodiments, on how to use the scale to communicate the user data to external circuitry for further processing, correlation, and/or other features, such as social network connections. The scale, in response to the priority, displays various feedback to the user, such as user-targeted advertisements and/or suggestions. In some embodiments, only users with priority user data have data output to the external circuitry to determine risks, although embodiments in accordance with the present disclosure are not so limited.

In some embodiments, one or more users of the scale have multiple different scale-obtained biometrics used to authorize different communication modes. The different scale-obtained biometrics are used to authorize communication of different levels of sensitivity of the data, such as the different user-data types and sensitivity values as illustrated in the above-table. For example, the different scale-obtained biometrics include a high security biometric, a medium security biometric, and a low security biometric. Using the above illustrated table as an example, three different biometrics are used to authorize communication of the user-data types of the different sensitivity values. For instance, the high security biometric authorizes communication of user-data types with sensitivity values of 8-10, the medium security biometric authorizes communication of user-data types with sensitivity values of 4-7, and the low security biometric authorizes communication of user-data types with sensitivity values of 1-3. The user can adjust the setting of the various biometrics and authorization of user-data types.

In a specific example, low security biometrics includes estimated weight (e.g., a weight range), and a toe tap on the foot-controlled user interface. Example medium security biometrics includes one or more the low security biometrics in addition to length and/or width of the user's foot, and/or a time of day or location of the scale. For example, as illustrated by FIG. 2a and 13 and discussed with regard to FIG. 3c, the scale includes impedance electrodes that are interleaved and engage the feet of the user. The interleaved electrodes assist in providing measurement results that are indicative of the foot length, foot width, and type of arch. Further, a specific user, in some embodiments, may use the scale at
a particular time of the day and/or authorize communication of data at the particular time of
the day, which is used to verify identity of the user and authorize the communication. The
location of scale, in some embodiments, is based on Global Positioning System (GPS)
coordinates and/or a Wi-Fi code. For example, if the scale is moved to a new house, the Wi-
Fi code used to communicate data externally from the scale changes. Example high security
biometrics include one or more low security biometrics and/or medium security biometrics
in addition to cardiogram characteristics and, optionally, a time of day and/or heart rate.
Example cardiogram characteristics include a QRS complex, and QRS complex and P/T
wave, weight, BCG wave characteristics, and combinations thereof.

In various embodiments, the user adjusts the table displayed above to revise the
sensitivity values of each data type. Further, although the above-illustrated table includes a
single sensitivity value for each data type, in various embodiments, one or more of the data
types are separated into sub-data types and each sub-data type has a sensitivity value. As an
example, the user-specific advertisement is separated into: prescription advertisements,
external device advertisements, exercise advertisements, and diet plan advertisements.
Alternatively and/or in addition, the sub-data types for user-specific advertisements include
generic advertisements based on a demographic of the user and advertisements in response
to scale collected data (e.g., advertisement for a device in response to physiologic
parameters), as discussed further herein.

For example, weight data includes the user's weight and historical weight as
collected by the scale. In some embodiments, weight data includes historical trends of the
user's weight and correlates to dietary information and/or exercise information, among other
user data. Body mass index data, includes the user's body mass index as determined using
the user's weight collected by the scale and height. In some embodiments, similar to weight,
body mass index data includes history trends of the user's body mass index and correlates to
various other user data.

User-specific advertisement data includes various prescriptions, exercise plans,
dietary plans, and/or other user devices and/or sensors for purchase, among other
advertisements. The user-specific advertisements, in various embodiments, are correlated to
input user data and/or scale-obtained data. For example, the advertisements include generic
advertisements that are relevant to the user based on a demographic of the user. Further, the
advertisements include advertisements that are responsive to scale collected data (e.g.,
physiological parameter includes a symptom or problem and advertisement is correlated to
the symptom or problem). A number of specific examples include advertisements for beta
blockers to slow heart rate, advertisements for a user wearable device (e.g., Fitbit®) to
monitor heart rate, and advertisements for a marathon exercise program (such as in response
to an indication the user is training for a marathon), etc.

Physician provided diagnosis/report data includes data provided by a physician and,
in various embodiments, is in response to the physician reviewing the scale-obtained data.
For example, the physician provided diagnosis/report data includes diagnosis of a
disorder/condition by a physician, prescription medication prescribed by a physician, and/or
reports of progress by a physician, among other data. In various embodiments, the physician
provided diagnosis/reports are provided to the scale from external circuitry, which includes
and/or accesses a medical profile of the user.

Suggestion data includes data that provides suggestions or advice for symptoms,
diagnosis, and/or user goals. For example, the suggestions include advice for training that is
user specific (e.g., exercise program based on user age, weight, and cardiogram data or
exercise program for training for an event or reducing time to complete an event, such as a
marathon), suggestions for reducing symptoms including dietary, exercise, and sleep advice,
and/or suggestions to see a physician, among other suggestions. Further, the suggestions or
advice include reminders regarding prescriptions. For example, based on physician provided
diagnosis/report data and/or user inputs, the scale identifies the user is taking a prescription
medication. The identification includes the amount and timing of when the user takes the
medication, in some embodiments. The scale reminds the user and/or asks for verification of
consumption of the prescription medication using the FUI.

As further specific examples, recent discoveries may align and associate different
attributes of scale-based user data collected by the scale to different tools, advertisements,
and physician provided diagnosis. For example, it has recently been discovered that atrial
fibrillation is more directly correlated with obesity. The scale collects various user data and
monitors weight and various components/symptoms of atrial fibrillation. In a specific
embodiment, the scale recommends/suggests to the user: closely monitor weight,
recommends a diet, recommends goals for losing weight, and correlates weight gain and
losses for movement in cardiogram data relative to arrhythmia. The movement in cardiogram
data relative to arrhythmia, in specific embodiments, is related to atrial fibrillation. For
example, atrial fibrillation is associated with indiscernible p-waves and beat to beat
fluctuations. Thereby, the scale correlates weight gain/loss with changes in amplitude (e.g.,
discernibility) of a p-wave of a cardiogram (preceding a QRS complex) and changes in beat
to beat fluctuations.
The scale, in various embodiments, performs various security measures on the user-sensitive data. For example, the scale performs encryption techniques on the data, has a hardware key and/or a software key. In various embodiments, the encryption scheme includes an asymmetric or symmetric key and the user data and/or the identifier is encrypted using an asymmetric or symmetric key cryptography. For example, the scale may not allow the ability to add additional applications or software to the circuitry (or the user may choose not to) and, thus, is more secure than if additional applications or software were added. In such embodiments, a symmetric key is used.

A symmetric key can be used by each scale using symmetric encryption. The key is randomly assigned by the scale instead of derived using a single key. A table of identifiers to keys is stored at the external circuitry (e.g., the second database). With symmetric encryption, the key and/or other data is encrypted by changing the data in a particular way. For example, the data is encrypted by shifting each letter or number by a number of places. Both the scale and the external circuitry know the symmetric key used to decode the data.

Thereby, the symmetric key is a shared secret (e.g., piece of data known to the scale and to the external circuitry). The shared secret is known by the external circuitry before or at the start of the communication session.

Alternatively, an asymmetric key is used, which is sometimes referred to as a public key. With asymmetric key cryptography, there are two keys: a private key and a public key. The scale contains the only instance of the private key, which is kept secret, and the public key is provided to the external circuitry. Any message encrypted using the private key is decrypted using the matching public key and any message encrypted using the public key is decrypted using the private key. The external circuitry contains a list of identifiers to public key mappings. The proof-of-identity supplied by the scale in the exchange is its identifier, as well as information to show authenticity and freshness of the message encrypted with its private key. To verify the user data, the external system looks up the public key and identifies that only the private key on the scale would create a message matching the known public key.

In various embodiments, the scale includes a hardware token that encrypts the data using a hardware security key generated using the hardware token. For example, the scale includes a hardware token and the external circuitry verifies authorization of the user data based on the hardware security key generated using the hardware token.

In accordance with a number of embodiments, the levels of verification and the security measures are provided by the scale based on the level of sensitivity of the data. For
example, in response to a data communicate of a high sensitivity, the scale verifies identity of the user using a high level biometric, encrypts the data using a symmetric key encryption and adds a key using a hardware token. If the data is of a medium sensitivity, the scale verifies the identity of the user using a medium level biometric and encrypts the data using a symmetric key encryption. If the data is a low sensitivity, the scale verifies the identity of the user using a low level biometric. Embodiments are not limited to the specific example given and can include various combinations of biometric levels and other data security measures.

Using the scale as a hub to collect various user data that is sensitive to the user and to communicate the user data to external circuitry, automatically and without user input, can reduce the time for a user to output various user data for correlation and processing. Further, as the scale is not accessible by other circuitry and/or may not include additional applications, the scale is less likely to be accessed by others, as compared to the user devices. For example, the scale accesses user data only in response to verifying the user using a scale-based biometric, in some embodiments.

In various embodiments, as previously described, the aggregated data from the scale and user devices is further processed and/or analyzed. For example, using the aggregated data, external circuitry medically assess the user, provides clinical indications, provides generic health information that correlates to the correlated data, and controls access to the various data, among other analysis.

As a specific example, illustrated by FIG. 1k, the scale and user devices collect various user data that is user-sensitive data. The user devices can collect various user-sensitive data, such as sleep data, cardiogram data, exercise data, heart rate data, and food/liquid intake data. In some embodiments, various user data is manually entered by the user to the standalone CPU, the scale, and/or a smartphone. Such data includes user demographic data, food/liquid intake data, and/or sleep data, in some embodiments.

The various user devices communicate various user-sensitive data to the scale. The scale aggregates the user data and secures the aggregated user-data prior to sending to data to external circuitry, such as the standalone CPU and/or server CPU. In response to the user standing on the scale, the scale transitions from a reduced power-consumption mode of operation 176 to at least one higher power-consumption mode of operation 175. At 173, the scale collects signals from the user and processes the signals to generate cardio-related physiologic data, as previously described.
At 171, the processing circuitry of the scale identifies a scale-based biometric of the
user using the collected signals and validates the user data as concerning the user associated
with the scale-based biometric. The scale can receive user-sensitive data from the user
device. In some embodiments, the scale authorizes the communication in response to a dual-
authorization. For example, optionally, at 170, the scale waits for dual-authorization, as
previously described.

One or more of the user devices can be configured to operate in multiple modes. For
example, a user device can wait for user authorization data from the user to transition from a
reduced-power mode of operation to a higher-power mode of operation in response. The
user device collects signals, such as signals indicative of the cardio-physiologic data,
exercise data, sleep data, and generates therefrom the user-sensitive data. The user device
can activate the communication by outputting the authorization data to the scale, which can
be output as a portion of the user-sensitive data.

At 184, in response to the communication of user-sensitive data to the scale, the scale
aggregates the user-sensitive data from the user devices with scale obtained user-sensitive
data. The aggregation can include the scale correlating and storing the data obtained by the
user device and the scale with a user profile of the user. And, at 185, the scale secures the
data. Securing the data, as previously discussed, includes various verification of the identity
of the user (e.g., different biometrics to authorize different sensitivity levels), encryption
schemes, software keys, hardware token keys, among other techniques. The scale outputs
the user-sensitive data, as aggregated, to external circuitry in response to the authorization
and security at 186.

In a number of embodiments, the external circuitry further process the user-sensitive
data (e.g., determines) such as determining additional health information and provides the
additional health information for display to the user, as previously described. The additional
health information is indicative of the clinical indication data and correlates to the categories
of interest provided by the user. In various embodiments, the additional health information
is based on historical user data and can include a correlation to the category of interest and
the user data over time.

FIG. 11 shows an example apparatus for collecting user data from a plurality of
different sources, consistent with various aspects of the present disclosure. Specifically,
FIG. 1b shows an example of a user-specific scale based enterprise system consistent with
aspects of the present disclosure. As illustrated, user-specific scale based enterprise system
includes at least one scale 127, the Internet (e.g., world-wide-web) 191, a standalone user
CPU 184, and one or more user devices, such as a smartwatch 189, fitness tracking device, smartphone 190, smartbed, among other devices. In various embodiments, the user devices can include implantable medical devices and/or other medical devices, such as a pacemaker that securely shares data to the scale.

As previously discussed, the scale 127 collects highly user-sensitive data, such as cardiogram data and data indicative of disorders and disease, and other user data, such as demographic information and weight. The scale 127 displays data, such as user weight, prompts or notification, and other information using a user interface and/or user display 102, such as a GUI. The one or more user devices include devices that collect various user-sensitive information, such as exercise data, food intake or liquid intake data, sleep data, cardiogram data, among other information. The standalone user CPU 188 includes a user device that include additional processing resources and/or a user display that is easier for the user to view data than the scale or other user devices. Thereby, the standalone user CPU 188, and other user devices form a robust graphical user interface (R-GUI) (e.g., illustrated by the dashed-circle) for the user to view various data. The standalone user CPU 188 can include a personal computer, a laptop, a tablet, and/or a smartphone.

In various embodiments, the scale 127 includes trigger data. The trigger data includes user-sensitive data values and/or combinations of different data values with user demographic information that indicates that the user has a risk for a condition, such as a disorder or disease. In specific embodiments, the trigger data includes values of various user-sensitive data that indicate the user has a likelihood above a particular threshold. In response to the trigger data and the scale-obtained data or other user-sensitive data from the other user devices indicating that the user has a risk for a condition, the scale prompts the user to determine if the user would like additional health information. Additionally, the scale can prompt the user to ask about other likely symptoms, prompt for further tests, such as breath hold, valsalva, etc. The prompt is display on the user display 102 of the scale 127 and/or using the R-GUI. For example, a synopsis of the prompt is displayed on the user display of the scale 127 and further information is display using the R-GUI if the user is interested.

The aggregated data from the scale 127 and the one or more user devices, in various embodiments, is compared to trigger data to determine if the user is at risk for a condition. The trigger data is stored directly on a memory circuit of the scale 127 and/or is stored on a memory circuit of the standalone user CPU 188 (and accessible by the scale). In response to
a match with the trigger data, the scale indicates a potential risk to the user and prompts the user to indicate if they would like more information.

In response to the user indicating they would like further information, the enterprise system filters the user data for data correlated with the condition and filters the Internet for various data regarding the condition and/or matching the filtered user data. For example, the scale 127 and/or standalone user CPU 188 filters the user data from the scale 127 and the other user devices 189, 190 and filters data from the Internet 191 to identify data that is relevant to the condition. In this manner, the enterprise system is used as a medical analytic driver that filters scale-obtained data, user device-obtained data, and data from the Internet to identify data related to the condition.

In response to the filter, the user and/or the scale, in various embodiments, are used to further assess the condition of the user and/or obtain additional information. The assessment includes the user assessing, using the user display 102 or the R-GUI. For example, in response to the filter, the enterprise system identifies various addition information. The additional information include various generic health information, articles, blogs/forums or social groupings, and other data identified based on the filter of the Internet using the data that correlates with the condition and the trigger data. The user views the additional information using the user display 102 and/or R-GUI. The scale is used to further assess the condition of the user by performing additional tests (e.g., body-mass-index, QRS complex over time) and/or asking the user questions.

In various embodiments, the enterprise system provides a prompt to the user that indicates general information about the condition and the user has some risk for the condition. The prompt asks if the user would like more information and in response to the user requesting information, the enterprise system provides the aggregated user-sensitive data to a physician for review and to confirm the diagnosis. The physician is provided access to the user-sensitive data using the internet 191 and/or external circuitry 125, such as server CPU. In response to the physician confirming the diagnosis and/or correlation, the scale 127 is modified with the confirmed diagnosis.

The modification, in some embodiments, includes storing, on the scale 127, various correlation data (e.g., diagnosis data), adding additional devices and/or parameters to track (e.g., halter monitor, ECG tracking device, prescription drug titration, weight tracking and/or threshold values, exercise goals, stress test), and/or health information about the condition (e.g., articles), among other data. The standalone user CPU 188 of the enterprise system, in some embodiments is used to display various data to the user, such as generic health
information, user-specific diagnosis data, blogs/forums of social groups, physician reports, and/or studies, among other information.

FIG. 1m shows an example apparatus for collect user data from a plurality of scales, consistent with various aspects of the present disclosure. The apparatus can include a scale based user-physiologic heuristic system. The system includes one or more scales and external circuitry that pools user data from the one or more scales into a user-specific knowledge database 192. In various embodiments, the system optionally includes reference information. The scales collects user data that is indicative of cardio-related measurements and outputs the user data to external circuitry. The external circuitry includes the reference information and/or the user-specific knowledge database 192 and/or is in communication with the same. The system is used to provide a hierarchy of services to users of the scale based on scale-obtained data.

The hierarchy of services, as used herein, include different services that are enabled in response to user selection and activation of subscription levels of different weighted values. Each subscription level, in various embodiments, includes one or more services. As a specific example, a system includes five subscription levels and each subscription level includes one to ten services. Once a subscription level is activated, the user has access to each service of the particular subscription level. A service, as used herein, includes a function and/or action performed using scale-obtained data. Example services include providing generic health information (e.g., articles based on user interest and scale-obtained data, information based on risks identified, general correlation information or misdiagnosis information, and advertisements), tracking data from additional devices, performing additional tests, providing scale-obtained data to a physician for diagnosis purposes, providing physician reports based on scale-obtained data, providing access to social groups, and providing access to subsets of the user data (e.g., to other circuitry 141), among other services.

