



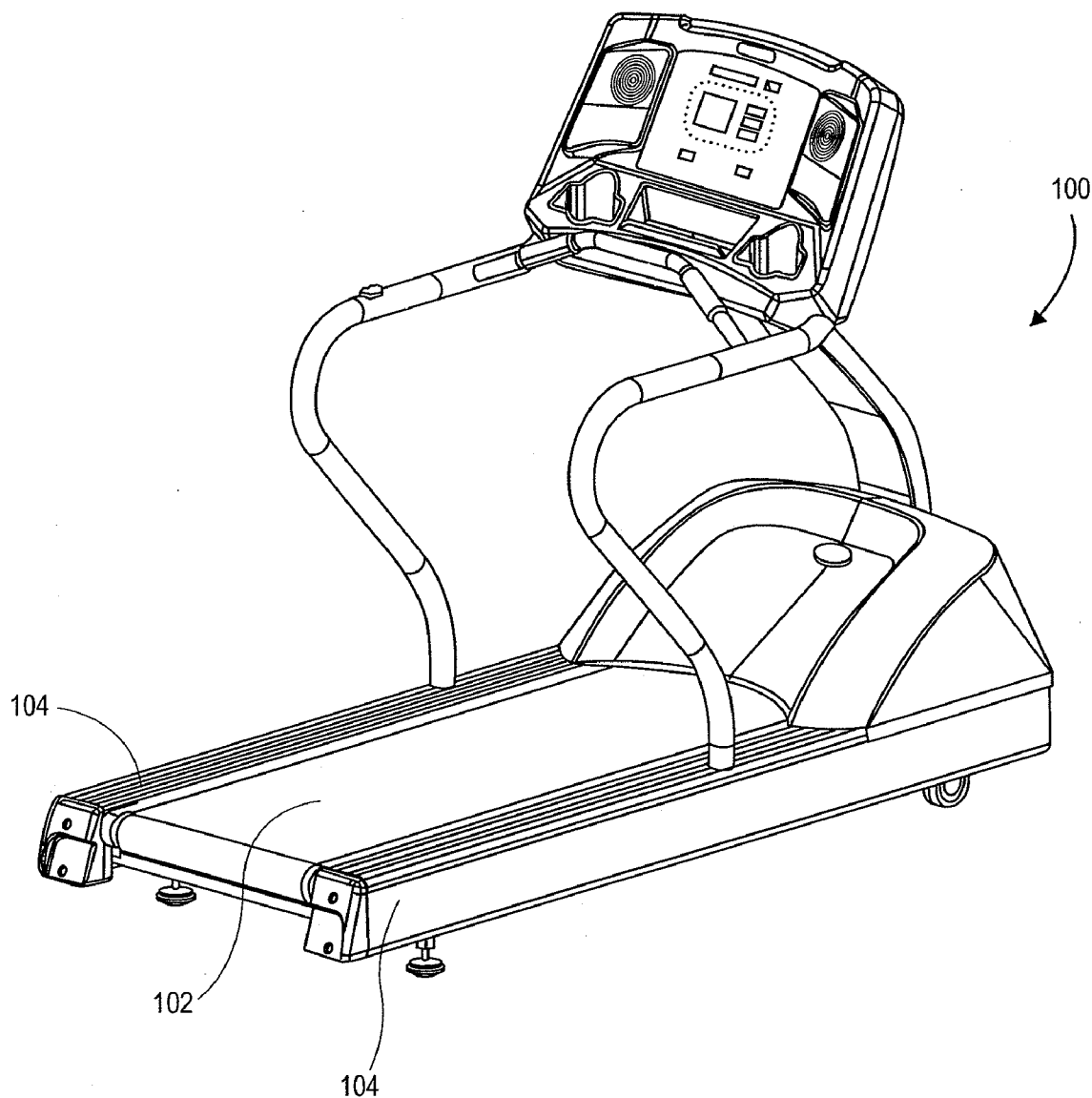
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Morris et al.(10) **Pub. No.: US 2010/0160115 A1**(43) **Pub. Date: Jun. 24, 2010**(54) **USER DETECTION FOR EXERCISE
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IRVINE, CA 92614 (US)(73) Assignee: **Unisen, Inc., dba Star Trac**, Irvine,
CA (US)(21) Appl. No.: **12/340,470**(57) **ABSTRACT**

Embodiments of the present disclosure include a user detection system for exercise equipment, such as a treadmill. In an embodiment, a sensor monitors displacement between a deck supporting a moveable treadmill belt and aspects of a treadmill frame. As users interact with the treadmill, a processor uses a sensor signal indicative of the displacement to determine whether a user has mounted the treadmill belt.

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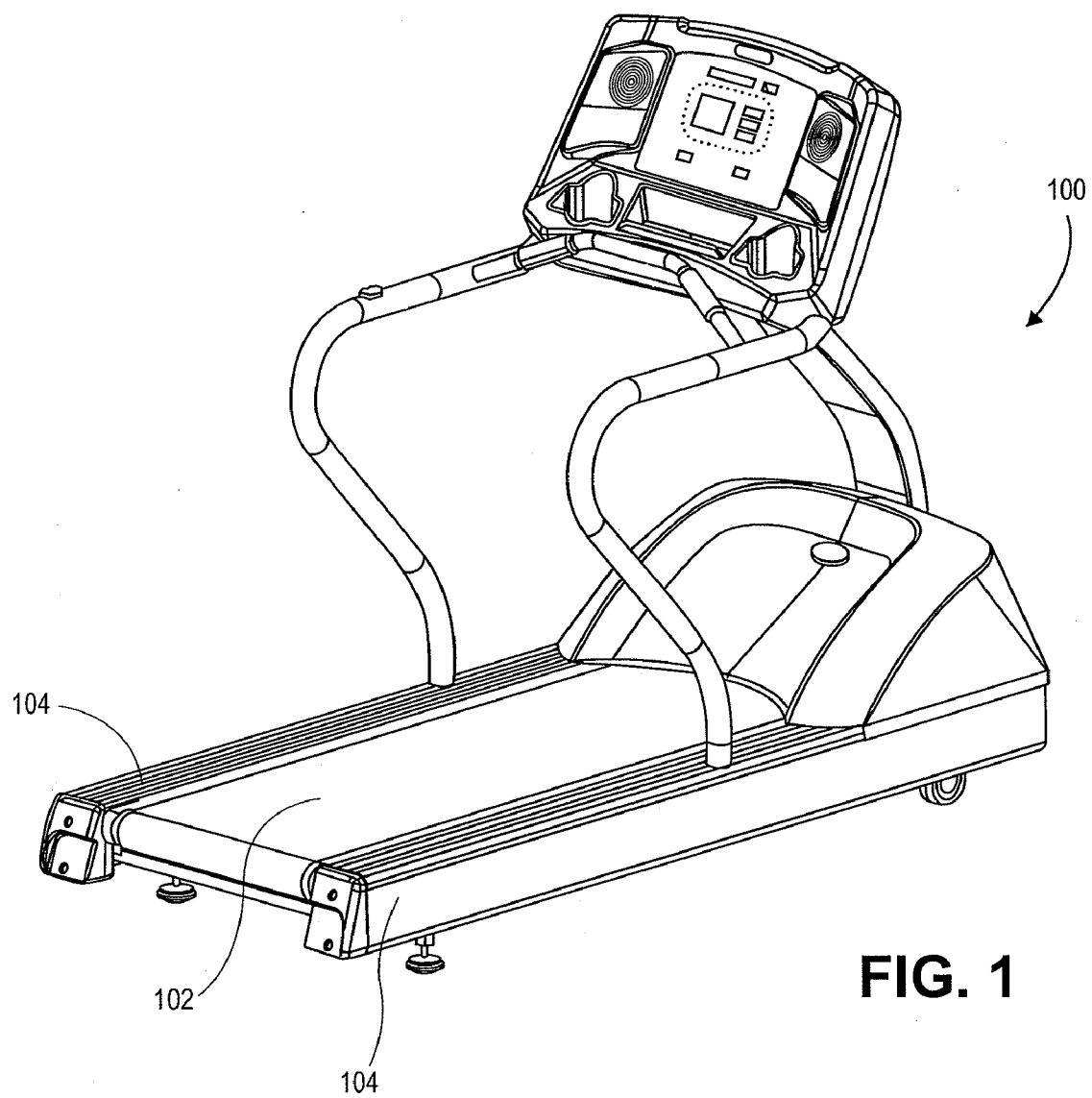