The weighted values include numerical values based on the value of the service or corresponding data to the user, the user-sensitivity and/or regulation of the corresponding data, the value of the corresponding data to the service provider/provider of the scales, value of the corresponding data to the requester. In various embodiments, the value of the service and/or corresponding data is determined based on a level of security of the data, a level of technical detail of the data, and/or a likelihood of diagnosing the user based on the data. The requester of the data provided by the service can include a third party, such as a researcher, physician, government entity, and/or other entity. The different subscription levels have
different weighted values that, in some embodiments, increase with the levels of subscription. Alternatively and/or in addition, the weighted values are provided to activate the different subscription levels by different parties. For example, one or more of the subscription levels are activated by the user selecting the prompt and a third party providing the weighted value, such as a researcher. The weighted values can be provided by the user and/or third party periodically (e.g., monthly or yearly) to activate the subscription level.

The scale-obtained data used to provide the various services is collected by each scale of the system. Each scale of the system can include a platform 101 and a user display 102, and can include a scale as illustrated and previously described in connection with FIG. 1a.

In various embodiments, the external circuitry and scale are part of a scale-based heuristic system. In such embodiments, the external circuitry pools user data from a plurality of scales in a user-specific knowledge database 192. As previously discussed, the user data includes data that is user-sensitive and/or that the user would otherwise not want compromised. To prevent the data from being compromised and/or the identity of the user being learned, the processing circuitry 104 of the scale removes portions of the user data that identifies the user and adds an identifier (e.g., code) that uniquely identifies the user and the scale to user data corresponding to each respective user. The removed portions, in some embodiments, includes a user ID, user name, date of birth, location, and a combination thereof. The identifier, in various embodiments, includes a scale ID and a user ID. For example, the scale ID remains the same for each user of the scale and identifies the scale. The user ID, by contrast, is different for each user of the scale and uniquely identifies the respective user profile corresponding to the scale. The identifiers (scale ID or user ID), in some embodiments, includes numeric and/or alphabetic assignment and/or is based on identifying data, such as an IP address of the scale and/or a social security (or part thereof) number of the user.

The external circuitry 125 receives the user data and, in response, replaces the identifier with an alias ID. For example, the external circuitry creates an alias ID corresponding to each identifier and, for certain types of access requests, provides the alias identifier in place of the identifier. The external circuitry stores the user data with the identifier in the user-specific knowledge database 192 and stores the identification of the scale and user that correspond to the alias ID in another database. For security purposes, the identifier is encrypted and access to the encrypted identifier can be restricted. The scale and/or the external circuitry, in various embodiments, encrypt the identifier. In various
embodiments, the user data is sent over time and the user-specific knowledge database 192 includes historical data for the user. The alias ID, in some embodiments, is associated with a generic user profile such that user data with the alias ID is associated with the same generic user profile over time.

An alias ID is data that is independent of the identifier (e.g., not invertible back to the identifier) and formatted as the identifier is. The alias ID is used in place of the identifier that identifies the user and the scale and that appears in the same format. The alias ID can include a substitute value for the identifier that has no algorithmic relationship with the identifier and is not reversible. The alias ID is provided in place of the identifier for certain types of access requests. The alias ID can be used in place of the identifier for accessing the user data unless the user data is requested by an authorized user (such as, the user corresponding to the user data and/or a physician for a fee). The system stores the user data in a user-specific knowledge database 192 with the alias IDs, and stores an association of each alias ID to a scale and user in the other database. The user-specific knowledge database 192 can be more accessible than the other database, which may be more secure than the user-specific knowledge database 192. The system maintains the association between the alias ID and the user data, regardless of the form of the user data. The association can remain the same whether the user data is decrypted, formatted, encrypted or re-encrypted using a different encryption scheme.

An output of the system provides the alias ID in place of the identifier for accesses to the user data unless the sensitive data is specifically requested by an authorized user. The alias IDs are independent of the user data in that the identifier indicative of identification of the user and the scale cannot be derived directly from the alias IDs. This independence can be implemented using a variety of alias ID creation techniques such as a randomly generated identifier, a sequentially generated identifier, or a non-invertible derivation of the transaction card identifier. The aliases may also be uniquely associated with exactly one scale and one user. In some instances, the user, administrator, or another application using the invention may configure the format of the alias IDs. For example, the user may designate that the alias IDs should be formatted to each contain six capital letters or to each contain nine digits (the numbers "6" and "9" being merely illustrative). In another embodiment, the user may designate a portion of the identifier that is retained and used as a portion of the alias ID. In an example, the system uses the first number of an identifier as the first number of its corresponding alias.
For example, the alias ID is generated as a hash value. The external circuitry generates a hash value for each identifier or encrypted identifier. The external circuitry uses this hash value for searching, sorting, and similar database-related processes. For instance, the hash value may represent alphanumeric, numeric, or other limited values. The hash value may also represent a compression of the identifier. Additionally, the external circuitry may format the hash value further by using another hash algorithm, such as first using Secure Hash Algorithm (SHA-1) and then using Media Digest Algorithm (MD5). Once the hash value has been created, a database application may use the hash when accessing the database. To search for identification of a user of user data in the second database, the system determines the identifier hash value for use in finding records that correspond to the hash value.

In various embodiments, the identifier and/or portions of the user data are encrypted. The scale and/or the external circuitry encrypt the data using a suitable encryption scheme. Examples of encryption schemes that can be used include, but are not limited to, AES, Data Encryption Standard (DES), and International Data Encryption Algorithm (IDEA). For example, in some embodiments, the scale encrypts the identifier and/or the user data. Further, if the user data is not encrypted by the scale, the external circuitry encrypts the data and, optionally, serves as an encryption key for decrypting the indication and/or user data.

The external circuitry can change the alias IDs periodically, in response to an event, and/or in response to access of the user data. For example, each time the scale communicates user data to the external circuitry, the alias ID is changed and the external circuitry associates prior received user data with subsequent user data. The user-specific knowledge database 192 and other database are updated with the changed alias ID.

The other database can be used to identify the scale and user. For example, the external circuitry, such as a standalone CPU, uses the other database to identify the scale and user corresponding to the alias ID. The identification, in some instances, is used to provide a notification and/or additional data to the user through the scale. For example, the user-specific knowledge database 192 is used to identify correlated user data and identify various patterns of risks or conditions or diseases based on the correlation. The user can be notified of a potential correlation. The notification can be on the FUI and/or another user device. In some embodiments, the external circuitry outputs the correlations that includes user data with alias IDs. For example, output data may not identify that the user has such a problem or correlation but rather generic correlations of user data with alias IDs. The output data, optional, identifies patterns of risk for conditions or disease based on the correlation (without
actually identifying the user has the condition or disease but indicating correlation). Further, based on the correlation, the user can receive an advertisement, such as an advertisement for a physician, prescription drug, health program, and/or social group, as discussed further herein.

Although the present embodiments disclose the external circuitry replacing the identifier, embodiments are not so limited. For example, the scale can remove the identifying information and add an alias ID. The external circuitry can pool the user data with the alias IDs in the user-specific knowledge database 192 and may not include the other database. The external circuitry may not have the knowledge of the identification of the scale and user that correspond with the user data. Rather, the external circuitry correlates the user data with specific generic user (non-identifiable) using the alias ID. Alternatively, the scale may separately send the correlation of the alias ID with the scale and the user to the external circuitry for storage in the other database.

FIG. 1 shows an example of providing hierarchy of services using scale-based physiologic data and a scale-based user-physiological heuristic system. The scale-based user-physiological heuristic system includes a plurality of scales 127 and external circuitry 125, as previously described.

The external circuitry 125 includes a processing circuit and a memory circuit. The external circuitry 125 receives the user data from the scales 127 and stores the user data with alias IDs replacing identifying information in the user-specific knowledge database 192. The user data is collected and stored by the external circuitry 125 over time. For example, the external circuitry 125 validates the received user data as corresponding to a particular user associated with an alias ID based on the identifier and correlates the received user data with other user data stored in the user-specific knowledge database 192 and associated with the alias ID. The external circuitry 125 updates the user-specific knowledge database 192 with the user data and/or other feedback data obtained. In response to not identifying the identifier (in the second database), the external circuitry 125 generates a new alias ID for the respective scale and user. The external circuitry 125 stores an indication of which scale and user corresponds to the alias ID in another database (e.g., the alias ID database 193). For example, the other database (e.g., the alias ID database 193) includes a list of alias IDs to scale ID and user ID to identify the scale corresponding to the alias ID and the respective user of the scale. Alternatively and/or in addition, the scale outputs user data with an alias ID. In some embodiments, the scale outputs the correlation of the alias ID with a respective scale and user to the external circuitry. As previously described, typically, the alias ID is
randomly generated, but it also can be generated by other means, such as a sequential generation or by generating a hash value of the sensitive data. In an example embodiment, the user of the external circuitry determines the format of the alias IDs. In another embodiment, the alias IDs have the same format as the original identifier.

In various embodiments, the scale and/or external circuitry 125 encrypts all and/or portions of the user data. For example, the encryption and decryption can be implemented with a single device (e.g., the external circuitry) capable of both encryption and decryption of data. In other embodiments, encryption is implemented using multiple devices (e.g., one for encryption and one for decryption).

After the alias IDs are generated, the external circuitry 125 can provide access to the user data with alias IDs. The access can include the external circuitry using the user data to provide a hierarchy of services. In some embodiments, at least one service provided includes providing portions of the user data to other circuitry 194 for analytic purposes and/or to a particular scale. When user data is requested, the external circuitry 125 can provide the user data with the alias IDs instead of the identifiers. In this manner, user data can be used without supplying the original identification of users/scales that correspond to the user data.

Each scale can include the scale, including the platform 101 and user display 102, as previously discussed with regard to FIG. 1a. For example, a scale at block 139 waits for a user to stand on the platform, and, optionally is in a reduced power-consumption mode of operation. User-corresponding data is input and/or received prior to and/or in response to the user standing on the scale. In response to the user standing on the scale, the scale collects signals indicative of cardio-physiological measurements (e.g., force signals). At block 124, the scale processes the signals to generate physiologic data manifested as user data and outputs the user data to the external circuitry 125. In various embodiments, the processing includes adding (and storing) data with a time stamp indicating a time at about when the physiologic data is obtained.

As previously discussed, the scales 127 secure the user data by removing portions of the user data that identifies the respective users and adding an identifier that uniquely identifies the user and the scale. The external circuitry 125 receives the user data and replaces the identifiers with alias IDs, stores the user data with the alias IDs in a user-specific knowledge database 192 and identifies which scale and user corresponds to the respective alias ID in another database 193.
As further previously discussed, the hierarchy of services are enabled based on user selection and activation of different service levels of different weighted values. The weighted values can authorize access to user data and/or functions performed on the user data and is based on the value to the user, provider of the service, and/or a third party. For example, when a user uses a scale, a base-level of services are provided and that have a weighted value of zero. The base-level can includes a subscription level zero and can include the scale providing weight measurements and collecting user data. In various embodiments, the subscription level zero includes outputting the user data to the external circuitry 125 to identify correlations between users and/or potential risks for conditions.

As a specific example, the user is provided a prompt for a first service, at block 195-1, based on the external circuitry 125 identifying a correlation. The correlation includes risks, priority of the user data, and/or social groupings. The prompt includes a notification displayed on a user interface, such as the FUI or a user interface of another user device that is in communication with the scale. The prompt can be provided in the middle of another action on the scale/device (e.g., interrupts the user or the device) or provided the next time the user accesses the scale/device. The user can be provided with the service in response to the user selecting the prompt on the respective user interface and/or activating the service level of the service by providing the weighted value. In a specific example, the user selects the prompt by moving their foot in relation to the user interface of the scale and verifying authorization of providing the weighted value (e.g., an amount or fee for the subscription level). Alternatively, the user selects the prompt and the weighted value is provided by another party, such as a researcher.

In a number of embodiments, the scale is configured to collect data for multiple users and identifies one or more of the multiple users of the scale that have priority user data. As previously described, the user data with a priority, as used herein, includes an importance of the user and/or the user data. The importance of the user is based on parameter values identified and/or user goals, such as the user is an athlete and/or is using the scale to assist in training for an event (e.g., marathon) or is using the scale for other user goals (e.g., a weight loss program). Further, the importance of the user data is based on parameter values and/or user input data indicating a diagnosis of a condition or disease and/or a risk of the user having the condition or disease based on the scale-obtained data. In some embodiments, only users with priority user data have data output to the external circuitry to determine risks and/or additional services to offer, although embodiments in accordance with the present disclosure are not so limited.
The first service pertains to the subscription level zero and includes a weighted value of zero. Any user of a scale can access services of the subscription level zero. In various embodiments, services of subscription level zero include generic health information, social groupings of consumer related interest, advertisements for products or services, and are in response to the user data from the scale.

In various embodiments, the external circuitry 125 identifies correlations between the user data of respective users. For example, the external circuitry 125 identifies various correlations between the user data stored in the user-specific knowledge database 192 and associated with different users. The correlations include various patterns, symptoms, risk, and/or other similar data between user data sets. The correlation, in some embodiments, includes grouping users into groups based on similar symptoms, physiological parameter values, diagnosis, prescription drug user, lifestyle habits, medical history and a combination thereof and identify correlations.

In some embodiments, the external circuitry 125 includes and/is in communication with a database storing reference information, as previously described. The reference information is stored in a structured database and/or in an unstructured database. In some embodiments, the reference information includes the user-specific knowledge database 192. The user-specific knowledge database 192 includes pooled user data from a plurality of scales that is updated over time. Data from the scales can be used to identify trends, risks, and/or parameter values associated with and/or indicative of particular conditions. In various embodiments, the pooled data is secured using a variety of security techniques, as described herein.

In response to the user selecting the prompt for the first service, the scale and/or external circuitry provides the first service. For example, the external circuitry 125 provides the scale with generic health information that is based on a risk that the user has a condition and/or is otherwise related to the user data (e.g., lifestyle or user goals). In other embodiments, the first service includes providing the user with a link to a webpage for a social group, such as a forum and/or page of a social network that is related to a consumer interest and based on the user data. Alternatively and/or in addition, the user is provided with various advertisements based on the user data. In some embodiments, in response to the user selecting the advertisement, the provider of the service and/or scales is provided with a weighted value.

In various embodiments, data resulting from and/or included in the service (e.g., first service, second service, etc.) is displayed on a user interface of the scale and/or a user
interface of another device, at block 196. Further, the data is stored on the scale and/or on external circuitry (e.g., physiological data database 107). For example, the scale receives the data from the external circuitry 125 and discerns data to display. In some embodiments, the scale includes a display configuration filter (e.g., circuitry and/or computer readable medium) configured to discern the data to display to the user, as previously described. The display configuration filter discerns portions of the data to display using the user interface based on the data and the demographic information, and discerns other portions of the data to display on another user device. The other user device is selected by the scale based on various communication settings. The communication settings include settings such as user settings (e.g., the user identifying user devices to output data to), scale-based biometrics (e.g., user configures scale, or default settings, to output data to user devices in response to identifying scale-based biometrics), and/or proximity of the user device (e.g., the scale outputs data to the closest user device among a plurality of user devices and/or in response to the user device being within a threshold distance from the scale), among other settings, as previously described.

The user selecting the prompt for the first service, in accordance with various embodiments, drives displaying a prompt for a second service, at block 195-2. The second service includes a service pertaining to a subscription level one. The subscription level one can provide services of a higher level than the subscription level zero and includes a first weighted value. The first weighted value is greater than zero and is based on the value of the service to the user, the service provider and/or a third party. The services of subscription level one can include providing the user data to a physician for diagnosis purposes, physiological social groupings, and/or advertisements for products or services based on diagnosis by the physician, among other services.

In response to the user selecting the prompt for the second service and providing the first weighted value, the first subscription level is activated and the second service is provided to the user. For example, the external circuitry 125 provides the user data to a physician and obtains diagnosis data from the physician in response to their review. Alternatively and/or in addition, the external circuitry 125 identifies other users with the diagnosis and/or similar physiological parameters and groups the users. Data resulting from the second service (e.g., diagnosis data, link to the social group, advertisements based on the diagnosis) is output from the external circuitry 125 to the scale for display to the user, at block 196.
The user selecting the prompt for the second service, in accordance with various embodiments, drives a display of a prompt for a third service, at block 195-3. The third service includes a service pertaining to a subscription level two. The subscription level two can provide services of a higher level than the subscription level one and includes a second weighted value. The second weighted value is based on the value of the service to the user, the service provider and/or a third party. In various embodiments, services of subscription level two include providing a subset of user data to a third party for research and/or studies, providing a subset of the user data to the user, providing physician advice and suggestions, providing additional services (e.g., track other data from other devices), professional social groupings, and/or among other services.

In response to the user selecting the prompt for the third service and providing the second weighted value, the second subscription level is activated and the third service is provided to the user. In various embodiments, a third party, such as a requester of the subset of user data provides the second weighted value. For example, the third service include providing subsets of the user data, at block 197. The data provided includes user data with the alias IDs as stored in the user-specific knowledge database 192, which is provided with the alias IDs to protect the identity of the users.