FIG. 1

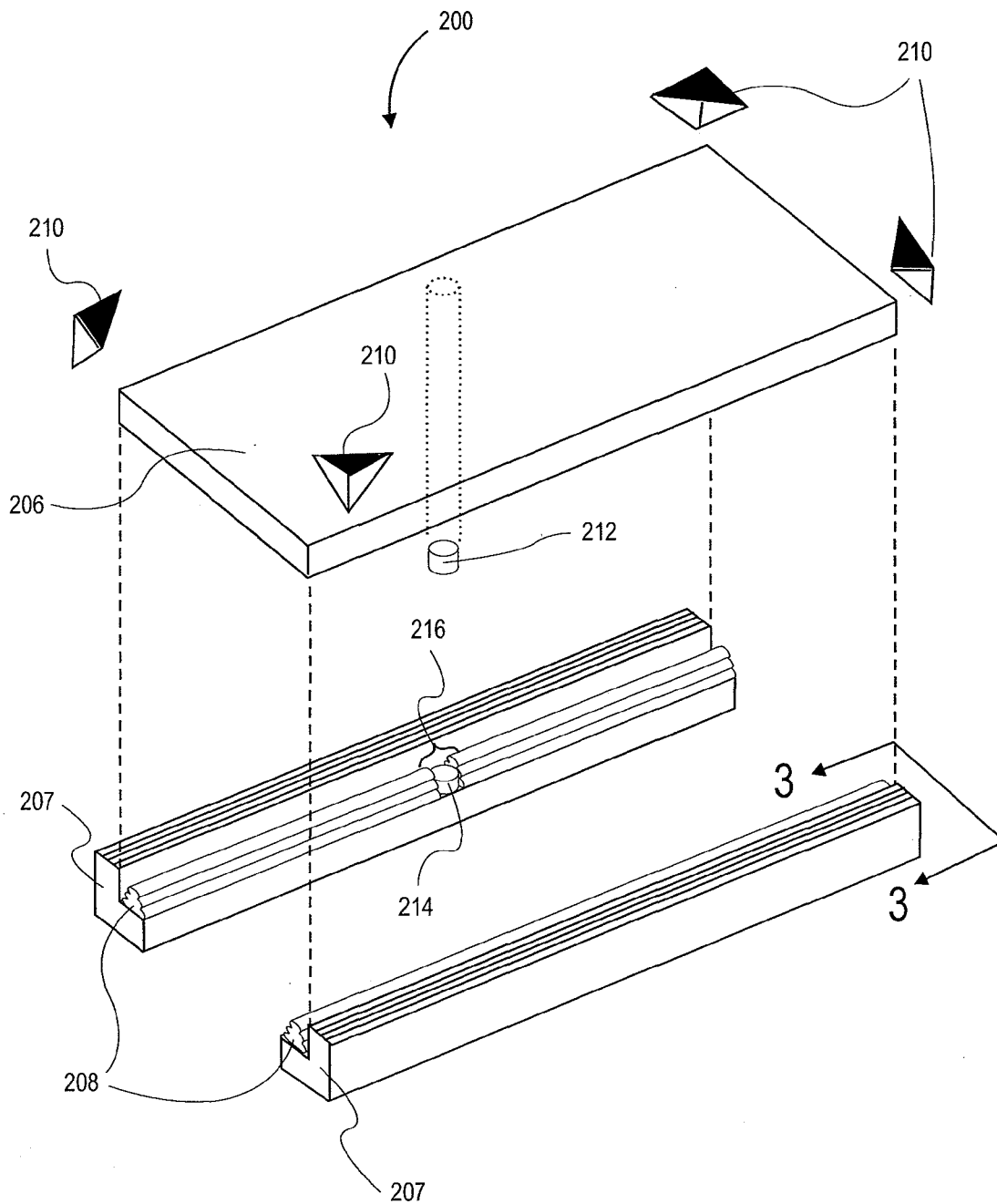


FIG. 2

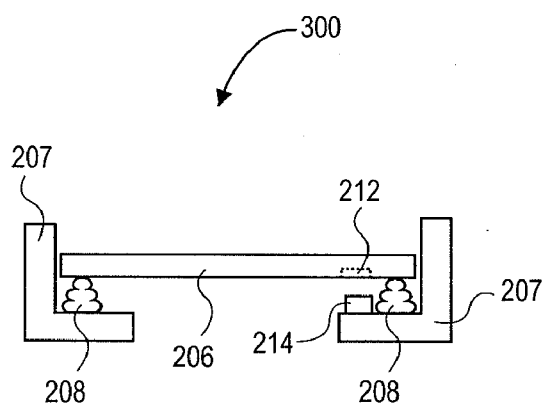


FIG. 3A

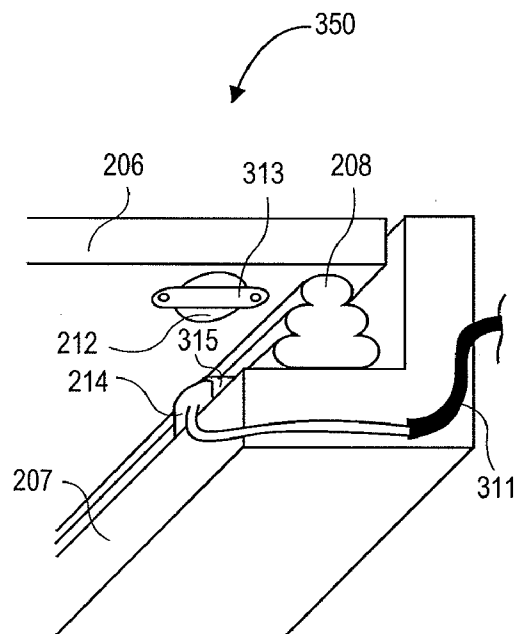


FIG. 3B

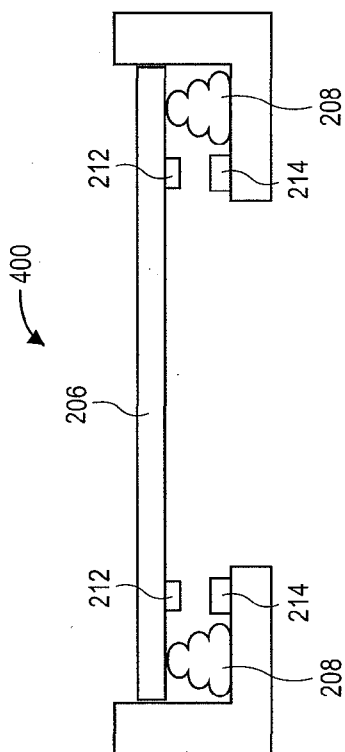


FIG. 4

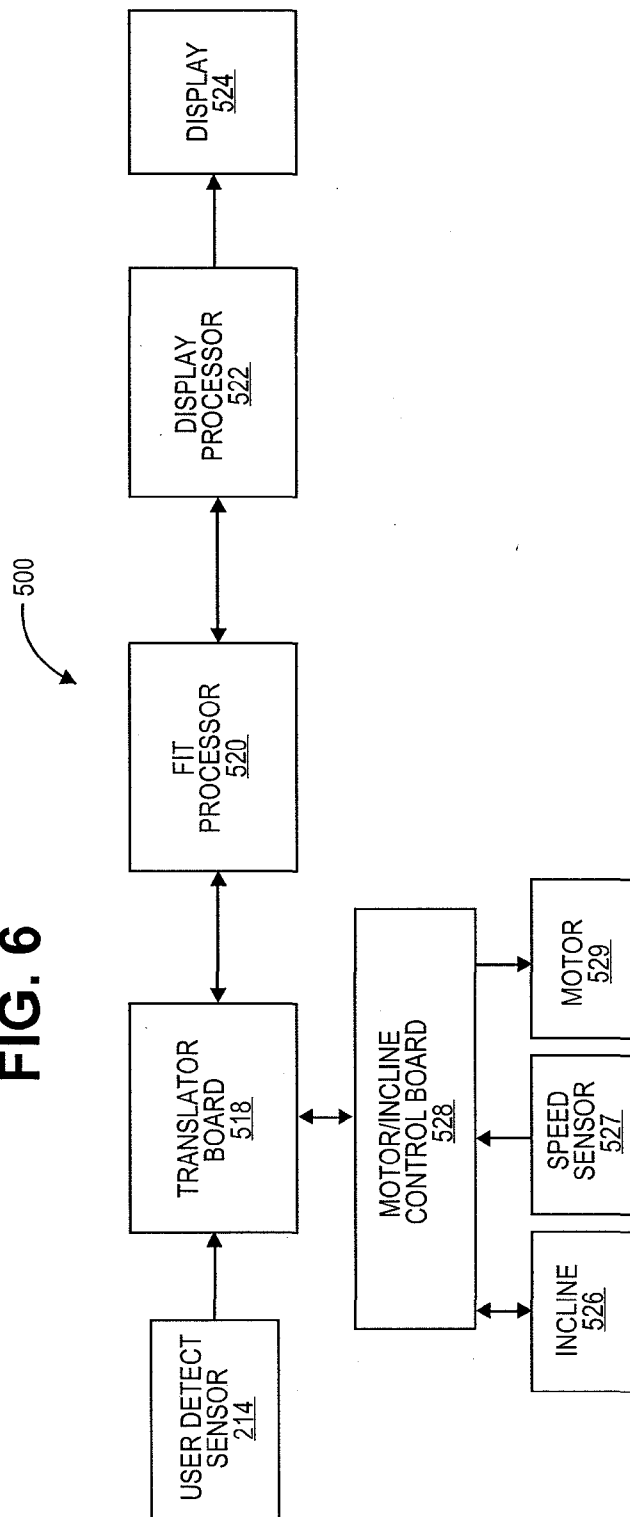
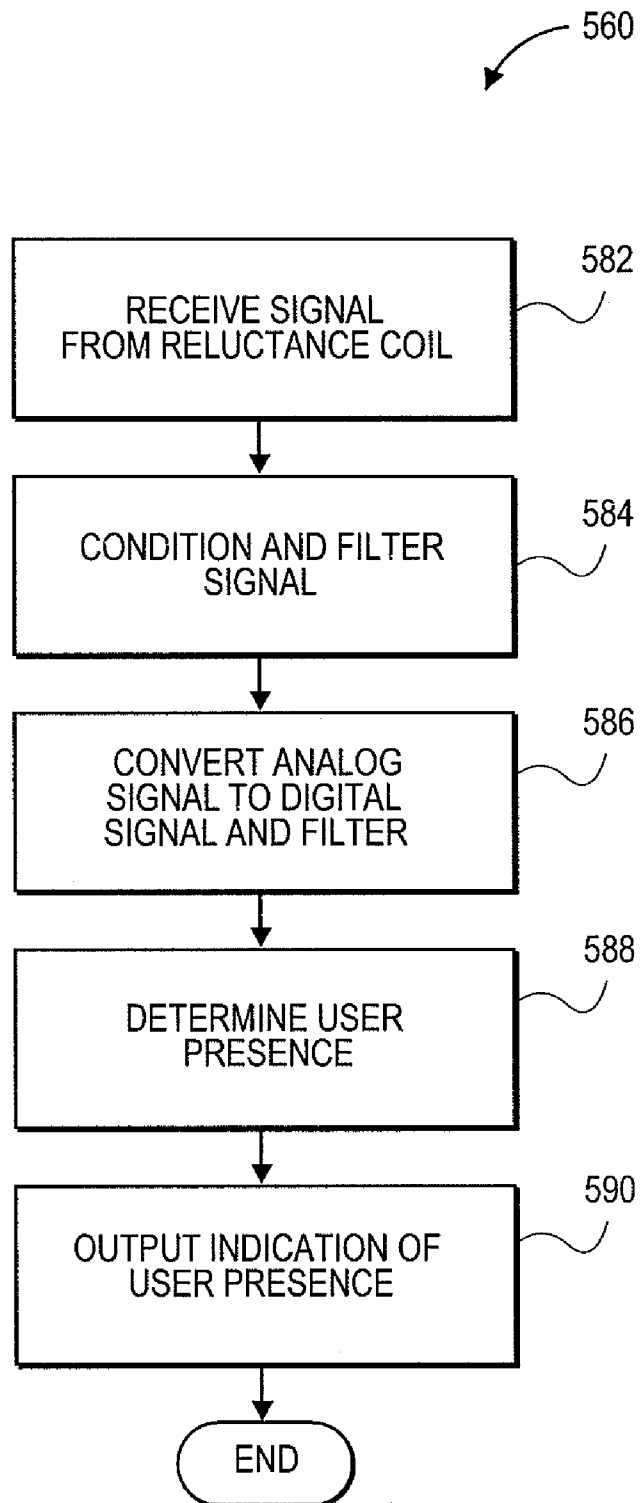