In various specific embodiments, the hierarchy of services includes providing a subset of the securely pooled user data to a requester, such as a physician and/or other researcher, and/or using the scales to participate in a study and/or experiment. The subset of user data provided to a requester is provided based on analysis parameters and security parameters. The analysis parameters are input by the requester for the data, and include parameters such as demographics of users, conditions or diseases, parameter values, lifestyle, and/or pseudo-random selection. The security parameters include restrictions on the user data output to protect the identity of the users and the user data, which include sensitive data. Various sources/entities request access to the user data. In some instances, the requester for the user data includes a researcher intending to perform research on the user data. Example sources/entities include government entities for research or census studies, environment groups, scientific research groups, including both private, academic, and public source, among other entities. The research is performed on existing user data and/or the requester requests specific data that is consequently obtained. As an example, in response to analytics performed and/or prior to, the researcher requests that the external circuitry contact particular user to perform an experiment. Various users are contacted based on the analysis parameters and are contacted through the user display of the scale and asked if they are
interested in participating in a statistic study, an experimental study, and/or an observation
study. In some embodiments, a portion of the users are used as a control group and the
remaining portion as an experimental group. The scale can be is used to perform the study
and/or encourage the user to actively participate.

In other embodiments, the requester for the user data includes a user of one of the
plurality of scales 127. For example, the user may be interested in learning about a
particular disorder. The user may know that they themselves have a disorder/condition or
have a goal or may be interested in learning more for someone they know. The user provides
the various analysis parameters using their scale and/or another user device. The scale

communicates with the external circuitry 125 to authorize the communication and outputs
data to the scale. The scale can output the user data to another user device, such that the user
can more easily view the data but the communication with the external circuitry 125 is
through the scale and responsive to identification of the user.

The external circuitry 125 identifies the various user data to output to the requester
based on the analysis parameters and the security parameters. In various embodiments, the
analysis parameters identify various types of user data, such as demographics of users,
conditions/disorders, lifestyle, user goals, physiological data, etc., that the requester is
interested in. In some embodiments, the analysis parameters establish various bias
parameters and/or requests for pseudo-random selection to provide analytics on a statistically
random sample population. The analysis parameters further include sample size (e.g.,
number of users) and/or data obtained. In other embodiments, the analysis parameters
identify various parameters, conditions or goals the requester is interested in learning about
and potential failures, successes, and/or correlated diagnosis. The external circuitry 125
scans the user-specific knowledge database 192 to identify various user data related to the
analysis parameters and collects the respective user data.

Based on the security parameters, the external circuitry 125 removes portions of the
user data and/or does not include the portions of the user data. Thus, the security parameters
restrict access to the user data. User data sets corresponding to each user include data that is
unrelated to the analysis parameters and/or otherwise not used for the purpose of analysis as
requested. Such data is not provided to the requester. The security parameters can include
specific data that cannot be accessed by requesters and/or restrictions on combinations of
data. The identification can be based on the risk of the data, such as location data and/or
date of birth.
The user data can have a sensitivity value that identifies a security risk of the data. The sensitivity values are set by the external circuitry 125 and/or the users of the scales. User data types with a sensitivity value above a threshold value may not be provided to requesters. Alternatively, data is provided based on a security of the requester. For example, if the requester has a high amount of security measures in place, a greater amount of data and/or data with higher sensitivity values is provided. If the requester has a low amount of security in place, a lower amount of data and/or only data with lower sensitivity values is provided. Examples of security measures in place include firewalls, encryption schemes used, access to the requesters database by external sources, authentication of people when accessing the data, such as tokens, passwords, and/or biometrics, among other security measures. As previously described, the scale can define a user data table that defines types of user data and sensitivity values of each type.

In various related embodiments, the security parameters include a set of rules restricting access to combinations of user data. For example, a particular requester is provided user data of particular combinations. The rules may include "can receive 2 out of the three: height, data of birth, and location data." The set of rules prevents or mitigates the requester from being able to identify the user's identities. The external circuitry 125, in some embodiments, changes the alias IDs each time a requester requests user data to prevent the requester from correlating a first data set with a second data set and obtaining the combination of user data that the set of rules are designed to prevent.

In a number of aspects, the user-specific knowledge database 192 includes a bias. For example, the user of the scale may include health conscious users and/or unhealthy or sick users. The bias can be such that the user-specific knowledge database 192 does not represent a random sample census of user data from a population. The external circuitry 125, optionally, identifies what the potential bias is. The external circuitry 125 provides the identified potential bias to the requester so that the requester can correct for the bias by adjusting the selection of user data and/or the external circuitry 125 can adjust the selection of user data to correct for the bias.

The external circuitry 125 (and/or the scale) can periodically change one or more alias IDs and updates the second database 193. For example, the external circuitry assigns a new alias ID to user data corresponding to a specific user each time the scale sends user data to the external circuitry. If previous data is compromised, such as by a security hacker, subsequent user data is more difficult to correlate to the previously compromised data. The external circuitry 125 identifies that the subsequent user data is correlated with a generic user.
and previously provided user data based on a correlation of the old alias ID with the new alias ID. For example, the first database, as previously discussed, includes generic user profiles corresponding with the alias IDs. The alias IDs of the generic user profiles can be updated in response to the changes in alias IDs. Alternatively, the correlation between the old alias ID and changed alias ID is stored in the second database and used to identify correlations of subsequent user data with historical user data.

As previously discussed, the external circuitry 125 can identify correlations and the correlation can used to provide generic health information to the user. For example, the external circuitry 125 identifies the scale and user that the particular user data is associated with and outputs data, such as the generic health information, to the identified scale. The external circuitry 125 identifies generic health information to provide the user and outputs the generic health information to the scale. The generic health information is displayed to the user, such as using the scale display or another user device depending on user preferences. As an example, the scale displays an indication that additional information is available to the user and/or a synopsis of the additional information and to log-in to their smartphone or other user device to view the additional information. The correlation can include identified risks. For example, external circuitry receives the user data and identifies a risk that the user has a condition using the user-specific knowledge database 192 and/or reference information, as previously described. The generic health information suggests prescription medicine to the user to ask their physician about and/or provides potential symptoms that the user should watch for and/or should go to the physician's office or an emergency room if the symptoms arise.

In various embodiments, the external circuitry 125 revises correlations identified using the (securely) pooled user data in the user-specific knowledge database 192 over time. For example, user data is received from a plurality of scales over time. Additional users receive a scale and provide additional data. Further, over time, the scale obtains additional data from the user. The external circuitry dynamically revises and updates correlations of the user-specific knowledge database based on the additional user data received from the plurality of scales and additional scales added to the system.

The external circuitry can update the user-specific knowledge database 192 using various user information. For example, the user-specific knowledge database 192 includes user data from a plurality of scales. The external circuitry and/or the scale updates the database 192 with the user data, the test results, and the responses to the questions. For example, the responses to the questions may identify a diagnosis the user has from a doctor.
and/or additional symptoms the user is experiencing. This information is used to
dynamically update the database 192 and potentially revises (e.g., increase or decreases) risks identified by the external circuitry.

In a number of embodiments, the scale including the processing circuitry provides a number of questions to the user in response to input from the external circuitry 125. The questions can be provided via a speaker component of the scale outputting computer generated natural voice (via a natural language interface), displaying the questions on the user display, and/or outputting the questions to another user-device. In specific embodiments, the scale uses voice input/output circuitry to provide questions to the user and/or to obtain answers to the questions, as previously described. The scale provides the input to the external circuitry 125 and the external circuitry verifies or revises the risk identified. Further, the external circuitry updates the user-specific knowledge database 192.

As a specific example, the external circuitry 125 receives the user data that corresponds to the plurality of users from the plurality of scales. The respective user data is received at over-lapping times and/or separate times. In response to receiving the user data, the external circuitry identifies the respective plurality of users based on an identifier and/or other identifying data and, correlates the received user data with generic profiles of the respective plurality of users based on an already generated alias ID and/or a newly generated alias ID. The external circuitry identifies that a particular user is at risk for the condition or disease by comparing the user data with reference information, identifies the respective user and scale using the second database, and outputs the generic health information to the scale that is tailored to each respective user based on the risk for the condition. The external circuitry further instructs the scales to collect feedback data, including symptoms, experiences, demographic information, medical history information etc., and uses the feedback data to revise and/or verify the risk. The feedback data and the user data is used to update a user-specific knowledge database 192, which is used to refine the identified risks.

Although the present embodiments illustrate discussion of three subscription levels and particular services for subscription levels, the embodiments are not limited to the number of subscription levels described and/or services listed. For example, one or more of the above listed services, in some embodiments, are included in an additional level and/or in a higher or lower level of subscription than described.

FIG. 10-1p show examples of different subscription levels for providing a hierarchy of services, consistent with various aspects of the present disclosure. For example, FIG. 10 illustrates an example of a hierarchy of services provided from five subscription levels. A
prompt for the various services is provided to a particular user in response to scale-obtained data and/or previous selection of a prompt for another service. In this manner, the users of the scales are provided with prompts for information in response to their scale-obtained data indicating risks for conditions and/or based on user-specific interests to prevent users from being over-whelmed with data and/or receiving data that is not interesting. Further, users indicate an interest in obtaining additional data and services by selecting prompts for the services of the hierarchy.

As illustrated, subscription level zero 198-1 has a weight of zero. A prompt for a service pertaining to subscription level zero 198-1 is provided to a user of the scale in response to the user data obtained using the scale. Further, the service is provided to the user in response to the user selecting the prompt. Example services for subscription level zero include generic health information, advertisements, and non-prescription health information that is correlated to the scale-obtained user data.

Subscription level one 198-2 has a first weighted value. A prompt for a service pertaining to subscription level one 198-2 is provided to a user of the scale in response to the user selecting a prompt for a service of subscription level zero 198-1. The first weighted value, in various embodiments, is greater than zero. Further, the service is provided to the user in response to the user selecting the prompt and providing the first weighted value. Example services for subscription level one 198-2 include providing the scale-obtained data to a physician for diagnosis purposes.

Subscription level two 198-3 has a second weighted value. A prompt for a service pertaining to subscription level two 198-3 is provided to a user of the scale in response to the user selecting a prompt for a service of subscription level one 198-2 and activating the subscription level one 198-2 by providing the first weighted value. The second weighted value can be greater than the first weighted value. Further, the service is provided to the user in response to the user selecting the prompt and providing the second weighted value. Example services for subscription level two 198-3 include providing the user access to different social groups based on the diagnosis and/or professional social groups.

Subscription level three 198-4 has a third weighted value. A prompt for a service pertaining to subscription level three 198-4 is provided to a user of the scale in response to the user selecting a prompt for a service of subscription level two 198-3 and activating the subscription level two 198-3 by providing the second weighted value. The third weighted value can be greater than the second weighted value. Further, the service is provided to the user in response to the user selecting the prompt and providing the third weighted value.
Example services for subscription level three 198-4 include additional physician-provided advices and suggestions, such as titration of prescriptions and/or further tracking of user data, and/or tracking of data from additional devices.

Subscription level four 198-5 has a fourth weighted value. A prompt for a service pertaining to subscription level four 198-5 is provided to a user of the scale in response to the user selecting a prompt for a service of subscription level three 198-4 and activating the subscription level three 198-4 by providing the third weighted value. The fourth weighted value can be greater than the third weighted value. The service is provided to the user in response to the user selecting the prompt and providing the fourth weighted value. The fourth weighted value can be provided by a third party, such as a physician and/or researcher. Example services for subscription level four 198-5 include participation in a study and/or experiment that is physician-led and/or research-based.

As previously described, the scale can be used in different setting and/or modes, such as a consumer mode, a professional mode, and a combination mode. In an example consumer mode, five different people use the scale, and three of the five people have activated subscription levels above a zero or base level. Prior to providing a service to a user, the identity of the respective user is verified via the scale using scale-based biometric. In an example professional mode, similar to the consumer mode, the scale can selectively provide the services by verifying the identity of the user. The identification can include higher-level biometrics and/or identifications than the consumer mode. As a specific professional mode example, a scale is located at a doctor’s office and is used to obtain data from multiple patients (e.g., 10 in a day, 500 in a year). When a patient checks-in, they stand on the scale and the scale-obtained data is output to external circuitry for document retention and/or other purposes. A subset (or all) of the patients participate or use a service that corresponds with and/or includes acquisition and/or aggregation of data from a user device and the scale, and provides the aggregated data to the doctor (via external circuitry, such as server CPU) for review. In an example combination consumer/professional mode, a scale is located at a user’s dwelling and used by multiple family members. A first user of the family is diagnosed with a heart-related condition and the doctor may offer a service to review data from the scale of the first user. When the other family members stand on the scale, the scale operates in the consumer mode. When the first user that is diagnosed with heart-related condition stands on the scale, the scale recognizes the user and operates in a professional mode or a combination mode.
The hierarchy of services offered and/or corresponding levels can be different between the different operation modes. In an example consumer mode, the hierarchy of services offered can include services based on scale-obtained data at one or more lower subscription levels, services based on pooled data from a plurality of scales at one or more middle subscription levels, and services based on physician or other professional review at one or more higher subscription levels. For example, in a consumer mode, a first subscription level service may include providing the user access to health magazines that correspond to the user based on scale-obtained data, a second subscription level service may include providing the user access to a social group of the other users with similar demographic background and/or health condition, and a third subscription level may include providing physician diagnosis of the user based on scale-obtained data.

In an example professional mode, the hierarchy of services offered can include services based on scale-obtained data at one or more lower subscription levels, services related to the professional and/or business at one or more middle subscription levels, and services for a study and/or research at one or more higher subscription levels. For example, in a professional mode, a first subscription level service may include providing the user with access to health information that corresponds to the user based on scale-obtained data, a second subscription level service may include the physician tracking various data from the user over time, a third subscription level service may include a physician's using the data obtained from the user in a study. To participate in the study, the user may be given access to a social group and/or purchase (or be provided as compensation) a scale for use at home and to communicate with external circuitry.

In an example combination mode, the hierarchy of services offered can include services based on scale-obtained data at one or more lower subscription levels, services based on data communicated between multiple scales and/or user devices at one or more middle subscription levels, and pooled data from a plurality of scale's at one or more higher subscription levels. For example, in a combination mode, a first subscription level service may include providing the user with access to health information that corresponds to the user based on scale-obtained data, a second subscription level service may include communicating data from the scale to another scale or other circuitry (at the professional location or consumer location, respectively), and a third subscription level service may include a use by the professional or other business, such as a study by the physician, on-demand personal training by an exercise facility, review of the scale-obtained data, generating and monitoring progress toward a goal and/or lifestyle changes, etc. The above
described hierarchy of services for different scale operation modes includes examples and
the embodiments in accordance with the present disclosure are not so limited.

FIG.1p shows an example of a hierarchy of social grouping services provided using
scale-based user physiological data consistent with aspects of the present disclosure. The
social grouping services illustrated by FIG.1p, in various embodiments, is provided in
combination with the services illustrated by FIG. 1o.

In various embodiments, the external circuitry groups respective sets of user data
into groups. The groups are based on demographics, user goals, symptoms, physiological
parameter values, diagnosis, prescription drug usage, lifestyle habits, medical history, family
medical history, and a combination thereof. For example, the external circuitry groups user
data based on fitness goals (current or historical). The correlation can be provided to the
user, without identifying other users, such that the user identifies how other users of a similar
demographic reached their fitness goals. In other embodiments, the correlation includes
users with a specific condition, disorder, and/or disease and causes of improvements or
potential lack of improvement of symptoms of the condition, disorder and/or disease, such as
lifestyle changes, prescription drugs, and/or change in exercise habits or geographic location.
The securely pooled user data can be used to educate users based on other user's successes,
failures, and/or general result.

The hierarchy of services can be based on the grouping of users. For example, one or
more services of one or more subscription levels includes providing access to different social
grouping of users. The access can include access to a forum, webpage, and/or application.
Alternatively and/or in addition, the access is to reports and/or dashboards of scale-obtained
data from the users of the social group over a period of time, such as changes in
physiological parameters and/or weights and potential causes of the changes (e.g.,
treatments, exercise, lifestyle changes). Social groupings, as used herein, includes grouping
of a set of scale users based on scale-obtained data. The forum, webpage, and/or application
provided as the service includes automatically linking the uses of the group and providing
the users access. The forum, webpage and/or application can be automatically populated
with reports of the user, such as rankings, progress of the users, new observation, and/or
other information. Further, users in the social groupings can remain anonymous and are
identified by their alias ID and/or another ID selected by the user. In some embodiments,
the social groups are intra scale or inter scale. For example, the scale is configured to collect
user data for two or more users and correlate the respective data with a user profile of each
respective users. The social grouping can include the users of the scale (e.g., intra scale) and/or users of different scales (e.g., inter scale) based on the pooled database of user data.

The social grouping of an intra scale includes grouping the users of the scale and providing various reports, updates, alerts, and/or forums for the users of the group to interact. The forum, blog, and/or webpage can include a private (or public) page of a social network webpage that the users of the group access and communicate. A private page, for instance, is only accessible by the users of the group and/or persons authorized by users of the group. In other embodiments, the social groupings are inter scale. For example, an external circuitry, such as a server CPU, may receive user data (with user identifying data removed) from a plurality of scales and identifies various users with correlated user data. The users with correlated user data are grouped by the external circuitry without user input. The external circuitry outputs an indication of an available social group to the scales of the users with the correlated user data and each scale displays, using the user interface of the scale, an alert of an available social group. The user accesses the social grouping using the user interface of the scale and/or a standalone CPU that is in communication with the scale. For example, in response to an alert, the user selects an interest in the social grouping using the user interface of the scale. The scale outputs the indication and a link to a webpage or application associated with the social group (or information on how to access the social grouping) via the standalone CPU, such as a user smartphone or tablet. The webpage can include a page of a social network, an application or portal for the user to log-in to, a forum, etc. Data can be tracked for users of the social group and reports are provided, such as rankings of the users in the group, progress of the users, new observations, and/or information learned. The indication can include a notification that a report and/or dashboard is available and/or an alert. Alternatively and/or in addition, the users of the group are provided a forum to discuss various health issues, successes, failures, exercise, eating, etc.