FIG. 6

**FIG. 5**

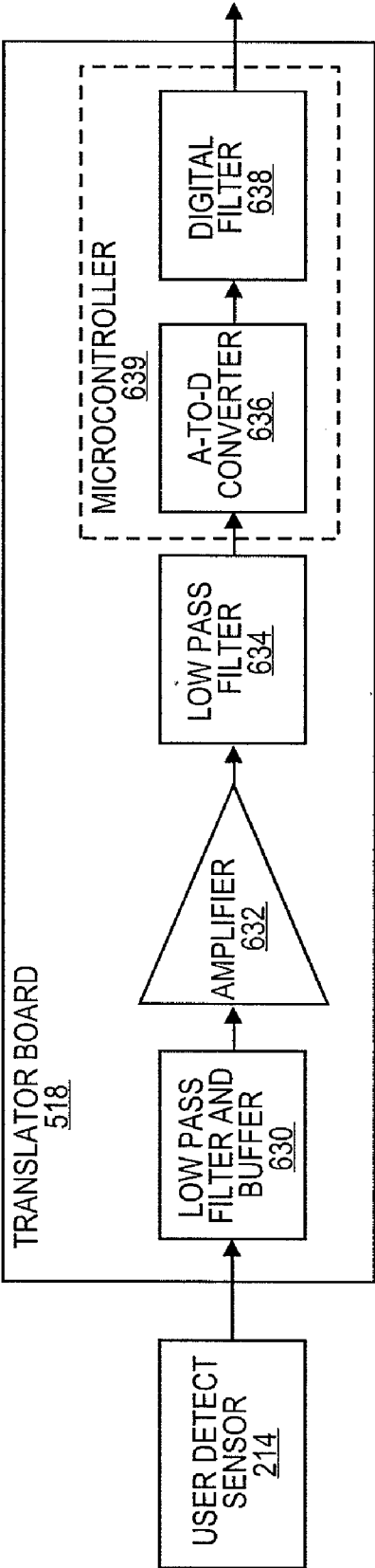


FIG. 7A

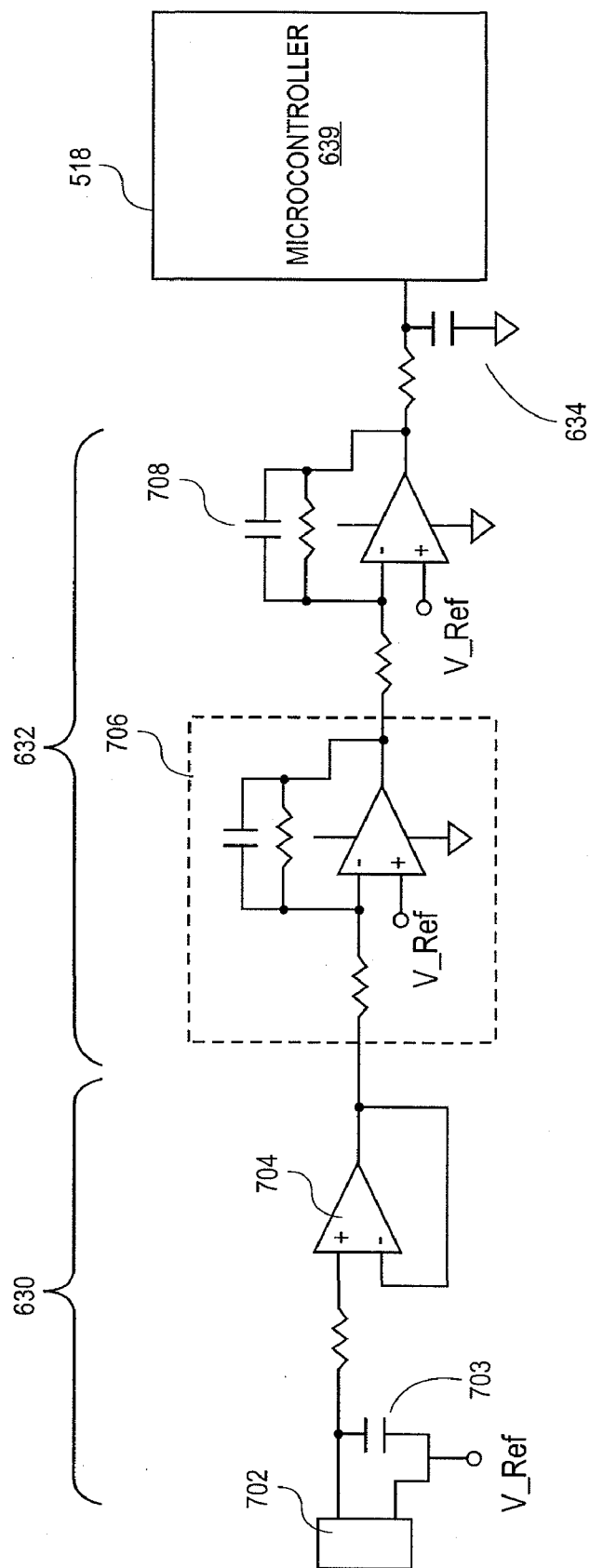


FIG. 7B

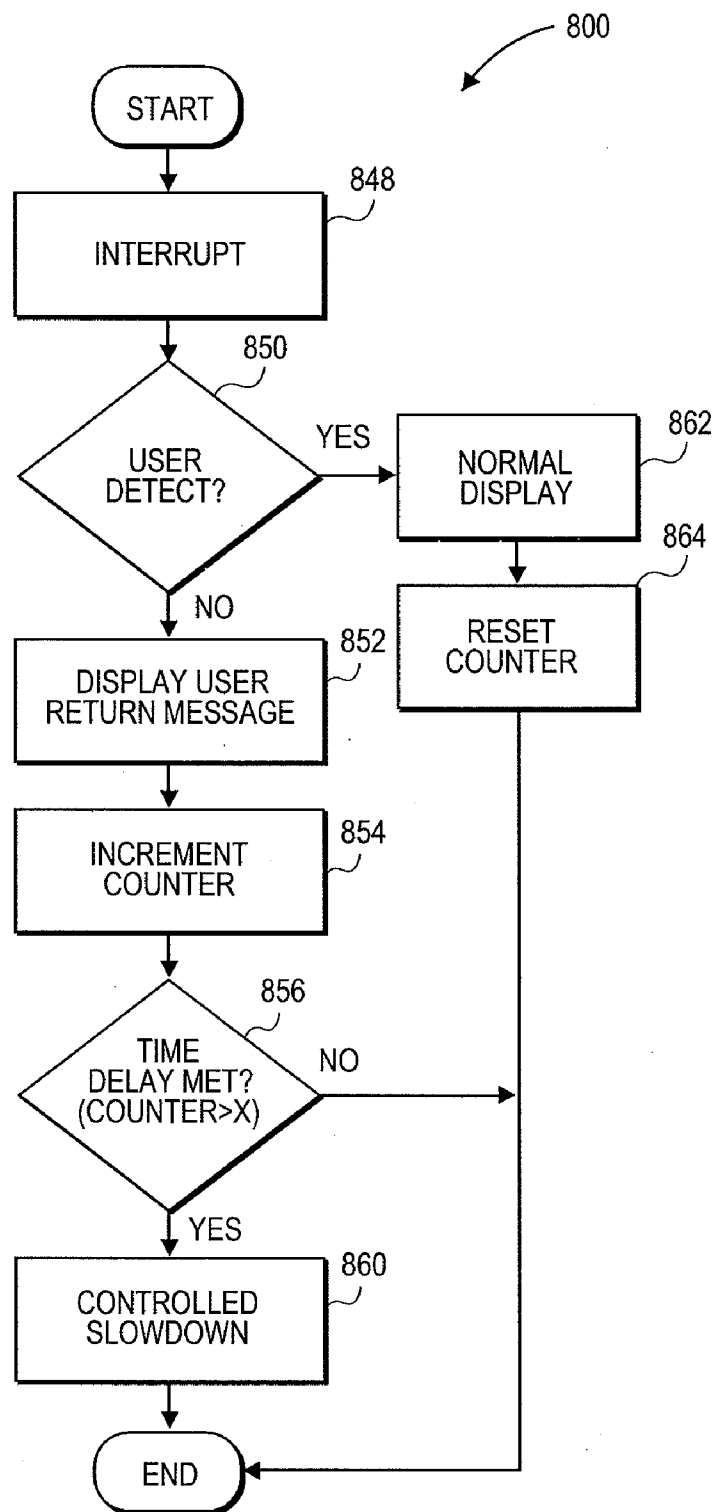


FIG. 8

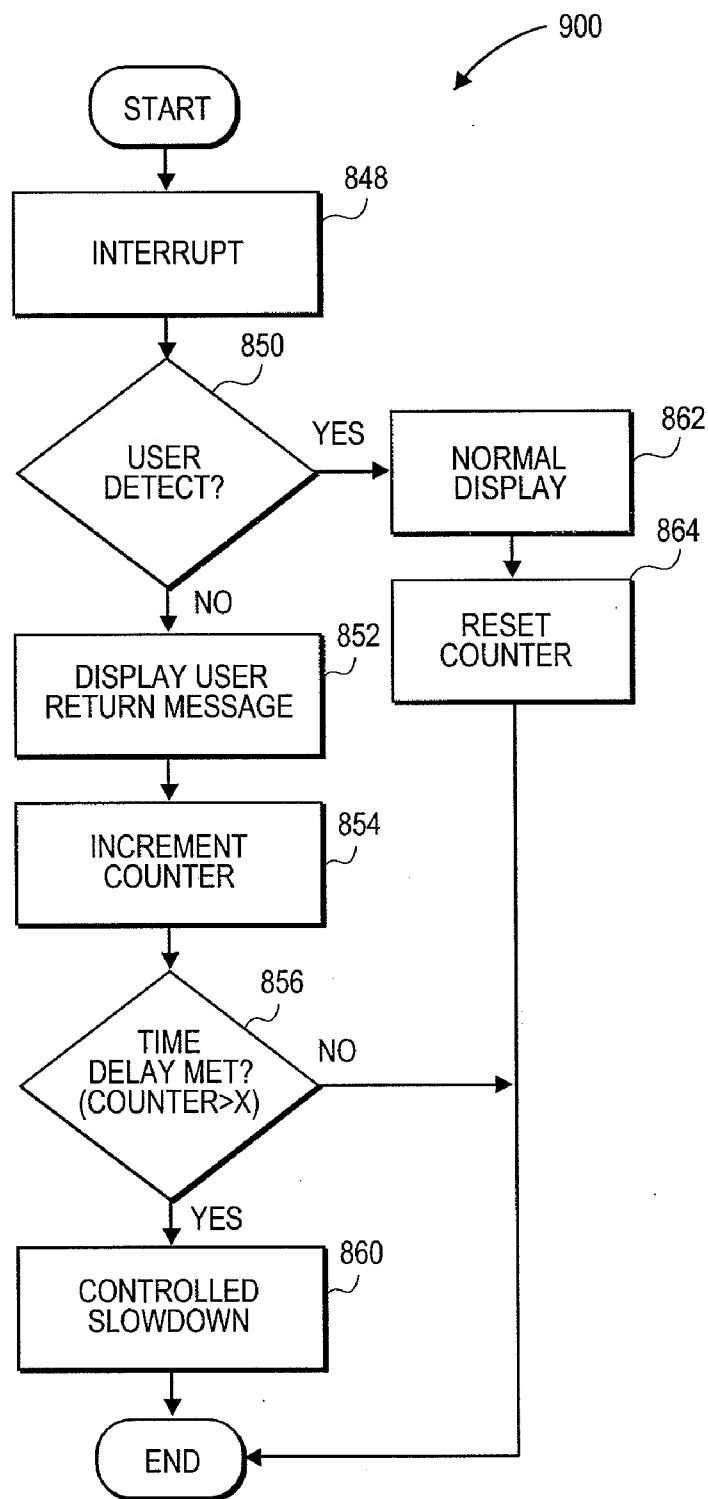
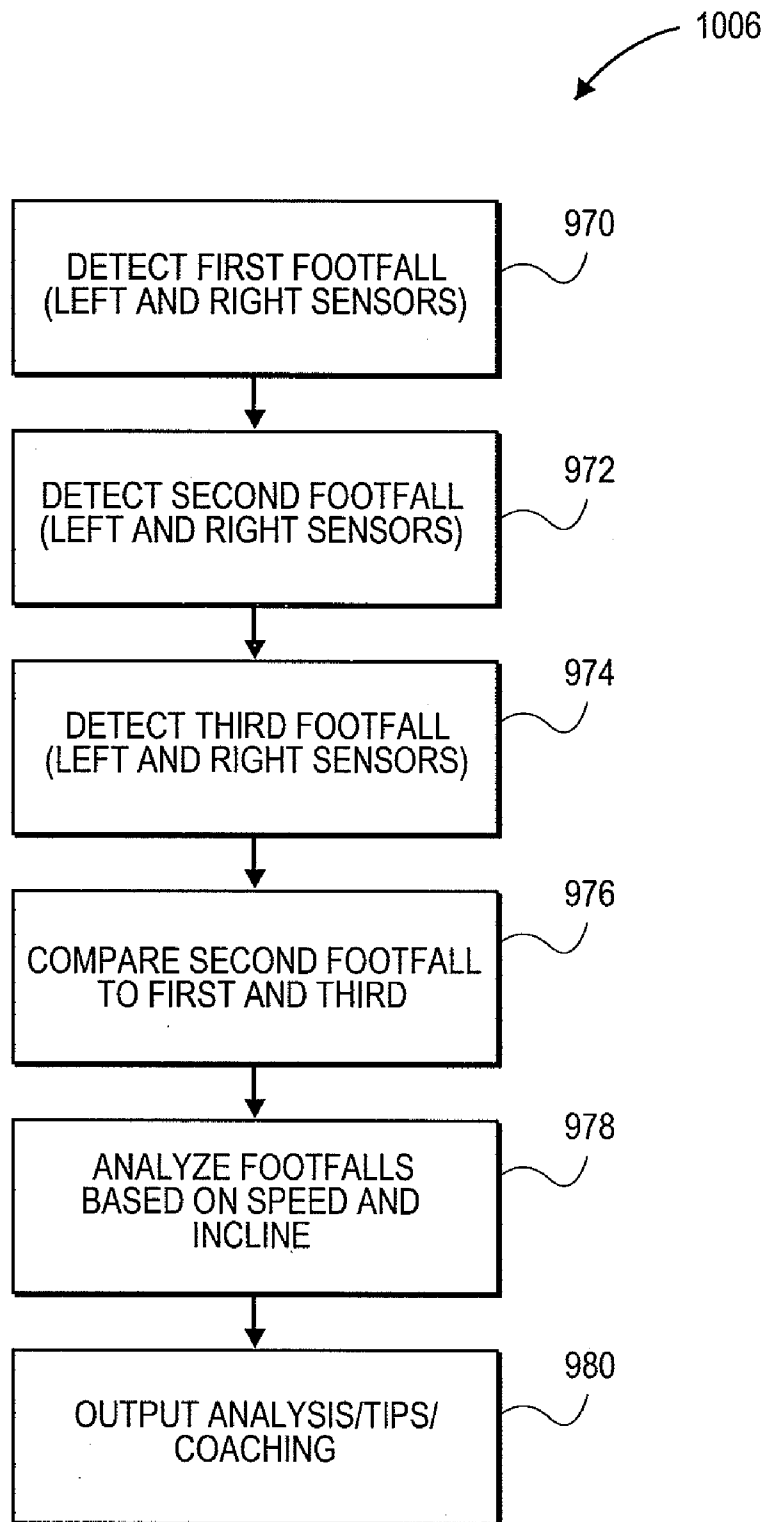