As a specific example, a scale is used by a family training for a marathon. Each member of the family uses the scale to track various physiological parameters, including cardiogram related characteristics, recovery parameters, weight, body-mass-index, and exercise results. The family is grouped into an intra scale social grouping and provided with alerts when reports of progress and/or rankings are available for the family. In another specific example, multiple scales are used by different users located at different locations that have indicators for atrial fibrillation, are female, are over-weight, and are over the age of sixty-years old. The users are grouped into an inter scale social grouping and provided with an alert of an available social grouping. In response to at least a subset of the users selecting
an interest in the social grouping, the subset of users are provided with a link to a webpage, portal, application, and/or forum. The subset of users access the link and are connected to one another. In various embodiments, user data (with user identifying data removed) is displayed to the social group so that users can view other users’ success and/or failures.

In a number of specific embodiments, social groupings are provided as services in a plurality of different subscription levels. The subscription levels can have various weighted values, as previously described. For example, in a subscription level zero 199-1, a user is provided access to a social group based on an exercise interest and/or goals or other consumer related interest. A prompt for the social group pertaining to subscription level zero is provided to a user of the scale in response to the user data obtained using the scale. Further, access to the social group is provided to the user in response to the user selecting the prompt.

At a first subscription level 199-2, a user is provided access to physiological social group, which is based on scale-obtained data and/or diagnosis of the scale-obtained data by a physician. A prompt for a physiological social group pertaining to the first subscription level 199-2 is provided to a user of the scale in response to the user selecting a prompt for a service of subscription level zero 199-1. Further, access to the physiological social group is provided to the user in response to selecting the prompt and providing the first weighted value.

At a second subscription level 199-3, a user is provided access to the (more) professional social group. For example, a physician may participate in the professional social group with other users and/or actively track progress of the user. Alternatively and/or in addition, the physician uses the professional social group to perform a study and/or experiment. A prompt for a professional social group pertaining to second subscription level 199-3 is provided to a user of the scale in response to the user selecting a prompt for a service of first subscription level 199-2. Further, access to the professional social group is provided to the user in response to selecting the prompt and providing the second weighted value.

The remaining figures illustrate various ways to collect the physiologic data from the user, electrode configurations, and alternative modes of the processing circuitry 104. For general and specific information regarding the collection of physiologic data, electrode configurations, and alternative modes, reference is made to U.S. Patent Application 14/338,266 filed on October 7, 2015, which is hereby fully incorporated by references for its teachings.
FIG. 1q shows current paths 100 through the body of a user 105 standing on a scale 110 for the IPG trigger pulse and Foot IPG, consistent with various aspects of the present disclosure. Impedance measurements 115 are measured when the user 105 is standing and wearing coverings over the feet (e.g., socks or shoes), within the practical limitations of capacitive-based impedance sensing, with energy limits considered safe for human use. The measurements 115 can be made with non-clothing material placed between the user's bare feet and contact electrodes, such as thin films or sheets of plastic, glass, paper or wax paper, whereby the electrodes operate within energy limits considered safe for human use. The IPG measurements can be sensed in the presence of callouses on the user's feet that normally diminish the quality of the signal.

As shown in FIG. 1q, the user 105 is standing on a scale 110, where the tissues of the user's body will be modeled as a series of impedance elements, and where the time-varying impedance elements change in response to cardiovascular and non-cardiovascular movements of the user. ECG and IPG measurements sensed through the feet can be challenging to take due to small impedance signals with (1) low SNR, and because they are (2) frequently masked or distorted by other electrical activity in the body such as the muscle firings in the legs to maintain balance. The human body is unsteady while standing still, and constant changes in weight distribution occur to maintain balance. As such, cardiovascular signals that are measured with weighing scale-based sensors typically yield signals with poor SNR, such as the Foot IPG and standing BCG. Thus, such scale-based signals require a stable and high quality synchronous timing reference, to segment individual heartbeat-related signals for signal averaging to yield an averaged signal with higher SNR versus respective individual measurements.

The ECG can be used as the reference (or trigger) signal to segment a series of heartbeat-related signals measured by secondary sensors (optical, electrical, magnetic, pressure, microwave, piezo, etc.) for averaging a series of heartbeat-related signals together, to improve the SNR of the secondary measurement. The ECG has an intrinsically high SNR when measured with body-worn gel electrodes, or via dry electrodes on handgrip sensors. In contrast, the ECG has a low SNR when measured using foot electrodes while standing on said scale platforms; unless the user is standing perfectly still to eliminate electrical noise from the leg muscles firing due to body motion. As such, ECG measurements at the feet while standing are considered to be an unreliable trigger signal (low SNR). Therefore, it is often difficult to obtain a reliable cardiovascular trigger reference timing when using ECG sensors incorporated in base scale platform devices. Both Inan, et al. (IEEE Transactions on
Information Technology in Biomedicine, 14:5, 1188-1196, 2010) and Shin, et al. (Physiological Measurement, 30, 679-693, 2009) have shown that the ECG component of the electrical signal measured between the two feet while standing was rapidly overpowered by the electromyogram (EMG) signal resulting from the leg muscle activity involved in maintaining balance.

The accuracy of cardiovascular information obtained from weighing scales is also influenced by measurement time. The number of beats obtained from heartbeats for signal averaging is a function of measurement time and heart rate. Typically, a resting heart rates range from 60 to 100 beats per minute. Therefore, short signal acquisition periods may yield a low number of beats to average, which may cause measurement uncertainty, also known as the standard error in the mean (SEM). SEM is the standard deviation of the sample mean estimate of a population mean. Where, \( SE \) is the standard error in the samples \( N \), which is related to the standard error or the population \( S \). The following is an example \( SE \) for uncorrected noise:

\[
SE = \frac{S}{\sqrt{N}}
\]

For example, a five second signal acquisition period may yield a maximum of five to eight beats for ensemble averaging, while a 10 second signal acquisition could yield 10-16 beats. However, the number of beats available for averaging and SNR determination is usually reduced for the following factors; (1) truncation of the first and last ensemble beat in the recording by the algorithm, (2) triggering beats falsely missed by triggering algorithm, (3) cardiorespiratory variability, (4) excessive body motion corrupting the trigger and Foot IPG signal, and (5) loss of foot contact with the measurement electrodes.

Sources of noise can require multiple solutions for SNR improvements for the signal being averaged. Longer measurement times increase the number of beats lost to truncation, false missed triggering, and excessive motion. Longer measurement times also reduce variability from cardiorespiratory effects. If shorter measurement times (e.g., less than 30 seconds) are desired for scale-based sensor platforms, sensing improvements need to tolerate body motion and loss of foot contact with the measurement electrodes.

The human cardiovascular system includes a heart with four chambers, separated by valves that return blood to the heart from the venous system into the right side of the heart, through the pulmonary circulation to oxygenate the blood, which then returns to the left side...
of the heart, where the oxygenated blood is pressurized by the left ventricles and is pumped into the arterial circulation, where blood is distributed to the organs and tissues to supply oxygen. The cardiovascular or circulatory system is designed to ensure oxygen availability and is often the limiting factor for cell survival. The heart normally pumps five to six liters of blood every minute during rest and maximum cardiac output during exercise increases up to seven-fold, by modulating heart rate and stroke volume. The factors that affect heart rate include autonomic innervation, fitness level, age and hormones. Factors affecting stroke volume include heart size, fitness level, contractility or pre-ejection period, ejection duration, preload or end-diastolic volume, afterload or systemic resistance. The cardiovascular system is constantly adapting to maintain a homeostasis (set point) that minimizes the work done by the heart to maintain cardiac output. Blood pressure is continually adjusting to minimize work demands during rest. Cardiovascular disease encompasses a variety of abnormalities in (or that affect) the cardiovascular system that degrade the efficiency of the system, which include but are not limited to chronically elevated blood pressure, elevated cholesterol levels, edema, endothelial dysfunction, arrhythmias, arterial stiffening, atherosclerosis, vascular wall thickening, stenosis, coronary artery disease, heart attack, stroke, renal dysfunction, enlarged heart, heart failure, diabetes, obesity and pulmonary disorders.

Each cardiac cycle results in a pulse of blood being delivered into the arterial tree. The heart completes cycles of atrial systole, delivering blood to the ventricles, followed by ventricular systole delivering blood into the lungs and the systemic arterial circulation, where the diastole cycle begins. In early diastole the ventricles relax and fill with blood, then in mid-diastole the atria and ventricles are relaxed and the ventricles continue to fill with blood. In late diastole, the sinoatrial node (the heart's pacemaker) depolarizes then contracting the atria, the ventricles are filled with more blood and the depolarizationthen reaches the atroventricular node and enters the ventricular side beginning the systole phase. The ventricles contract and the blood is pumped from the ventricles to arteries.

The ECG is the measurement of the heart's electrical activity and is described in five phases. The P-wave represents atrial depolarization, the PR interval is the time between the P-wave and the start of the QRS complex. The QRS wave complex represents ventricular depolarization. The QRS complex is the strongest wave in the ECG and is frequently used as a timing reference for the cardiovascular cycle. Atrial repolarization is masked by the QRS complex. The ST interval represents the period of zero potential between ventricular depolarization and repolarization. The cycle concludes with the T-wave representing ventricular repolarization.
The blood ejected into the arteries creates vascular movements due to the blood's momentum. The blood mass ejected by the heart first travels headward in the ascending aorta and travels around the aortic arch then travels down the descending aorta. The diameter of the aorta increases during the systole phase due to the high compliance (low stiffness) of the aortic wall. Blood traveling in the descending aorta bifurcates in the iliac branch which transitions into a stiffer arterial region due to the muscular artery composition of the leg arteries. The blood pulsation continues down the leg and foot. Along the way, the arteries branch into arteries of smaller diameter until reaching the capillary beds where the pulsatile blood flow turns into steady blood flow, delivering oxygen to the tissues. The blood returns to the venous system terminating in the vena cava, where blood returns to the right atrium of the heart for the subsequent cardiac cycle.

Surprisingly, high quality simultaneous recordings of the Leg IPG and Foot IPG are attainable in a practical manner (e.g., a user operating the device correctly simply by standing on the impedance body scale foot electrodes), and can be used to obtain reliable trigger fiducial timings from the Leg IPG signal. This acquisition can be far less sensitive to motion-induced noise from the Leg EMG that often compromises Leg ECG measurements. Furthermore, it has been discovered that interleaving the two Kelvin electrode pairs for a single foot, result in a design that is insensitive to foot placement within the boundaries of the overall electrode area. As such, the user is not constrained to comply with accurate foot placement on conventional single foot Kelvin arrangements, which are highly prone to introducing motion artifacts into the IPG signal, or result in a loss of contact if the foot is slightly misaligned. Interleaved designs begin when one or more electrode surfaces cross over a single imaginary boundary line separating an excitation and sensing electrode pair. The interleaving is configured to maintain uniform foot surface contact area on the excitation and sensing electrode pair, regardless of the positioning of the foot over the combined area of the electrode pair.

Various aspects of the present disclosure include a weighing scale platform (e.g., scale 110) of an area sufficient for an adult of average size to stand comfortably still and minimize postural swaying. The nominal scale length (same orientation as foot length) is 12 inches and the width is 12 inches. The width can be increased to be consistent with the feet at shoulder width or slightly broader (e.g., 14 to 18 inches, respectively).

FIG. 1r is a flow chart depicting an example manner in which a user-specific physiologic meter or scale may be programmed in accordance with the present disclosure. This flow chart uses a computer processor circuit (or central processing unit
(CPU)) along with a memory circuit shown herein as user profile memory 146a. The CPU operates in a low-power consumption mode, which may be in off mode or a low-power sleep mode, and at least one other higher power consumption mode of operation. The CPU can be integrated with presence and/or motion sense circuits, such as a passive infrared (PIR) circuit and/or pyroelectric PIR circuit. In a typical application, the PIR circuit provides a constant flow of data indicative of amounts of radiation sensed in a field of view directed by the PIR circuit. For instance, the PIR circuit can be installed behind an upper surface which is transparent to infrared light (and/or other visible light) of the platform and installed at an angle so that the motion of the user approaching the platform apparatus is sensed. Radiation from the user, upon reaching a certain detectable level, wakes up the CPU which then transitions from the low-power mode, as depicted in block 140, to a regular mode of operation. Alternatively, the low-power mode of operation is transitioned from a response to another remote/wireless input used as a presence to awaken the CPU. In other embodiments, user motion can be detected by an accelerometer integrated in the scale or the motion is sensed with a single integrated microphone or microphone array, to detect the sounds of a user approaching.

The flow proceeds to block 142 where the user or other intrusion is sensed as data received at the platform apparatus. At block 144, the circuitry assesses whether the received data qualifies as requiring a wake up. If not, flow turns to block 140. If however, wake up is required, flow proceeds from block 144 to block 146 where the CPU assesses whether a possible previous user has approached the platform apparatus. This assessment is performed by the CPU accessing the user profile memory 146A and comparing data stored therein for one or more such previous users with criteria corresponding to the received data that caused the wake up. Such criteria includes, for example, the time of the day, the pace at which the user approached the platform apparatus as sensed by the motion detection circuitry, the height of the user as indicated by the motion sensing circuitry and/or a camera installed and integrated with the CPU, and/or more sophisticated bio-metric data provided by the user and/or automatically by the circuitry in the platform apparatus. As discussed herein, such sophisticated circuitry can include one or more of the following user-specific attributes: foot length, type of foot arch, weight of user, and/or manner and speed at which the user steps onto the platform apparatus, or sounds made by the user's motion or by user speech (e.g., voice). In some embodiments, facial or body-feature recognition may also be used in connection with the camera and comparisons of images therefrom to images in the user profile memory.
From block 146, flow proceeds to block 148 where the CPU obtains and/or updates user corresponding data in the user profile memory. As a learning program is developed in the user profile memory, each access and use of the platform apparatus is used to expand on the data and profile for each such user. From block 148, flow proceeds to block 150 where a decision is made regarding whether the set of electrodes at the upper surface of the platform are ready for the user, such as may be based on the data obtained from the user profile memory. For example, delays may ensue from the user moving his or her feet about the upper surface of the platform apparatus, as may occur while certain data is being retrieved by the CPU (whether internally or from an external source such as a program or configuration data updates from the Internet cloud) or when the user has stepped over the user display. If the electrodes are not ready for the user, flow proceeds from block 150 to block 152 to accommodate this delay.

Once the CPU determines that the electrodes are ready for use while the user is standing on the platform surface, flow proceeds to block 160. Stabilization of the user on the platform surface may be ascertained by injecting current through the electrodes via the interleaved arrangement thereof. Where such current is returned via other electrodes for a particular foot and/or foot size, and is consistent for a relatively brief period of time, for example, a few seconds, the CPU can assume that the user is standing still and ready to use the electrodes and related circuitry. At block 160, a decision is made that both the user and the platform apparatus are ready for measuring impedance and certain segments of the user's body, including at least one foot.

The remaining flow of FIG. 1r includes the application and sensing of current through the electrodes for finding the optimal electrodes (162) and for performing impedance measurements (block 164). These measurements are continued until completed at block 166 and all such useful measurements are recorded and are logged in the user profile memory of the user, at block 168. At block 172, the CPU generates output data to provide feedback and, as can be indicated as a request via the user profile for this user, as an overall report on the progress for the user and relative to previous measurements made for this user has stored in the user profile memory. Such feedback may be shown on the user display, through a speaker with co-located apertures in the platform for audible reception by the user, and/or by vibration circuitry which, upon vibration under control of the CPU, the user can sense through one or both feet while standing on the scale. From this output at block 172, flow returns to the low power mode as indicated at block 174 with the return to the beginning of the flow at the block 140.
FIG. 2a shows an example of the insensitivity to foot placement 200 on scale electrode pairs 205/210 with multiple excitation paths 220 and sensing current paths 215, consistent with various aspects of the present disclosure. An aspect of the platform is that it has a thickness and strength to support a human adult of at least 200 pounds without fracturing, and another aspect of the device platform is comprised of at least six electrodes, where the first electrode pair 205 is solid and the second electrode pair 210 are interleaved. Another aspect is the first and second interleaved electrode pairs 205/210 are separated by a distance of at least 40 +/- 5 millimeters, where the nominal separation of less than 40 millimeters has been shown to degrade the single Foot IPG signal. Another key aspect is the electrode patterns are made from materials with low resistivity such as stainless steel, aluminum, hardened gold, ITO, index matched ITO (IMITO), carbon printed electrodes, conductive tapes, silver-impregnated carbon printed electrodes, conductive adhesives, and similar materials with resistivity lower than 300 ohms/sq. The resistivity can be below 150 ohms/sq. The electrodes are connected to the electronic circuitry in the scale by routing the electrodes around the edges of the scale to the surface below, or through at least one hole in the scale (e.g., a via hole).