FIG. 9

**FIG. 10**

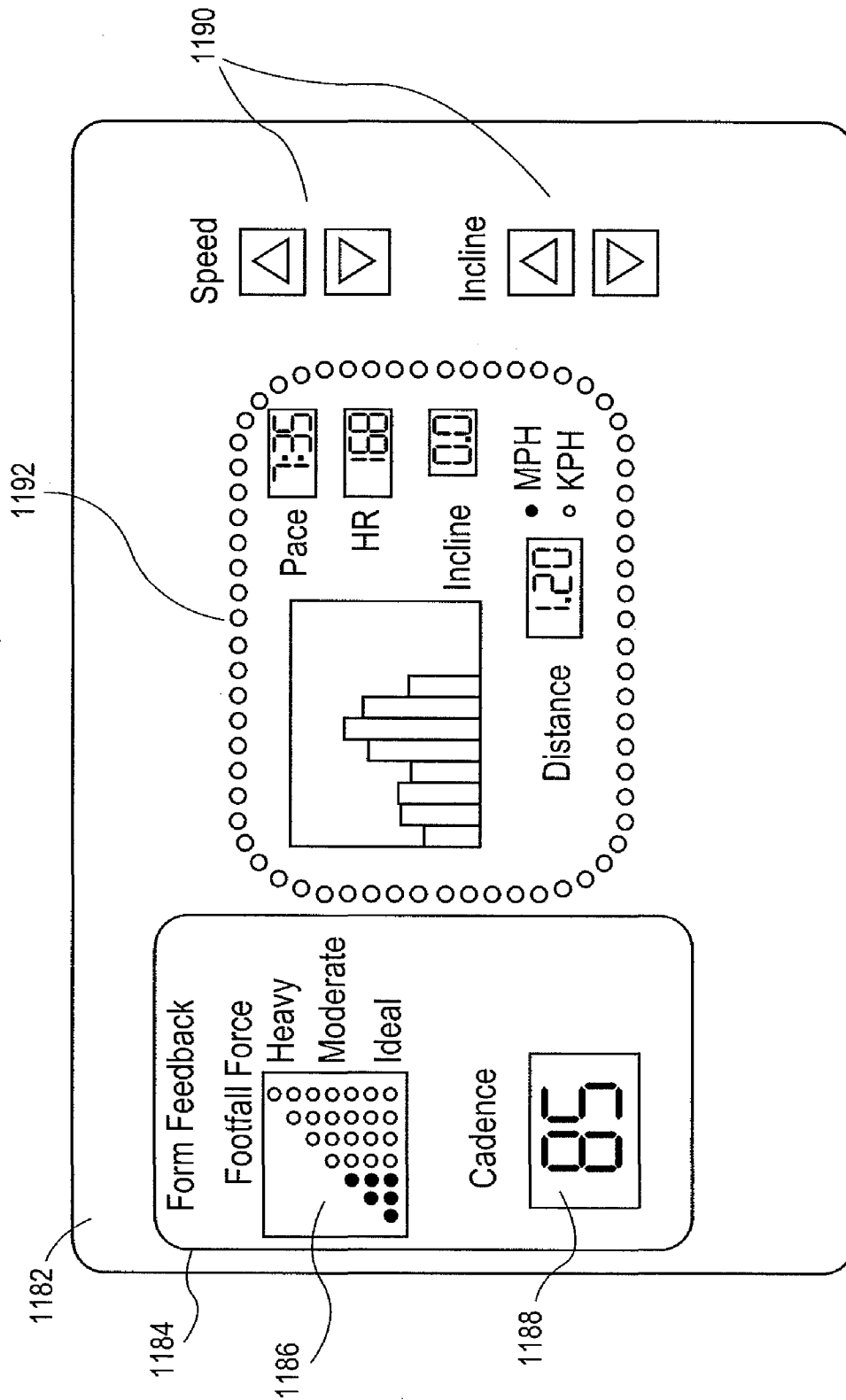


FIG. 11

FIG. 12A

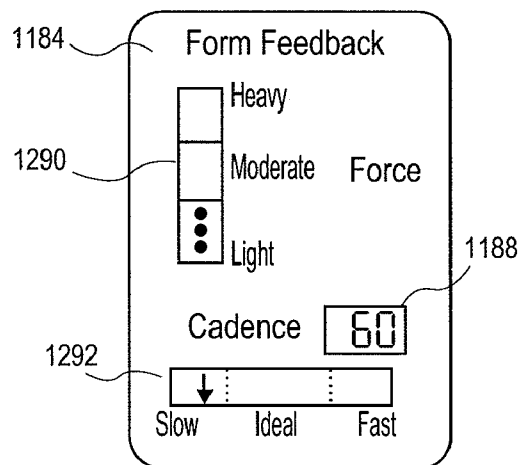


FIG. 12B

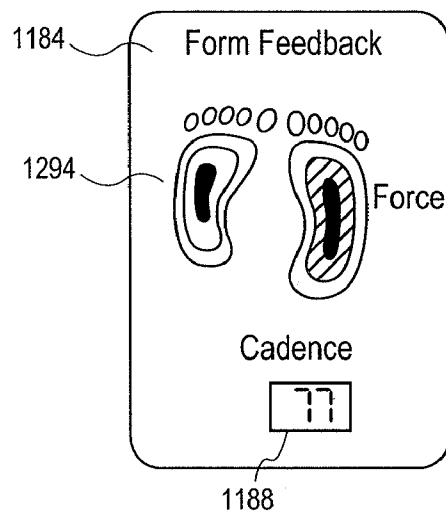
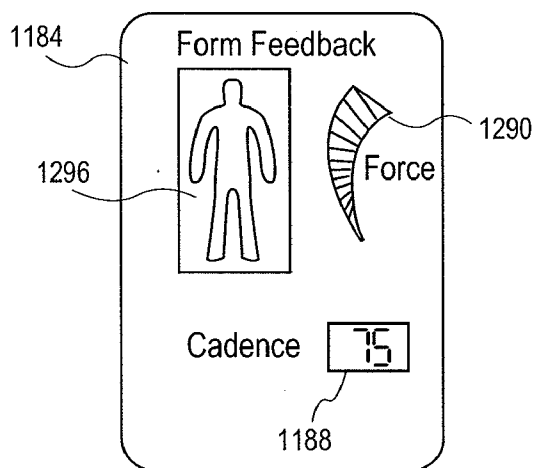


FIG. 12C



USER DETECTION FOR EXERCISE EQUIPMENT

BACKGROUND

[0001] 1. Field of the Invention

[0002] Aspects of the present disclosure relate to the field of exercise machines. More specifically, the invention relates to exercise machines having user detection features.

[0003] 2. Description of the Related Art

[0004] Commercially available residential and industrial exercise machines are popular with many individuals who want to enjoy cardiovascular exercise to lose weight, obtain or maintain fitness, and the like. Treadmills are one example, and nearly all treadmills have a kill function designed to stop the machine in an emergency situation, often implemented through a user tether or user accessible button. However, there remains a need to be able to detect the presence or absence of a user. Some manufacturers employ an infrared emitter and detector. Often the emitter emits radiation aimed at the approximate location of a user's chest, and the detector detects reflected radiation when a user is present. However, such a system can include inaccuracies. For example, lighting conditions where the machine is located may saturate or confuse the detector; the color and material of a user's clothes may similarly confuse the detector or the like.

[0005] Manufacturers also introduced detection devices that identify the presence of a user based on changes in load on the electric motor driving the belt of a treadmill. Each time a user plants a foot, the weight of the user supplies an additional load on the belt, and thus the motor, compared to when no user is present. There are limitations to such a solution, however, including the need for the belt to be moving. Moreover, as the incline of a treadmill increases, there is less or no load change to detect, which will generally affect the accuracy of the user detection.

SUMMARY

[0006] Accurate and consistent user detection with exercise equipment is important for a variety of reasons. For example, it is advantageous to be able to stop a machine in an emergency situation, such as if a user falls off the machine, cannot reach a kill switch mechanism, the user leaves a machine running, or the like. A particularly problematic issue occurs when a user wants to rest, stretch or otherwise stop exercising for a short time but leaves the belt running at speed. In such situations, it is advantageous to alert the user to reengage or halt the belt movement. Additionally, an accurate detection of force and/or cadence of a user's footfalls on a treadmill can help diagnose and correct running or walking form issues, such as to help prevent or reduce injuries or to train or retrain a person to walk. Such a system can also help control workouts, aid in rehabilitation settings, and the like.

[0007] An embodiment of this disclosure provides a user detection system for an exercise machine including one or more sensors that detect vertical and/or horizontal movement in a treadmill deck with respect to a treadmill frame. An example of this type of sensor includes a reluctance-type sensor comprising a magnet and induction coil to detect induced current based on the movements of a treadmill deck with respect to the treadmill frame caused by the movements of a user. More specifically, in an embodiment, a treadmill comprises a stationary frame supporting a floating deck beneath a treadmill belt. The deck may rest on, for example,

flexible rubber rails or the like attached to the frame or the like that allow some cushion and shock absorption for a user. The deck further includes a magnet operably affixed to move as the deck moves it and an induction coil operably affixed on at least one frame rail in close proximity to the magnet, together forming a reluctance sensor. As a user walks, runs, or even simply shifts his or her weight on the treadmill, the user will change weight on the deck, causing the flexible rubber rails to flex. The deck will thereby shift in relation to the frame, and therefore the magnet will move in relation to the induction coil, which may be operably stationary with the frame, thereby inducing a current/voltage in the coil that can be measured, and providing an indication of the presence of the user.

[0008] In an embodiment, these signals can be used to pause or stop a treadmill, for example, when a user departs without stopping the belt of the treadmill. These signals can also be used to power down a machine after a user has been gone for a certain period of time. In yet another embodiment, the user detection can be used to alter a display to include indicia designed to attract the attention of a potential user when there is no user at the machine; for example, the attract screens may include a challenge screen (such as displaying a message such as "Can you improve your mile time?" or "How far can you go today?") or a welcome screen. Additionally, the treadmill can initiate a program start sequence when a user is detected.

[0009] Moreover, in an embodiment, two or more of these sensor sets may be placed near opposite rails of a treadmill frame. The various readings from the multiple sensors can be compared to determine left footfalls versus right footfalls, cadence, impact variance between a user's legs and the like. Information that can be derived from the multiple sensors, in an embodiment, may be used to determine if a user is favoring one leg or the other, differences in stride or gait, and the like. In turn this information can be evaluated to provide technique suggestions, training tips, and so on.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] A general architecture that implements the various features of the disclosure will now be described with reference to the drawings. The drawings and the associated descriptions are provided to illustrate embodiments of the disclosure and not to limit its scope. Throughout the drawings, reference numbers are reused to indicate correspondence between referenced elements.

[0011] FIG. 1 illustrates a perspective view of an exemplary treadmill including a base and deck according to embodiments of this disclosure.

[0012] FIG. 2 illustrates an exploded view of an exemplary deck and sensor of the treadmill of FIG. 1.

[0013] FIG. 3A illustrates a cross sectional view of an embodiment of a treadmill deck resting on its rails and base, according to an embodiment of this disclosure.

[0014] FIG. 3B illustrates a perspective view of a corner of the deck of FIG. 3A.