Suitable electrode arrangements for dual Foot IPG measurements can be realized in other embodiments. In certain embodiments, the interleaved electrodes are patterned on the reverse side of a thin piece (e.g., less than 2mm) of high-ion-exchange (HIE) glass, which is attached to a scale substrate and used in capacitive sensing mode. In certain embodiments, the interleaved electrodes are patterned onto a thin piece of paper or plastic which can be rolled up or folded for easy storage. In certain embodiments, the interleaved electrodes are integrated onto the surface of a tablet computer for portable IPG measurements. In certain embodiments, the interleaved electrodes are patterned onto a kapton substrate that is used as a flex circuit.

In certain embodiments, the scale area has a length of 10 inches with a width of eight inches for a miniature scale platform. Alternatively, the scale may be larger (up to 36 inches wide) for use in bariatric class scales.

In the present disclosure, the leg and foot impedance measurements can be simultaneously carried out using a multi-frequency approach, in which the leg and foot impedances are excited by currents modulated at two or more different frequencies, and the resulting voltages are selectively measured using a synchronous demodulator as shown in FIG. 3a. This homodyning approach can be used to separate signals (in this case, the voltage drop due to the imposed current) with very high accuracy and selectivity.
This measurement configuration is based on a four-point configuration in order to minimize the impact of the contact resistance between the electrode and the foot, a practice well-known in the art of impedance measurement. In this configuration the current is injected from a set of two electrodes (the "injection" and "return" electrodes), and the voltage drop resulting from the passage of this current through the resistance is sensed by two separate electrodes (the "sense" electrodes), usually located in the path of the current. Since the sense electrodes are not carrying any current (by virtue of their connection to a high-impedance differential amplifier), the contact impedance does not significantly alter the sensed voltage.

In order to sense two distinct segments of the body (the legs and the foot), two separate current paths are defined by electrode positioning. Two injection electrodes can be used, each connected to a current source modulated at a different frequency. The injection electrode for leg impedance is located under the plantar region of the left foot, while the injection electrode for the Foot IPG is located under the heel of the right foot. Both current sources share the same return electrode located under the plantar region of the right foot. This is an illustrative example and other configurations may be used. The sensing electrodes can be localized so as to sense the corresponding segments. Leg IPG sensing electrodes are located under the heels of each foot, while the two foot sensing electrodes are located under the heel and plantar areas of the right foot. The inter-digitated nature of the right foot electrodes ensures a four-point contact for proper impedance measurement, irrespectively of the foot position.

FIGs. 2b-2e shows top views of a number of multifunction scale displays, consistent with various aspects of the present disclosure. FIG. 2b presents an exemplary image that may be selected by a user as a "screen saver," and displayed by the scale, in a large-area display mode 221, when not in use. In further embodiments, the scale, when not in use may enter "sleep mode" and present or display pleasant still or video images, including a slide-show of images selected by the user, such as family-photos or other pleasant preferred images or animations. In more specific embodiments of the present disclosure, a camera is communicatively coupled to the multifunction scale and operates with facial recognition software for identifying the user and greeting the user ("Hello Michael"). The apparatus may also identify the user based on multiple measurement characteristics (e.g., weight, body composition, body mass index (BMI), body fat percentage, PWV, etc., alone or correlated with additional measurements), and greet the user accordingly. Based on the identified user, the scale may operate in accordance with user-specific aspects as may relate to physiology or
preferences such as for a "screen saver." For instance, biometric and physiological tests can be conducted, with the test results saved to the identified user's file (and/or the results sent to a user's doctor for further review and analysis), as well as a number of other functionalities, such as playing the user's favorite musical artist and loading the display to present the user with pertinent information. Further, the scale may offer multiple modes that the user may choose between to ensure greater accuracy of physiological testing results, such as "athlete mode" for users that are very active.

As shown in FIG. 2c, a relaxing ambience may be provided to the room where the multifunction scale is located, such as by displaying a video of waves lapping over sand, in a large-area display mode of the display 221 (when the user is not standing on the scale). In some embodiments, the scale plays an audio track associated with the video. In FIGs. 2d-3, a reduced-area display mode 223 is utilized when the user is standing on the scale. In such an embodiment, the display area where the user is standing, 222 is turned-off as the user's feet prevent the user from seeing this portion of the screen 222, and the disabling of the display area 222 reduces battery consumption of the display 221.

While the scale conducts tests on the user (e.g., weight measurements, body fat, biometric and physiological tests (e.g., ballistocardiogram (BCG) or pulse wave velocity (PWV), etc.) or whenever the user desires, the user is able to access other information from the scale such as the user's current weight, pulse rate, and time of day, among other user-configurable information. In further more specific embodiments, as shown in 2d, the scale displays general or user-specific information, such as weather conditions, stocks, news, traffic conditions, home climate (e.g., screening air quality, oxygen level, temperature), commute times, user's daily schedule, personal reminders, or other information as may be collected by the scale via a wired or wireless connection to the internet, or to a smart device (e.g., a hand-held mobile or cellular phone, smart watch or other wearable electronic device, or tablet) or to fixed computing device (e.g., as a phone or watch). Information displayed on the scale is shown in an appropriately scaled font, composition and orientation to be readable from a standing position. In particular implementations of the disclosure directed to smart-homes, a multifunction scale user controls (via the touch-screen display) a plurality of other devices throughout the home such as a climate control system, security system, operation of the shower, etc. The electronic communications between the multifunction scale and the various devices may take the form of either wireless or wired communications.

The user display can display a FUI, which as shown in FIG. 2e, can include a variety of icons that represent functions that the scale can perform. The functions can include a
physiological test, a parameter to output, data to output, authorization for communication, authorization or activation of services, among other actions. As a specific example, the heart-shaped icon 226 can be indicative of a feature for comparing and/or analyzing trends heart rate and/or other cardiac parameters (e.g., BCG, PWV), the bike icon 227 may be indicative of feature or service including a fitness test, and the cellphone icon 228 may be indicative of authorization to pair with or otherwise output data to an identified external circuitry. Although the embodiment of 2e illustrates three icons, embodiments are not so limited and can include greater or less than three icons. In response to the user touching one of the icons with their foot, such as with their toe, the FUI is revised to verify the selection.

For example, the FUI displays text asking "Did you want to perform test A?" and include two icons listing "yes" or "no". In response to the user selecting yes, the scale performs the test or other function. In response to the user selecting no, the scale redispaly the variety of icons for the user to re-select on the FUI.

FIGs. 2f shows an example of electrode configurations, consistent with various aspects of the disclosure. As shown by the electrode connections, in some embodiments, ground is coupled to the heel of one foot of the user (e.g., the right foot) and the foot current injection (e.g., excitation paths 220) is coupled to the toes of the respective one foot (e.g., toes of the right foot). The leg current injection is coupled to the toes of the other foot (e.g., toes of the left foot).

FIG. 2g shows an example of electrode configurations, consistent with various aspects of the disclosure. As shown by the electrode connections, in some embodiments, ground is coupled to the heel of one foot of the user (e.g., the right foot) and the foot current injection (e.g., excitation paths 220) is coupled to the toes of the one foot (e.g., toes of the right foot). The leg current injection is coupled to the heels of the other foot of the user (e.g., heels of the left foot).

FIGs. 3a-3b show example block diagrams depicting the circuitry for sensing and measuring the cardiovascular time-varying IPG raw signals and steps to obtain a filtered IPG waveform, consistent with various aspects of the present disclosure. The example block diagrams shown in FIGs. 3a-3b are separated in to a leg impedance sub-circuit 300 and a foot impedance sub-circuit 305.

Excitation is provided by way of an excitation waveform circuit 310. The excitation waveform circuit 310 provides a stable amplitude excitation signal by way of various wave shapes of various, frequencies, such as more specifically, a sine wave signal (as is shown in FIG. 3a) or, more specifically, a square wave signal (as shown in FIG. 3b). This excitation
waveform (of sine, square, or other wave shape) is fed to a voltage-controlled current source circuit 315 which scales the signal to the desired current amplitude. The generated current is passed through a decoupling capacitor (for safety) to the excitation electrode, and returned to ground through the return electrode (grounded-load configuration). Amplitudes of 1 and 4 mA peak-to-peak are typically used for Leg and Foot IPGs, respectively.

The voltage drop across the segment of interest (legs or foot) is sensed using an instrumentation differential amplifier (e.g., Analog Devices AD8421) 320. The sense electrodes on the scale are AC-coupled to the inputs of the differential amplifier 320 (configured for unity gain), and any residual DC offset is removed with a DC restoration circuit (as exemplified in Burr-Brown App Note Application Bulletin, SBOA003, 1991, or Burr-Brown/Texas Instruments INA118 datasheet). Alternatively, a fully differential input amplification stage can be used which eliminates the need for DC restoration.

The signal is then demodulated with a phase-sensitive synchronous demodulator circuit 325. The demodulation is achieved in this example by multiplying the signal by 1 or -1 synchronously in-phase with the current excitation. Such alternating gain is provided by an operational amplifier (op amp) and an analog switch (SPST), such as an ADG442 from Analog Devices. More specifically, the signal is connected to both positive and negative inputs through 10 kOhm resistors. The output is connected to the negative input with a 10 kOhm resistor as well, and the switch is connected between the ground and the positive input of the op amp. When open, the gain of the stage is unity. When closed (positive input grounded), the stage acts as an inverting amplifier with a gain of -1. Further, fully differential demodulators can alternatively be used which employ pairs of DPST analog switches whose configuration can provide the benefits of balanced signals and cancellation of charge injection artifacts. Alternatively, other demodulators such as analog multipliers or mixers can be used. The in-phase synchronous detection allows the demodulator to be sensitive to only the real, resistive component of the leg or foot impedance, thereby rejecting any imaginary, capacitive components which may arise from parasitic elements associated with the foot to electrode contacts.

Once demodulated, the signal is band-pass filtered (0.4-80 Hz) with a band-pass filter circuit 330 before being amplified with a gain of 100 with a non-inverting amplifier circuit 335 (e.g., using an LT1058 operational amplifier from Linear Technology Inc.). The amplified signal is further amplified by 10 and low-pass filtered (cut-off at 20 Hz) using a low-pass filter circuit 340 such as 2-pole Sallen-Key filter stage with gain. The signal is then ready for digitization and further processing. In certain embodiments, the signal from
the demodulator circuit 325 can be passed through an additional low-pass filter circuit 345 to determine body or foot impedance.

In certain embodiments, the generation of the excitation voltage signal, of appropriate frequency and amplitude, is carried out by a microcontroller, such as an MSP430 (Texas Instruments, Inc.) or a PIC18Fxx series (Microchip Technology, Inc.). The voltage waveform can be generated using the on-chip timers and digital input/outputs or pulse width modulation (PWM) peripherals, and scaled down to the appropriate voltage through fixed resistive dividers, active attenuators/amplifiers using on-chip or off-chip operational amplifiers, as well as programmable gain amplifiers or programmable resistors. In certain embodiments, the generation of the excitation frequency signal can be accomplished by an independent quartz crystal oscillator whose output is frequency divided down by a series of toggle flip-flops (such as an ECS-100AC from ECS International, Inc., and a CD4024 from Texas Instruments, Inc.). In certain embodiments, the generation of the wave shape and frequency can be accomplished by a direct digital synthesis (DDS) integrated circuit (such as an AD9838 from Analog Devices, Inc.). In certain embodiments, the generation of the wave shape (either sine or square) and frequency can be accomplished by a voltage-controlled oscillator (VCO) which is controlled by a digital microcontroller, or which is part of a phase-locked loop (PLL) frequency control circuit. Alternatively, the waveforms and frequencies can be directly generated by on- or off-chip digital-to-analog converters (DACs).

In certain embodiments, the shape of the excitation is not square, but sinusoidal. Such configuration can reduce the requirements on bandwidth and slew rate for the current source and instrumentation amplifier. Harmonics, potentially leading to higher electromagnetic interference (EMI), can also be reduced. Such excitation may also reduce electronics noise on the circuit itself. Lastly, the lack of harmonics from sine wave excitation may provide a more flexible selection of frequencies in a multi-frequency impedance system, as excitation waveforms have fewer opportunities to interfere between each other. Due to the concentration of energy in the fundamental frequency, sine wave excitation could also be more power-efficient. In certain embodiments, the shape of the excitation is not square, but trapezoidal. Alternatively, raised cosine pulses (RCPs) could be used as the excitation wave shape, providing an intermediate between sine and square waves. RCPs could provide higher excitation energy content for a given amplitude, but with greatly reduced higher harmonics.

To further reduce potential electromagnetic interference (EMI), other strategies may be used, such as by dithering the square wave signal (i.e., introducing jitter in the edges
following a fixed or random pattern) which leads to so-called spread spectrum signals, in
which the energy is not localized at one specific frequency (or a set of harmonics), but rather
distributed around a frequency (or a set of harmonics). Because of the synchronous
demodulation scheme, phase-to-phase variability introduced by spread-spectrum techniques
will not affect the impedance measurement. Such a spread-spectrum signal can be generated
by, but not limited to, specialized circuits (e.g., Maxim MAX31C80, SiTime SiT9001), or
generic microcontrollers (see Application Report SLAA291, Texas Instruments, Inc.).
These spread-spectrum techniques can be combined with clock dividers to generate lower
frequencies as well.

As may be clear to one skilled in the art, these methods of simultaneous measurement
of impedance in the leg and foot can be used for standard Body Impedance Analysis (BIA),
aiming at extracting the relative content of total water, free-water, fat mass and other body
composition measures. Impedance measurements for BIA are typically done at frequencies
ranging from kilohertz up to several megahertz. The multi-frequency synchronous detection
measurement methods described above can readily be used for such BIA, provided that low-
pass filtering (345, FIGs. 3a and 3b) instead of band-pass filtering (330, FIGs. 3a and 3b) is
performed following the demodulation. In certain embodiments, a separate demodulator
channel may be driven by the quadrature phase of the excitation signal to allow the
imaginary component of the body impedance to be extracted in addition to the real
component. A more accurate BIA can be achieved by measuring both the real and imaginary
components of the impedance. This multi-frequency technique can be combined with
traditional sequential measurements used for BIA, in which the impedance is measured at
several frequencies sequentially. These measurements are repeated in several body segments
for segmental BIAs, using a switch matrix to drive the current into the desired body
segments.

While FIG. 2a shows a circuit and electrode configuration suitable to measure two
different segments (legs and one foot), this approach is not readily extendable to more
segments due to the shared current return electrode (ground). To overcome this limitation,
and provide simultaneous measurements in both feet, the system can be augmented with
analog switches to provide time-multiplexing of the impedance measurements in the
different segments. This multiplexing can be a one-time sequencing (each segment is
measured once), or interleaved at a high-enough frequency that the signal can be
simultaneously measured on each segment. The minimum multiplexing rate for proper
reconstruction is twice the bandwidth of the measured signal, based on signal processing
theory (the Nyquist rate), which equals to about 100 Hz for the impedance signal considered here. The rate must also allow for the signal path to settle in between switching, which usually limits the maximum multiplexing rate. Referring to FIG. 14a, one cycle might start the measurement of the leg impedance and left foot impedances (similarly to previously described, sharing a common return electrode), but then follow with a measurement of the right foot after reconfiguring the switches. For specific information regarding typical switch configurations, reference to U.S. Patent Application 14/338,266 filed on October 7, 2015, which is fully incorporated for its specific and general teaching of switch configurations.

Since right and left feet are measured sequentially, one should note that a unique current source (at the same frequency) may be used to measure both, providing that the current source is not connected to the two feet simultaneously through the switches, in which case the current would be divided between two paths. One should also note that a fully-sequential measurement, using a single current source (at a single frequency) successively connected to the three different injection electrodes, could be used as well, with the proper switch configuration sequence (no splitting of the current path).

In certain embodiments, the measurement of various body segments (e.g., the legs, right foot and left foot) is achieved simultaneously due to as many floating current sources as segments to be measured, running at separate frequencies so they can individually be demodulated. Such configuration is exemplified in FIG. 14b for three segments (legs, right and left feet). Such configuration provides true simultaneous measurements without the added complexity of time-multiplexing/ demultiplexing, and associated switching circuitry. An example of such a floating current source is found in Pickett, et al., Physiological Measurement, 32 (2011). Another approach to floating current sources is the use of transformer-coupled current sources (as depicted in FIG. 14c). Using transformers to inject current into the electrodes enables the use of simpler, grounded-load current sources on the primary, while the electrodes are connected to the secondary. The transformer turns ratio can typically be 1:1, and since frequencies of interest for impedance measurement are typically in the 10-1000 kHz (occasionally 1 kHz for BIA), relatively small pulse transformers can be used. In order to limit the common mode voltage of the body, one of the electrodes in contact with the foot can be grounded.

While certain embodiments presented in the above specification have used current sources for excitation, the excitation can also be performed by a voltage source, where the resulting injection current is monitored by a current sense circuit so that impedance can still be derived by the ratio of the sensed voltage (on the sense electrodes) over the sensed current.
(injected in the excitation electrodes). It should be noted that broadband spectroscopy methods could also be used for measuring impedances at several frequencies. Combined with time-multiplexing and current switching described above, multi-segment broadband spectroscopy can be achieved.

Various aspects of the present disclosure are directed toward robust timing extraction of the blood pressure pulse in the foot which is achieved by means of a two-step processing. In a first step, the usually high-SNR Leg IPG is used to derive a reference (trigger) timing for each heart pulse. In a second step, a specific timing in the lower-SNR Foot IPG is extracted by detecting its associated feature within a restricted window of time around the timing of the Leg IPG.

Consistent with yet further embodiments of the present disclosure, FIG. 3c depicts an example block diagram of circuitry, including, for example, the operation of the CPU as in FIG. 1a with the related more specific circuit blocks/modules in FIGs. 3A-3B. As shown in the center of FIG. 3c, the computer circuit 370 is shown with other previously-mentioned circuitry in a generalized manner without showing some of the detailed circuitry (e.g., amplification and current injection/sensing (372)). The computer circuit 370 can be used as a control circuit with an internal memory circuit (or as integrated with the memory circuit for the user profile memory 146A of FIG. 1a) for causing, processing and/or receiving sensed input signals as at block 372. These sensed signals can be responsive to injection current and/or these signals can be sensed by less complex grid-based sense circuitry surrounding the platform as is convention in capacitive touch-screen surfaces which, in certain embodiments, the platform includes.

The memory circuit can be used not only for the user profile memory, but also as to provide configuration and/or program code and/or other data such as user-specific data from another authorized source such as from a user monitoring his/her logged data and/or profile from a remote desk-top. The remote device or desk-top can communicate with and access such data via a wireless communication circuit 376. For example, the wireless communication circuit 376 provides an interface between an app on the user’s cellular telephone/tablet and the apparatus, wherefrom the phone is the output/input interface for the platform (scale) apparatus including, for example, an output display, speaker and/or microphone, and vibration circuitry.

A camera 378 and image encoder circuit 380 (with compression and related features) can also be incorporated as an option. As discussed above, the weighing scale components,
as in block 382, are also optionally included in the housing which encloses and/or surrounds the platform.

For long-lasting battery life in the platform apparatus (batteries not shown), at least the CPU 370, the wireless communication circuit 376, and other current draining circuits are inactive unless and until activated in response to the intrusion/sense circuitry 388. As shown, one specific implementation employs a Conexant chip (e.g., CX93510) to assist in the low-power operation. This type of circuitry is designed for motion sensors configured with a camera for visual verification and image and video monitoring applications (e.g., by supporting JPEG and MJPEG image compression and processing of images). When combined with an external CMOS sensor, the chip retrieves and stores compressed JPEG and audio data in an on-chip memory circuit (e.g., 256 KB/128 KB frame buffer) to alleviate the necessity of external memory.

In a specific embodiment, a method of using the platform with the plurality of electrodes are concurrently contacting a limb of the user, includes operating such to automatically obtain measurement signals from the plurality of electrodes. As noted above, these measurement signals might initially be through less complex (e.g., capacitive grid-type) sense circuitry. Before or while obtaining a plurality of measurement signals, the signal-sense circuitry 388 is used to sense wireless-signals indicative of the user approaching the platform and, in response, cause the CPU circuitry 370 to transition from a reduced power-consumption mode of operation and at least one higher power-consumption mode of operation. After the circuitry is operating in the higher power-consumption mode of operation, the CPU accesses the user-corresponding data stored in the memory circuit and causes a plurality of impedance-measurement signals to be obtained by using the plurality of electrodes while they are contacting the user via the platform; therefrom, the CPU generates signals corresponding to cardiovascular timings of the user.

The signal-sense circuit can be employed as a passive infrared detector and with the CPU programmed (as a separate module) to evaluate whether radiation from the passive infrared detector is indicative of a human. For example, sensed levels of radiation that corresponds to a live being, such as a dog, that is less than a three-foot height, and/or has not moved for more than a couple seconds, can be assessed as being a non-human.

As the user is recognized as being human, the CPU is activated and attempts the discernment process of which user might be approaching. This is performed by the CPU accessing the user-corresponding data stored in the memory circuit (the user profile memory). If the user is recognized based on parameters such as discussed above (e.g., time
of morning, speed of approach, etc.), the CPU can select one of a plurality of different types of user-discernible visual/audible/tactile information for presenting the discerned user with visual/audible/tactile information that is retrieved from the memory. For example, user-selected visual/audible data can be outputted for the user. Also, responsive to the motion detection indication, the camera can be activated to capture at least one image of the user while the user is approaching the platform (and/or while the user is on the platform to log confirmation of the same user with the measured impedance information). As shown in block 374 of FIG. 3c, where a speaker is also integrated with the CPU, the user can simply command the platform apparatus to start the process and activation proceeds. As previously discussed, the scale can include voice input/output circuitry to receive the user commands via voice commands.

In another method, the circuitry of FIG. 3c is used with the electrodes being interleaved and engaging the user, as a combination weighing scale (via block 382) and a physiologic user-specific impedance-measurement device. By using the impedance-measurement signals and obtaining at least two impedance-measurement signals between one foot of the user and another location of the user, the interleaved electrodes assist the CPU in providing measurement results that indicate one or more of the following user-specific attributes as being indicative or common to the user: foot impedance, foot length, and type of arch, and wherein one or more of the user-specific attributes are accessed in the memory circuit and identified as being specific to the user. This information can be retrieved by the user, medical and/or security personnel, according to a data-access authorization protocol as might be established upon initial configuration for the user.

FIG. 3d shows an exemplary block diagram depicting the circuitry for interpreting signals received from electrodes (e.g., 372 of FIG. 3c), and/or CPU 370 of FIG. 3c. The input electrodes 375 transmit electrical signals through the patient's body (depending on the desired biometric and physiological test to be conducted) and output electrodes 380 receive the modified signal as affected by a user's electrical impedance 385. Once received by the output electrodes 380, the modified signal is processed by processor circuitry 370 based on the selected test. Signal processing by the processor circuitry 370 is discussed with regards to FIGs. 3a-b. In certain embodiments of the present disclosure, the circuitry within 370 is provided by Texas Instruments part # AFE4300.

FIG. 4 shows an example block diagram depicting signal processing steps to obtain fiducial references from the individual Leg IPG "beats," which are subsequently used to obtain fiducials in the Foot IPG, consistent with various aspects of the present disclosure.
As shown in block 400, the Leg IP and the Foot IPG are simultaneously measured. At 405, the Leg IPG is low-pass filtered at 20 Hz with an 8-pole Butterworth filter, and inverted so that pulses have an upward peak. The location of the pulses is determined by taking the derivative of this signal, integrating over a 100 ms moving window, zeroing the negative values, removing the large artifacts by zeroing values beyond 15x the median of the signal, zeroing the values below a threshold defined by the mean of the signal, and then searching for local maxima. Local maxima closer than a defined refractory period of 300 ms to the preceding ones are dismissed. The result is a time series of pulse reference timings.

At 410, the foot IPG is low-pass filtered at 25 Hz with an 8-pole Butterworth filter and inverted (so that pulses have an upward peak). Segments starting from the timings extracted (415) from the Leg IPG (reference timings) and extending to 80% of the previous pulse interval, but no longer than one second, are defined in the Foot IPG. This defines the time windows where the Foot IPG is expected to occur, avoiding misdetection outside of these windows. In each segment, the derivative of the signal is computed, and the point of maximum positive derivative (maximum acceleration) is extracted. The foot of the IPG signal is then computed using an intersecting tangent method, where the fiducial (420) is defined by the intersection between a first tangent to the IPG at the point of maximum positive derivative and a second tangent to the minimum of the IPG on the left of the maximum positive derivative within the segment.

The time series resulting from this two-step extraction is used with another signal to facilitate further processing. These timings are used as reference timings to improve the SNR of BCG signals to extract intervals between a timing of the BCG (typically the I-wave) and the Foot IPG for the purpose of computing the PWV, as previously disclosed in U.S. 2013/0310700 (Wiard). In certain embodiments, the timings of the Leg IPG are used as reference timings to improve the SNR of BCG signals, and the foot IPG timings are used to extract intervals between timing fiducials of the improved BCG (typically the I-wave) and the Foot IPG for the purpose of computing the PTT and the (PWV).

In certain embodiments, the processing steps include an individual pulse SNR computation after individual timings are extracted, either in Leg IPG or Foot IPG.

Following the computation of the SNRs, pulses with a SNR below a threshold value are eliminated from the time series, to prevent propagating noise. The individual SNRs may be computed in a variety of methods known to one skilled in the art. For instance, an estimated pulse can be computed by ensemble averaging segments of signal around the pulse reference timing. The noise associated with each pulse is defined as the difference between the pulse
and the estimated pulse. The SNR is the ratio of the root-mean-square (RMS) value of the estimated pulse over the RMS value of the noise for that pulse.

In certain embodiments, the time interval between the Leg IPG pulses, and the Foot IPG pulses, also detected by the above-mentioned methods, is extracted. The Leg IPG measuring a pulse occurring earlier in the legs compared to the pulse from the Foot IPG, the interval between these two is related to the propagation speed in the lower body, i.e., the peripheral vasculature. This provides complementary information to the interval extracted between the BCG and the Foot IPG for instance, and is used to decouple central versus peripheral vascular properties. It is also complementary to information derived from timings between the BCG and the Leg ICG.

FIG. 5 shows an example flowchart depicting signal processing to segment individual Foot IPG "beats" to produce an averaged IPG waveform of improved SNR, which is subsequently used to determine the fiducial of the averaged Foot IPG, consistent with various aspects of the present disclosure. Similar to the method shown in FIG. 4, the Leg IP and the Foot IPG are simultaneously measured (500), the Leg IPG is low-pass filtered (505), the foot IPG is low-pass filtered (510), and segments starting from the timings extracted (515) from the Leg IPG (reference timings). The segments of the Foot IPG extracted based on the Leg IPG timings are ensemble-averaged (520) to produce a higher SNR Foot IPG pulse. From this ensemble-averaged signal, the start of the pulse is extracted using the same intersecting tangent approach as described earlier. This approach enables the extraction of accurate timings in the Foot IPG even if the impedance signal is dominated by noise, as shown in FIG. 7b. These timings are used together with timings extracted from the BCG for the purpose of computing the PTT and (PWV). Timings derived from ensemble-averaged waveforms and individual waveforms can also be both extracted, for the purpose of comparison, averaging and error-detection.

Specific timings extracted from the IPG pulses (from either leg or foot) are related (but not limited) to the peak of the pulse, the minimum preceding the peak, or the maximum second derivative (maximum rate of acceleration) preceding the point of maximum derivative. An IPG pulse and the extraction of a fiducial (525) in the IPG can be performed by other signal processing methods, including (but not limited to) template matching, cross-correlation, wavelet-decomposition, or short window Fourier transform.

FIG. 6a shows examples of the Leg IPG signal with fiducials (plot 600); the segmented Leg IPG into beats (plot 605); and the ensemble-averaged Leg IPG beat with fiducials and calculated SNR (plot 610), for an exemplary high-quality recording, consistent
with various aspects of the present disclosure. FIG. 6b shows examples of the Foot IPG
signal with fiducials derived from the Leg IPG fiducials (plot 600); the segmented Foot IPG
into beats (plot 605); and the ensemble-averaged Foot IPG beat with fiducials and calculated
SNR (plot 610), for an exemplary high-quality recording.

FIG. 7a shows examples of the Leg IPG signal with fiducials (plot 700); the
segmented Leg IPG into beats (plot 705); and the ensemble averaged Leg IPG beat with
fiducials and calculated SNR (plot 710), for an exemplary low-quality recording, consistent
with various aspects of the present disclosure.

FIG. 7b shows examples of the Foot IPG signal with fiducials derived from the Leg
IPG fiducials (plot 700); the segmented Foot IPG into beats (plot 705); and the ensemble-
averaged Foot IPG beat with fiducials and calculated SNR (plot 710), for an exemplary low-
quality recording, consistent with aspects of the present disclosure.

FIG. 8 shows an example correlation plot 800 for the reliability in obtaining the low
SNR Foot IPG pulse for a 30-second recording, using the first impedance signal as the
trigger pulse, from a study including 61 test subjects with various heart rates, consistent with
various aspects of the present disclosure.

In certain embodiments, a dual-Foot IPG is measured, allowing the detection of
blood pressure pulses in both feet. Such information can be used for diagnostic of peripheral
arterial diseases (PAD) by comparing the relative PATs in both feet to look for asymmetries.
It can also increase the robustness of the measurement by allowing one foot to have poor
contact with electrodes (or no contact at all). SNR measurements can be used to assess the
quality of the signal in each foot, and to select the best one for downstream analysis.
Timings extracted from each foot can be compared and set to flag potentially inaccurate
PWV measurements due to arterial peripheral disease, in the event these timings are different
by more than a threshold. Alternatively, timings from both feet are pooled to increase the
overall SNR if their difference is below the threshold.

In certain embodiments, the disclosure is used to measure a PWV, where the IPG is
augmented by the addition of BCG sensing into the weighing scale to determine
characteristic fiducials between the BCG and Leg IPG trigger, or the BCG and Foot IPG.

The BCG sensors are comprised typically of the same strain gage set used to determine the
bodyweight of the user. The load cells are typically wired into a bridge configuration to
create a sensitive resistance change with small displacements due to the ejection of the blood
into the aorta, where the circulatory or cardiovascular force produce movements within the
body on the nominal order of 1-3 Newtons. BCG forces can be greater than or less than the nominal range in cases such as high or low cardiac output.

FIGs. 9a-b show example configurations to obtain the PTT, using the first IPG as the triggering pulse for the Foot IPG and BCG, consistent with various aspects of the present disclosure. The I-wave of the BCG 900 normally depicts the headward force due to cardiac ejection of blood into the ascending aorta which is used as a timing fiducial indicative of the pressure pulse initiation of the user’s proximal aorta relative to the user’s heart. The J-wave is indicative of timings in the systole phase and also incorporates information related to the strength of cardiac ejection and the ejection duration. The K-Wave provides systolic and vascular information of the user’s aorta. The characteristic timings of these and other BCG waves are used as fiducials that can be related to fiducials of the IPG signals of the present disclosure.

FIG. 10 shows nomenclature and relationships of various cardiovascular timings, consistent with various aspects of the present disclosure.

FIG. 11 shows an example graph 1100 of PTT correlations for two detection methods (white dots) Foot IPG only, and (black dots) Dual-IPG method, consistent with various aspects of the present disclosure.

FIG. 12 shows an example graph 1200 of PWV obtained from the present disclosure compared to the ages of 61 human test subjects, consistent with various aspects of the present disclosure.

FIG. 13 shows an example of a scale 1300 with integrated foot electrodes 1305 to inject and sense current from one foot to another foot, and within one foot.

FIG. 14a-c shows various examples of a scale 1400 with interleaved foot electrodes 1405 to inject/ sense current from one foot to another foot, and measure Foot IPG signals in both feet.

FIGs. 15a-d shows an example breakdown of a scale 1500 with interleaved foot electrodes 1505 to inject and sense current from one foot to another foot, and within one foot.

FIG. 16 shows an example block diagram of circuit-based building blocks, consistent with various aspects of the present disclosure. The various circuit-based building blocks shown in FIG. 16 can be implemented in connection with the various aspects discussed herein. In the example shown, the block diagram includes foot electrodes 1600 that can collect the IPG signals. Further, the block diagram includes strain gauges 1605, and an LED/photosensor 1610. The foot electrodes 1600 is configured with a leg impedance
measurement circuit 1615, a foot impedance measurement circuit 1620, and an optional
second foot impedance measurement circuit 1625. The leg impedance measurement circuit
1615, the foot impedance measurement circuit 1620, and the optional second foot impedance
measurement circuit 1625 report the measurements collected to a processor circuitry 1645.

The processor circuitry 1645 collects data from a weight measurement circuit 1630 and an
optional balance measurement circuit 1635 that are configured with the strain gauges 1605.
Further, an optional photoplethysmogram (PPG) measurement circuit 1640, which collects
data from the LED/photosensor 1610, provides data to the processor circuitry 1645.

The processor circuitry 1645 is powered via a power circuit 1650. Further, the
processor circuitry 1645 collects user input data from a user interface 1655 (e.g., iPad®,
smart phone and/or other remote user handy/CPU with a touch screen and/or buttons). The
data collected/measured by the processor circuitry 1645 is shown to the user via a display
1660. Additionally, the data collected/measured by the processor circuitry 1645 can be
stored in a memory circuit 1680. Further, the processor circuitry 1645 can optionally control
a haptic feedback circuit 1665, a speaker or buzzer 1670, a wired/wireless interface 1675,
and an auxiliary sensor 1685 for one-way or two-way communication between the scale and
the user.

FIG. 17 shows an example flow diagram, consistent with various aspects of the
present disclosure. At block 1700, a PWV length is entered. At block 1705, a user's weight,
balance, leg, and foot impedance are measured. At 1710, the integrity of signals is checked
(e.g., SNR). If the signal integrity check is not met, the user's weight, balance, leg, and foot
impedance are measured again (block 1705), if the signals integrity check is met, the leg
impedance pulse timings are extracted (as is shown at block 1715). At block 1720, foot
impedance and pulse timings are extracted, and at block 1725, BCG timings are extracted.

At block 1730, a timings quality check is performed. If the timings quality check is not
validated, the user's weight, balance, leg and foot impedance are again measured (block
1705). If the timings quality check is validated, the PWV is calculated (as is shown at block
1735). At block 1740, the PWV is displayed to the user.

FIG. 18 shows an example scale 1800 communicatively coupled to a wireless device,
consistent with various aspects of the present disclosure. A display 1805 can display the
various aspects measured by the scale 1800. The scale can also wirelessly broadcast the
measurements to a wireless device 1810. The wireless device 1810 can also be implemented
as an iPad®, smart phone or other CPU to provide input data for configuring and operating
the scale.
As an alternative or complementary user interface used in other embodiments, the scale includes a FUI which is enabled/implementable by one or more foot-based biometrics (for example, with the user being correlated to previously-entered user weight, and/or foot size/shape). In certain embodiments, the user foot-based biometric is also implemented by the user manually entering data (e.g., a password) on the upper surface or display area of the scale. In implementations in which the scale is configured with a haptic, capacitive or flexible pressure-sensing upper surface, the (upper surface/tapping) touching from or by the user is sensed in the region of the surface and processed according to conventional X - Y grid Signal processing in the logic circuitry/CPU that is within the scale. By using one or more of the accelerometers located within the scale at its corners, such user data entry is sensed by each such accelerometer so long as the user's toe, heel or foot pressure associated with each tap provides sufficient force. Although the present discussion refers to a FUI, embodiments are not so limited. Various embodiments include internal or external GUIs that are in communication with the scale and used to obtain a biometric and that can be in place of the FUI and/or in combination with a FUI. For example, a user device having a GUI, such as tablet, is in communication with the scale via a wired or wireless connection. The user device obtains a biometric, such a finger print, and communicates the biometric to the scale.

In various embodiments, the above discussed user interface is used with other features described herein for the purpose of controlling access to RX health information and providing additional non-RX health information such as: collecting the categories of interest input by the user, the biometric and/or passwords entered by the user, displaying the additional health information, and displaying an indication that RX health information can be accessed as a service or that additional health information is available. For example, the user enters the categories of interest to the scale using their foot and the user-interface. The user data (e.g., RX health information or other user data) might include less sensitive data (e.g., the user's weight) and more sensitive data (e.g., the user's scale obtains cardiograms and other data generated by or provided to the scale and associated with the user's symptoms and/or diagnoses). For data that may be more user-sensitive, the above described biometrics are used as directed by the user for indicating and defining protocol to permit such data to be exported from the scale to other remote devices and/or for such data to be displayed on the user-interface.

In some specific embodiments, the scale operates in different modes of data security and communication. The different modes of data security and communication are enabled in
response to biometrics identified by the user and using the user interface. In some embodiments, the scale is used by multiple users and/or the scale operates in different modes of data security and communication in response to identifying the user using biometrics. The different modes of data security and communication include, for example: a first mode (e.g., default mode) in which the user's body mass and/or weight is displayed regardless of any biometric which would associate with the specific user standing on the scale and no data is communicated to external circuitry; a second mode in which complicated/more-sensitive data (or data reviewed infrequently) is only exported from the scale under specific manual commands provided to the scale under specific protocols and in response to a biometric; and third mode or modes in which the user-specific data that is collected from the scale is processed and accessed based on the type of data and in response to a biometric. Such data categories include categories of different levels of importance and/or sensitivities such as the above-discussed high and low level data and other data that might be very specific to a symptom and/or degrees of likelihood for diagnoses. Optionally, the CPU in the scale is also configured to provide encryption of various levels of the user's sensitive data.

In some embodiments, the different modes of data security and communication are enabled in response to recognizing the user standing on the scale using a biometric and operating in a particular mode of data security and communication based on user preferences and/or services activated. For example, the different modes of operation include the default mode (as discussed above) in which certain data (e.g., categories of interest, categories of user-sensitive user data, or historical user data) is not communicated from the scale to external circuitry, a first communication mode in which data is communicated to external circuitry as identified in a user profile, a second or more communication modes in which data is communicated to a different external circuitry for further processing. The different communication modes are enabled based on biometrics identified from the user and user settings in a user profile corresponding with each user.

In a specific embodiment, a first user of the scale may not be identified and/or have a user profile set up. In response to the first user standing on the scale, the scale operates in a default mode. During the default mode, the scale displays the user's body weight on the FUI and does not output user data. A second user of the scale has a user profile set up that indicates the user would like data communicated to a computing device of the user. When the second user stands on the scale, the scale recognizes the second user based on a biometric and operates in a first communication mode. During the first communication mode, the scale outputs at least a portion of the user data to an identified external circuitry.
For example, the first communication mode allows the user to upload data from the scale to a user identified external circuitry (e.g., the computing device of the user) that includes non-regulated health information. In the first communication mode, the scale performs the processing of the raw sensor data and/or the external circuitry can. For example, the scale sends the raw sensor data and/or non-regulated health information to a computing device of the user. The computing device may not provide access to the raw sensor data to the user and/or can send the raw sensor data to another external circuitry for further processing in response to a user input. For example, the computing device can ask the user if the user would like additional health information and/or regulated health information as a service. In response to receiving an indication the user would like the additional health information and/or regulated health information, the computing device outputs the raw sensor data and/or non-regulated health information to another external circuitry for processing, providing to a physician for review, and controlling access, as discussed above.

In one or more additional communication modes, the scale outputs raw sensor data to an external circuitry for further processing. For example, during a second communication mode and a third communication, the scale sends the raw sensor data and other data to external circuitry for processing. Using the above-provided example, a third user of the scale has a user profile set up that indicates the third user would like additional health information, such as non-regulated health information based on categories of interest. When the third user stands on the scale, the scale recognizes the third user based on one or more biometrics and operates in a second communication mode. During the second communication mode, the scale outputs the raw sensor data to the external circuitry. The external circuitry processes the raw sensor data, determines at least one physiologic parameter of the user, and derives the additional health information. The external circuitry allows access to the user to additional health information but does not allow the user to access regulated health information, including the physiologic parameter. For example, the regulated health information may not be accessed by the third user until the third user has paid a service fee and/or until a prescription by a physician is obtained. In some embodiments, the external circuitry outputs the additional health information and/or an indication that additional health information can be accessed to the scale to display to the third user on the user interface.

A fourth user of the scale has a user profile set up that indicates the fourth user has enabled a service to access regulated health information. When the fourth user stands on the scale, the scale recognizes the user based on one or more biometrics and operates in a fourth
communication mode. In the fourth communication mode, the scale outputs raw sensor data to the external circuitry, and the external circuitry processes the raw sensor data and controls access to the data. For example, the external circuitry may not allow access to the regulated health information until a physician reviews the information. In some embodiments, the external circuitry outputs data to the scale, in response to physician review. For example, the output data can include the regulated health information and/or an indication that regulated health information is ready for review. The external circuitry may be accessed by the user, using the scale and/or another user device. In some embodiments, using the FUI of the scale, the scale displays the regulated health information to the user. In various embodiments, if the scale is unable to identify a particular (high security) biometric that enables the fourth communication mode, the scale may operate in a different communication mode and may still recognize the user. For example, the scale may operate in a default communication mode in which the user data collected by the scale is stored in a user profile corresponding to the fourth user and on the scale. In some related embodiments, the user data is output to the external circuitry at a different time.

Although the present embodiments illustrates a number of security and communication modes, embodiments in accordance with the present disclosure can include additional or fewer modes. Furthermore, embodiments are not limited to different modes based on different users. For example, a single user may enable different communication modes in response to particular biometrics of the user identified and/or based on user settings in a user profile.

As further specific examples, recent discoveries may align and associate different attributes of scale-based user data collected by the scale to different tools, advertisements, and physician provided diagnosis. For example, it has recently been discovered that atrial fibrillation is more directly correlated with obesity. The scale collects various user data and monitors weight and various components/symptoms of atrial fibrillation. In a specific embodiment, the scale recommends/suggests to the user to: closely monitor weight, recommends a diet, goals for losing weight, correlates weight gain and losses for movement in cardiogram data relative to arrhythmia. The movement in cardiogram data relative to arrhythmia, in specific embodiments, is related to atrial fibrillation. For example, atrial fibrillation is associated with indiscernible or fibrillating p-waves and beat to beat fluctuations. Thereby, the scale correlates weight gain/loss with changes in amplitude (e.g., discernibility) of a p-wave of a cardiogram (preceding a QRS complex) and changes in beat to beat fluctuations.
FIGs. 19a-c show example impedance as measured through different parts of the foot based on the foot position, consistent with various aspects of the present disclosure. Example impedance measurement configurations may be implemented using a dynamic electrode configuration for measurement of foot impedance and related timings.

Dynamic electrode configuration may be implemented using independently-configurable electrodes to optimize the impedance measurement. As shown in FIG. 19a, interleaved electrodes 1900 are connected to an impedance processor circuit 1905 to determine foot length, foot position, and/or foot impedance. As is shown in FIG. 19b, an impedance measurement is determined regardless of foot position 1910 based on measurement of the placement of the foot across the electrodes 1900. This is based in part in the electrodes 1900 that are engaged (blackened) and in contact with the foot (based on the foot position 1910), which is shown in FIG. 19c.

More specifically regarding FIG 19a, configuration includes connection/deconnection of the individual electrodes 1900 to the impedance processor circuit 1905, their configuration as current-carrying electrodes (injection or return), sense electrodes (positive or negative), or both. The configuration is preset based on user information, or updated at each measurement (dynamic reconfiguration) to optimize a given parameter (impedance SNR, measurement location). The system algorithmically determines which electrodes under the foot to use in order to obtain the highest SNR in the pulse impedance signal. Such optimization algorithm may include iteratively switching configurations and measuring the impedance, and selecting the best suited configuration. Alternatively, the system first, through a sequential impedance measurement between each individual electrode 1900 and another electrode in contact with the body (such as an electrode in electrode pair 205 on the other foot), determine which electrodes are in contact with the foot. By determining the two most apart electrodes, the foot size is determined. Heel location can be determined in this manner, as can other characteristics such as foot arch type. These parameters are used to determine programmatically (in an automated manner by CPU/logic circuitry) which electrodes are selected for current injection and return (and sensing if a Kelvin connection issued) to obtain the best foot IPG.

In various embodiments involving the dynamically reconfigurable electrode array 1900/1905, an electrode array set is selected to measure the same portion/segment of the foot, irrespective of the foot location on the array. FIG. 19b illustrates the case of several foot positions on a static array (a fixed set of electrodes are used for measurement at the heel and plantar/toe areas, with a fixed gap of an inactive electrode or insulating material between
them). Depending on the position of the foot, the active electrodes are contacting the foot at different locations, thereby sensing a different volume/segment of the foot. If the IPG is used by itself (e.g., for heart measurement), such discrepancies may be non-consequential. If timings derived from the IPG are referred to other timings (e.g., R-wave from the ECG, or specific timing in the BCG), such as for the calculation of a PTT or PWV, the small shifts in IPG timings due to the sensing of slightly different volumes in the foot (e.g., if the foot is not always placed at the same position on the electrodes) can introduce an error in the calculation of the interval. With respect to FIG. 19b, the timing of the peak of the IPG from the foot placement on the right (sensing the toe/plantar region) is later than from the foot placement on the left, which senses more of the heel volume (the pulse reaches first the heel, then the plantar region). Factors influencing the magnitude of these discrepancies include foot shape (flat or not) and foot length.

Various embodiments address challenges relating to foot placement. FIG. 19c shows an example embodiment involving dynamic reconfiguration of the electrodes to reduce such foot placement-induced variations. As an example, by sensing the location of the heel first (as described above), it is possible to activate a subset of electrodes under the heel, and another subset of electrodes separated by a fixed distance (1900). The other electrodes (e.g., unused electrodes) are left disconnected. The sensed volume will therefore be the same, producing consistent timings. The electrode configuration leading to the most consistent results may be informed by the foot impedance, foot length, the type of arch (all of which can be measured by the electrode array as shown above), but also by the user ID (foot information can be stored for each user, then looked up based on automatic user recognition or manual selection (e.g., in a look-up-table stored for each user in a memory circuit accessible by the CPU circuit in the scale).

In certain embodiments, the apparatus measures impedance using a plurality of electrodes contacting one foot and with at least one other electrode (typically many) at a location distal from the foot. The plurality of electrodes (contacting the one foot) is arranged on the platform and in a partem configured to inject current signals and sense signals in response thereto, for the same segment of the foot so that the timing of the pulse-based measurements does not vary because the user placed the one foot at a slightly different position on the platform or scale. In FIG. 19a, the foot-to-electrode locations for the heel are different locations than that shown in FIGs. 19b and 19c. As this different foot placement can occur from day to day for the user, the timing and related impedance measurements are for the same (internal) segment of the foot. By having the processor circuit inject current
and sense responsive signals to first locate the foot on the electrodes (e.g., sensing where positions of the foot's heel plantar regions and/or toes), the pattern of foot-to-electrode locations permits the foot to move laterally, horizontally and both laterally and horizontally via the different electrode locations, while collecting impedance measurements relative to the same segment of the foot.

The BCG/IPG system can be used to determine the PTT of the user, by identification of the average I-Wave or derivative timing near the I-Wave from a plurality of BCG heartbeat signals obtained simultaneously with the Dual-IPG measurements of the present disclosure to determine the relative PTT along an arterial segment between the ascending aortic arch and distal pulse timing of the user's lower extremity. In certain embodiments, the BCG/IPG system is used to determine the PWV of the user, by identification of the characteristic length representing the length of the user's arteries, and by identification of the average I-Wave or derivative timing near the I-Wave from a plurality of BCG heartbeat signals obtained simultaneously with the Dual-IPG measurements of the present disclosure to determine the relative PTT along an arterial segment between the ascending aortic arch and distal pulse timing of the user's lower extremity. The system of the present disclosure and alternate embodiments may be suitable for determining the arterial stiffness (or arterial compliance) and/or cardiovascular risk of the user regardless of the position of the user's feet within the bounds of the interleaved electrodes. In certain embodiments, the weighing scale system incorporated the use of strain gage load cells and six or eight electrodes to measure a plurality of signals including: bodyweight, BCG, body mass index, fat percentage, muscle mass percentage, and body water percentage, heart rate, heart rate variability, PTT, and PWV measured simultaneously or synchronously when the user stands on the scale to provide a comprehensive analysis of the health and wellness of the user.

In other certain embodiments, the PTT and PWV are computed using timings from the Leg IPG or Foot IPG for arrival times, and using timings from a sensor located on the upper body (as opposed to the scale measuring the BCG) to detect the start of the pulse. Such sensor may include an impedance sensor for impedance cardiography, a hand-to-hand impedance sensor, a photoplethysmogram on the chest, neck, head, arms or hands, or an accelerometer on the chest (seismocardiograph) or head.
Communication of the biometric information is another aspect of the present disclosure. The biometric results from the user are stored in the memory on the scale and displayed to the user via a display on the scale, audible communication from the scale, and/or the data is communicated to a peripheral device such as a computer, smartphone, tablet computing device. The communication occurs to the peripheral device with a wired connection, or can be sent to the peripheral device through wireless communication protocols such as Bluetooth or WiFi. Computations such as signal analyses described therein may be carried out locally on the scale, in a smartphone or computer, or in a remote processor (cloud computing).

Other aspects of the present disclosure are directed toward apparatuses or methods that include the use of at least two electrodes that contacts feet of a user. Further, circuitry is provided to determine a pulse arrival time at the foot based on the recording of two or more impedance signals from the set of electrodes. Additionally, a second set of circuitry is provided to extract a first pulse arrival time from a first impedance signal and use the first pulse arrival time as a timing reference to extract and process a second pulse arrival time in a second impedance signal.

Various embodiments are implemented in accordance with the following U.S. Provisional Applications. U.S. Provisional Application (Ser. No. 62/258,238), entitled "Condition or Treatment Assessment Methods and Platform Apparatuses", filed November 20, 2015, which is herein incorporated by reference generally for its teaching of physiological scales, measurements, and communications and specifically with regards to obtaining derivation data, assessing a condition or treatment of the user, and drug titration features and aspects as described in connection with FIGs. 1a-1b in the underlying provisional. U.S. Provisional Application (Ser. No. 62/258,253), entitled "Initialization Method and Devices and User Physiological Platforms", filed November 20, 2015, which is herein incorporated by reference generally for its teaching of physiological scales, measurements, and communications and specifically with regards to using a scale to instruct a user to have a particular posture while obtaining scale-data features and aspects as described in connection with FIGs. 1a-1b of the underlying provisional. U.S. Provisional Application (Ser. No. 62/263,385), entitled "Scale-based Biometric Authorization of Communication Between Scale and Remote User-Physiologic Device", filed December 4, 2015, which is herein incorporated by reference generally for its teaching of physiological scales, measurements, and communications and specifically with regards to dual authorization of communication between a scale and other devices and biometrics features.
and aspects as described in connection with FIGs. 1a-lc in the underlying provisional. U.S. Provisional Application (Ser. No. 62/264,797), entitled "Aggregation and Analysis of Scale-Based User Data and Remote User-Physiologic Device-Based User Data", filed December 8, 2015, which is herein incorporated by reference generally for its teaching of physiological scales, measurements, and communications and specifically with regards to aggregating data from a scale and a remote user-physiologic device and assessing the user medically including identifying clinical indications that the user is at risk for a condition, updating medical profiles, and providing generic health information features and aspects as described in connection with FIGs. 1a-lc in the underlying provisional. U.S. Provisional Application (Ser. No. 62/264,803), entitled "Scale-Based Biometric Authorization of Multiple Communication Modes of the Scale", filed December 8, 2015, which is herein incorporated by reference generally for its teaching of physiological scales, measurements, and communications and specifically with regards to providing different levels of data communication and to different sources by identifying and verifying scale-based biometrics features and aspects as described in connection with FIGs. 1a-lc in the underlying provisional. U.S. Provisional Application (Ser. No. 62/265,841), entitled "Scale With Foot-Controlled User Interface", filed December 10, 2015, which is herein incorporated by reference generally for its teaching of physiological scales, measurements, and communications and specifically with regards to a scale having a FUI that allows the user to interact with the scale via inputs using the user's foot features and aspects as described in connection with FIGs. 1A-1B in the underlying provisional. U.S. Provisional Application (Ser. No. 62/266,403), entitled "Scale-Based User-Physiological Data Hierarchy System", filed December 11, 2015, which is herein incorporated by reference generally for its teaching of physiological scales, measurements, and communications and specifically with regards to providing different levels of services to scale users by selectively prompting the user and responsive to different weighted values features and aspects as described in connection with FIGs. 1a-Id in the underlying provisional. U.S. Provisional Application (Ser. No. 62/266,484), entitled "Scale-Based Aggregation and Communication of Sensitive User-Data", filed December 11, 2015, which is herein incorporated by reference generally for its teaching of physiological scales, measurements, and communications and specifically with regards to aggregating user data from a plurality of sources using a scale and securely communicating the aggregated data response to scale-based biometric features and aspects as described in connection with FIGs. 1a-Id in the underlying provisional. For instance, embodiments herein and/or in the provisional applications may be combined in varying
degrees (including wholly). Reference may also be made to the experimental teachings and underlying references provided in the underlying provisional application. Embodiments discussed in the provisional applicants are not intended, in any way, to be limiting to the overall technical disclosure, or to any part of the claimed invention unless specifically noted.

Reference may also be made to published patent documents U.S. Patent Publication 2010/0094147 and U.S. Patent Publication 2013/03 10700, which are, together with the references cited therein, herein fully incorporated by reference for the purposes of sensors and sensing technology. The aspects discussed therein may be implemented in connection with one or more of embodiments and implementations of the present disclosure (as well as with those shown in the figures). In view of the description herein, those skilled in the art will recognize that many changes may be made thereto without departing from the spirit and scope of the present disclosure.

As illustrated herein, various circuit-based building blocks and/or modules may be implemented to carry out one or more of the operations/activities described herein shown in the block-diagram-type figures. In such contexts, these building blocks and/or modules represent circuits that carry out these or related operations/activities. For example, in certain embodiments discussed above (such as the pulse circuitry modularized as shown in FIGs. 3a-b), one or more blocks/modules are discrete logic circuits or programmable logic circuits for implementing these operations/activities, as in the circuit blocks/modules shown. In certain embodiments, the programmable circuit is one or more computer circuits programmed to execute a set (or sets) of instructions (and/or configuration data). The instructions (and/or configuration data) can be in the form of firmware or software stored in and accessible from a memory circuit. As an example, first and second modules/blocks include a combination of a CPU hardware-based circuit and a set of instructions in the form of firmware, where the first module/block includes a first CPU hardware circuit with one set of instructions and the second module/block includes a second CPU hardware circuit with another set of instructions.

Based upon the above discussion and illustrations, those skilled in the art will readily recognize that the above described aspects and features, and without limitation to the number thereof, can be combined in specific designs so that the scale is configured and arranged to perform these aspects and features in combination in a manner consistent with the description thereof. Further, based upon the above discussion and illustrations, those skilled in the art will readily recognize that various modifications and changes may be made to the present disclosure without strictly following the exemplary embodiments and applications
illustrated and described herein. For example, the input terminals as shown and discussed may be replaced with terminals of different arrangements, and different types and numbers of input configurations (e.g., involving different types of input circuits and related connectivity). Such modifications do not depart from the true spirit and scope of the present disclosure, including that set forth in the following claims.
What is claimed is:

1. A weighing scale apparatus comprising:
   a platform in which a plurality of electrodes and force sensor circuitry are integrated and configured and arranged for engaging a user;
   a user interface configured and arranged to output user-specific information for the user while the user is standing on the platform; and
   processing circuitry, including a CPU and a memory circuit with user data stored in the memory circuit, the processing circuit being configured and arranged with the plurality of electrodes and the force sensor circuitry and being configured to:
      provide an instruction to the user directing the user to have a particular posture until an alert is provided in response to the user standing on the platform;
      collect physiologic data from the user while the user is standing on the platform using signals obtained by the plurality of electrodes and the force sensor circuitry;
      provide the alert to the user indicating the user may move in response to collecting the physiologic data; and
      provide user-specific cardio data to the user using the user interface based on the collected physiologic data.

2. The weighing scale apparatus of claim 1, further including assessment circuitry configured and arranged to:
   derive and output derivation data indicative of a physiologic status of the user for assessment of a condition or treatment of the user that corresponds with the physiologic status; and
   store, in response to the derived derivation data, additional data in the memory circuit to supplement user-corresponding data with information corresponding to the physiologic data obtained while the user is standing on the platform.

3. The weighing scale apparatus of claim 1, wherein the user interface is a graphical user interface (GUI) integrated with external circuitry that is not located under the platform, the external circuitry further including output circuitry configured and arranged to communicate with the processing circuitry.
4. The weighing scale apparatus of claim 2, wherein the assessment circuitry is integrated with external circuitry that is not located under the platform, and further includes output circuitry configured and arranged to communicate with the processing circuitry.

5. The weighing scale apparatus of claim 2, wherein the assessment circuitry is configured and arranged to:
   - compare the derivation data, including the physiologic data, to reference information; and
   - determine an adjusted dose for a prescription drug in response to the comparison.

6. The weighing scale apparatus of claim 5, wherein the assessment circuitry is integrated with external circuitry and wherein the reference information includes symptoms of a health condition being treated by the prescription drug and potential side effects of the prescription drug and wherein the assessment circuitry is configured and arranged to determine an adjusted dose in response to identifying at least one of: a symptom above a threshold and a side effect above a threshold.

7. The weighing scale apparatus of claim 1, wherein the user interface is a foot-controlled user interface (FUI) integrated with the platform, and the processing circuitry and the FUI are configured and arranged to provide the instruction that directs the user to remain still with their eyes focused in a direction until the alert is provided and/or the instruction further directs the user to hold their head up, or to continue to hold their head up, until the alert is provided.

8. The weighing scale apparatus of claim 7, wherein the processing circuitry is further configured and arranged to:
   - verify accuracy of the physiologic data;
   - in response to verifying the accuracy, provide the alert; and
   - in response to being unable to verifying the accuracy, provide another instruction via the FUI to the user to re-collect the physiologic data and instruct the user to have the particular posture.
9. The weighing scale apparatus of claim 1, wherein the user interface includes voice input/output circuitry integrated with the platform, and configured and arranged with the processing circuitry to provide the instruction to the user directing the user to have the particular posture and provide the alert to the user indicating the user can move.

10. The weighing scale apparatus of claim 1, wherein processing circuitry is further configured and arranged to identify a scale-based biometric of the user using signals collected from at least one of the force sensor circuitry and the plurality of electrodes, and therefrom, validate user data, including data indicative of the user's identity and the physiologic data, as concerning the user associated with the scale-based biometric, and the weighing scale apparatus further including a communication activation circuitry configured and arranged to activate communication between the weighing scale apparatus and a remote user-physiologic device in response identifying the scale-based biometric and verifying authorization data received from the remote user-physiologic device corresponds to the user associated with the scale-based biometric.

11. The weighing scale apparatus of claim 10, wherein the communication activation circuitry includes an AND gate configured and arranged to activate communication between the weighing scale and the remote user-physiologic device in response to receiving both the identified scale-based biometric from the processing circuitry and the authorization data from the remote user-physiologic device, and verifying both the scale-based biometric and the authorization data corresponding to the user.

12. The weighing scale apparatus of claim 10, wherein responsive to the activation, the processing circuitry is further configured and arranged to:
   - determine cardio-related data using the physiologic data collected by the remote physiologic device and the user data collected by the weighing scale apparatus; and
   - perform additional cardio-related processing of the cardio-related data, wherein the additional cardio-related processing includes deriving clinical indication data for assessment of a condition or treatment of the user using the cardio-related data and/or historical cardio-related data within a user profile corresponding to the user.
13. The weighing scale apparatus of claim 12, wherein the processing circuitry is further configured and arranged to correlate the physiologic data with the user data based on additional data selected from the group consisting of: time stamping of each data set, time ranges of each data set, time scales of each data set, a phase of at least one of the data sets, and a combination thereof.

14. The weighing scale apparatus of claim 12, further including an output circuit configured and arranged to receive data and communicate with the user interface and/or external circuitry, wherein the processing circuitry and the output circuit are further configured and arranged to output a signal to external circuitry associated with the user in response to the cardio-related data including a physiological parameter that is outside a threshold value, wherein the signal includes a message indicating the user should visit a physician and/or an emergency room.

15. The weighing scale apparatus of claim 1, further including an output circuit configured and arranged to receive the user data and, in response,
   
   operate in a default communication mode in response to an unidentified scale-based biometric, the default communication mode including the output circuit configured and arranged to display user data using the user interface; and
   
   operate in a user verified communication mode in response the user data and identifying one or more scale-based biometrics, the user verified communication mode including the output circuit configured and arranged to output at least a portion of the user data to external circuitry.

16. The weighing scale apparatus of claim 15, wherein the one or more scale-based biometrics include a high security biometric and a low security biometric and wherein the user verified communication mode includes a high verified communication mode and a low verified communication mode, wherein the output circuit is further configured and arranged to:

   operate in the low verified communication mode in response to identifying the low security biometric; and

   operate in the high verified communication mode in response to one of identifying the high security biometric and identifying both the low and the high security biometrics.
17. The weighing scale apparatus of claim 15, wherein, in response to the output circuit operating in the default communication mode, the processing circuitry and the user interface are further configured and arranged to instruct the user on using the weighing scale apparatus with or without foot coverings.

18. The weighing scale apparatus of claim 1, wherein the user interface is a foot-controlled user interface (FUI) including circuitry configured and arranged to provide data to the user while the user is standing on the platform and receive a foot-based user input from the user for the user to interact with the weighing scale, wherein the foot-based user input includes a movement of at least one foot of the user relative to the platform.

19. The weighing scale apparatus of claim 18, wherein the foot-based user input includes at least one movement selected from the group consisting of: the user moving their foot, the user contacting a specific portion of the platform with their foot, and a combination thereof.

20. The weighing scale apparatus of claim 18, wherein the FUI includes a touch screen and is configured and arranged to receive the foot-based user input from the user responsive to at least one foot of the user contacting the touch screen, and wherein the foot-based user input causes the FUI to undergo a change in appearance.

21. The weighing scale apparatus of claim 1, wherein the processing circuitry is further configured and arranged to:
   aggregate scale-obtained user data with user data received by the weighing scale apparatus from at least one user device;
   authorize of communication of at least a portion of the aggregated user data by identifying a scale-based biometric of a hierarchy of different scale-based biometrics, wherein the hierarchy of different scale-based biometrics include a plurality of scale-base biometrics of different security levels used to authorize communication of user data of different security levels; and
   the weighing scale apparatus further including output circuitry configured and arranged to output at least a portions of the aggregated user data to external circuitry that is located remotely from the weighing scale apparatus in response the authorization.
22. The weighing scale apparatus of claim 21, wherein the processing circuitry is configured and arranged to authorize communication of user data of a plurality of different security levels using different levels of verification of user authorization based on identification of the scale-based biometrics of the different security levels and as a function of a value of a sensitivity of the respective user data to be communication.

23. The weighing scale apparatus of claim 21, wherein the processing circuitry is configured and arranged to:
   - authorize communication of a first set of user data to the external circuitry in response to identifying a first level biometric, and
   - authorize communication of a second set of user data in response to identifying a second level biometric that is a higher level of security than the first level biometric.

24. The weighing scale apparatus of claim 21, wherein the processing circuitry is further configured and arranged to perform different levels of security on the user data in response to the authorization and as a function of a value of sensitivity of the user data to be communication, wherein the different levels of security performed on the user data prior to communication the user data includes security selected from the group consisting of: data encryption, hardware token key, software token key, and a combination thereof.

25. The weighing scale apparatus of claim 21, wherein the processing circuitry is configured and arranged to perform different levels of security measures as a function of at least one of the sensitivity of the user data to be communication, identification of the external circuitry, and security of the external circuitry.

26. The weighing scale apparatus of claim 1, wherein the processing circuitry is configured and arranged to provide a hierarchy of services using scale-obtained data, wherein the hierarchy of services include different services enabled in response to user selection of one or more of the different services and activation of subscription levels of different weighted values.
FIG. 11

User Cardio-scale
102

User Display

Secure user-sensitive data:
ex: biometric authorized,
hardware key, software
key, encrypted)

Modify Scale (ex: from
additional services)

191

World Wide Web/Internet

User-sensitive Data

188

User CPU

189

User Watch

Robust GUI

190

Smartphone

User-sensitive Data

Additional services

125

External Circuitry
FIG. 3c

Electrode drive/sense circuitry

I/O DRIVERS (display/vibration-circuit/speaker-microphone)

CPU (computer circuit)

Wireless Commun. Circuitry

To/from Wireless modem, Web, Cellular Systems, ISDN, etc.

Image Encoder with a Interface and Optional Microphone Input (e.g., Conexant CX93510)

Camera (CMOS sensor)

PIR/Motion/Intrusion sense circuitry

User Weighing mechanics & electronic interfaces

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FIG. 4

Simultaneously measure Leg IPG and Foot IPG

400

Extract fiducials from Leg IPG

405

Find fiducials in Foot IPG based on Leg IPG fiducials

410

420

Foot IPG

Leg IPG

415

$T_1, T_2, T_3, T_n$

$T_{F1}, T_{F2}, T_{Fn}$
FIG. 7a

IPG Leg Signal (with fiducials detected in Leg IPG)

Time [seconds]

Segmented Leg IPG beats (47 beats)

Time [samples]

Ensemble Averaged Leg IPG (47 beats, SNR = 61 dB)

Time [samples]

Vertical units are arbitrary

Example of low-quality Foot IPG signals
FIG. 8

$R^2 = 0.92$

$N = 61$ subjects

Metric of leg IPG triggering robustness, based on various heart rates in 61 subjects for a standardized 30-second recording interval.
Fig. 11

Correlation of PTT from direct detection in foot IPG (white dots) vs. Leg-IPG-triggered detection

- From Foot IPG only (white dots):
  \[ R^2 = 0.537, \ n = 57 \]
- From Dual-IPG (black dots):
  \[ R^2 = 0.701, \ n = 62 \]
Correlation of PWV to Subject Age from direct detection in Leg IPG triggered, BCG I-Wave to Foot IPG

FIG. 12

R = 0.75
N = 61 subjects

Scale aPWV

(s/m/s)

Age (years)

1200

20  18  16  14  12  10  8  6  4

20  30  40  50  60  70  80

Correlation of PWV to Subject Age from direct detection in Leg IPG triggered, BCG I-Wave to Foot IPG
Switched, ground-referenced current source implementation

FIG. 14a
Floating current source implementation

FIG. 14b

I_{eq, L, f, 2}

V_{foot, L, 1400}

V_{foot, R, 1405}

V_{eq, L, +} = V_{eq, L, -}

V_{foot, R, +} = V_{eq, L, -}
Transformer-coupled, grounded-load current source implementation

FIG. 14c
FIG. 17

Enter PWV length (1700)

Measure weight, balance, leg and foot impedance (1705)

Signals integrity check (1710)

Extract leg impedance pulse timings (1715)

Extract foot impedance pulse timings (1720)

Extract BCG timings (1725)

Timings quality check (1730)

Compute PWV (1735)

Display PWV (1740)
The impedance is measured consistently through the same parts of the foot.
INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/062484

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A61B 5/00; A61M 37/00; A61N 1/36; A63B 21/06; A63B 71/00; G01G 19/44; G06Q 50/24 (2016.01)
CPC - A61B 5/0002; A61B 5/0402; A61B 5/1118; A61B 5/1117; A61B 5/4872; A61N 1/08 (2016.08)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC - A61B 5/00; A61M 37/00; A61N 1/36; A63B 21/06; A63B 71/00; G01G 19/44; G06Q 50/24; H04L 9/00
CPC - A61B 5/0002; A61B 5/0402; A61B 5/1118; A61B 5/1117; A61B 5/4872; A61N 1/08; A61N 1/3607; A63B 2230/75
G01G 19/44; G06F 19/3416; G06F 21/602; G06G 50/24; H04L 9/3256; H04L 9/3263

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
U.S. - 482/6; 600/300; 604/66; 702/19; 705/3; 713/176 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Orbit, Google Patents, Google Scholar

Search terms used: weighting scale, weight scale, force sensor, physiologic data, adjusting prescription drug dose, health condition, side effect, foot controlled user interface, biometric data, cardio-related, encryption

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tbody>
<tr>
<td>Y</td>
<td>US 2013/006666 A1 (NAKAMURA) 03 January 2013 (03.01.2013) entire document</td>
<td>6</td>
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</tbody>
</table>

Further documents are listed in the continuation of Box C. See patent family annex.

* "A" document defining the general state of the art which is not considered to be of particular relevance
* "E" earlier application or patent but published on or after the international filing date
* "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
* "O" document referring to an oral disclosure, use, exhibition or other means
* "P" document published prior to the international filing date but later than the priority date claimed

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<td>10 January 2017</td>
<td>27 JAN 2017</td>
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