[0015] FIG. 4 illustrates a cross sectional view of an embodiment of a treadmill deck resting on its rails and base, according to an embodiment of this disclosure.

[0016] FIG. 5 illustrates a sample flow diagram for a user detection process according to embodiments of this disclosure.

[0017] FIG. 6 illustrates a block diagram of an embodiment of an exemplary treadmill system according to an embodiment of this disclosure, including user detection electronics.

[0018] FIG. 7A illustrates a block diagram of a translator board of the treadmill system of FIG. 6 according to an embodiment of the disclosure.

[0019] FIG. 7B illustrates an electronic circuit diagram of an embodiment of exemplary translator board components of the treadmill system of FIG. 6.

[0020] FIG. 8 illustrates a sample flow diagram for a user attraction process according to embodiments of this disclosure.

[0021] FIG. 9 illustrates a sample flow diagram for a user detection process during equipment operation according to embodiments of this disclosure.

[0022] FIG. 10 illustrates a sample flow diagram for user technique evaluation process according to embodiments of this disclosure.

[0023] FIG. 11 illustrates a sample display panel for providing user technique evaluation to a user according to embodiments of this disclosure.

[0024] FIGS. 12A-C illustrate exemplary alternative form feedback displays according to embodiments of this disclosure.

DETAILED DESCRIPTION

[0025] As stated the detection of a user's presence on exercise equipment can provide a number of benefits, including safety, power savings, motivation, training, and the like. A user detection system for exercise equipment, such as a treadmill will now be described with reference to the figures. FIG. 1 illustrates an exemplary treadmill 100, including a base 104 with a frame positioning two rollers stretching an endless treadmill belt 102 for exercising users. Within a loop formed by the treadmill belt 102 resides a generally resilient deck surface, preferably with a low coefficient of friction between the surface and the belt 102 that allows the belt 102 to glide over it while in use. In an embodiment, the deck may be any shape including flat, concave or the like. In an embodiment, a deck may advantageously be "floating" within a constrained space that in an embodiment is defined at least in part by the treadmill frame. In this type of floating support deck, a user exercising on the belt will experience cushioning with each step. In an embodiment, a user detection system may advantageously monitor displacement between the floating deck and portions of the frame to determine whether a user has mounted the belt 102. In an embodiment, the displacement may advantageously be indicative of a user's gait, exercise cadence, exercise form, or the like.

[0026] Although the treadmill 100 of FIG. 1 includes the foregoing elements in the present disclosure, a person of skill in the art will recognize from the disclosure herein a wide variety of treadmill designs or exercise equipment usable to exercise or rehabilitate a user thereof, including, for example, treadmills commercially available from StarTrac®, ICON, and many others. Moreover, one of skill in the art will recognize from the disclosure herein a wide variety of displacement monitoring schemes between user exercise structures and equipment frames.

[0027] FIG. 2 illustrates an exploded view of an embodiment of a treadmill base 200, including the base 104 and deck 206, illustrating internal components of FIG. 1. In an embodiment, elements of a frame 207 extend generally along the sides of the deck 206. The frame elements 207, in an embodi-

ment, are steel, other metal, or other strong, stiff material. In an embodiment, the frame elements 207 additionally position and often house the rollers for the treadmill belt, the belt driving mechanism, incline elements, and the like. The frame elements 207 support cushioning supports 208 upon which the deck 206 sits. The cushioning supports 208 can include a generally resilient, yet compressible material to provide some amount of cushioning to a user when his or her feet impact the belt above the deck 206, such as, for example, any rubber material or the like. As illustrated, the cushioning supports 208 resemble three ovals of decreasing size stacked atop each other. A shape such as this and others known to those of skill in the art from the disclosure herein allow some degree of both lateral movement and vertical compression when stressed by the force of a user's footfalls upon the deck 206. It is understood that other shapes can be used, however. In an embodiment, deck 206 is not attached to the cushioning supports 208 but is allowed to float within a confined place. Caps 210 attach to each corner of the frame elements 207 to restrict the movement of deck 206 to be within the frame. In an embodiment, the user detection sensor is located near one edge of deck 206. This provides an easy location for the sensor elements; additionally, the edges of the deck may provide the most upward flex when a user steps down on a more central area of the deck. In the embodiment illustrated, the sensor is near the middle of one cushioning support 208. In an embodiment, a magnet 212 attaches to the underside or within a cavity in deck 206. Also an induction coil 214 attaches in close proximity to the magnet, along frame element 207. Together, the magnet 212 and induction coil 214 comprise a reluctance sensor. As shown, a portion of the cushioning support 208 may be eliminated to provide a cut-out area 216 for placement of the inductance coil 214. This may allow the reduction of additional attachment pieces or enlargement of frame elements 207 that might otherwise be needed to align the sensor elements, although it is not a singular solution for accomplishing these goals. Deck 206 is generally made of a sturdy material that can withstand the forceful impacts of runners and other users. However, deck 206 will often flex slightly as a user steps towards the center of the deck 206 where there are no supporting rails. This, in conjunction with the free-floating deck and the preferably compressible cushioning supports 208, allows magnet 212 to move in relation to the inductance coil 214, which is fixed in place along the frame element 207. As the deck moves slightly from a user's footfalls or shifts in weight, the magnet's 212 corresponding movements induce a current in the induction coil 214, which is stationary with respect to the frame element 207, and this signal is in turn communicated through a wire 311 (FIG. 3B) to a processor for translation.

[0028] FIGS. 3A and 3B illustrate other views of an embodiment of treadmill bases 300, 350 with user detection sensors and provide examples of additional options for the placement of the sensors. FIG. 3A illustrates a cross sectional view of the deck and sensor arrangement similar to that of FIG. 2. In the embodiment illustrated in FIG. 3A, there is sufficient room along frame element 207 to place the inductance coil 214 along a side cushioning support 208. As shown in FIG. 3B, magnet 212 is set into a recess of deck 206 and held in place by a fastening element 313 in an embodiment. Similarly, inductance coil 214 is held in place, such as by a generally U-shaped fastening element 315. Of course, any of a number of fastening and/or positioning elements can be used for this purpose, including, for example, nails, screws, or bolts with braces or restraining plates; adhesives, tapes, or

glues; combinations of the same; and the like. In another embodiment, one or both of magnet **212** and inductance coil **214** can be frictionally held within an appropriately sized cavity (such as magnet **212** within deck **206**). In an embodiment, the magnet **212** and inductance coil **214** are interchangeable, in that the sensor could be operably mechanically associated with the deck **206**, while the magnet is operably mechanically associated with the frame element **207**. The inductance coil **214** may also be located under the frame element **207** in an embodiment, so long as the magnet **212** and inductance coil **214** are in sufficient proximity that the magnetic field of the magnet **212** induces a current in the inductance coil **214** based on motion of the magnet **212**. This distance may be influenced by the type and specification of sensor components.

[0029] FIG. 4 illustrates another embodiment of treadmill deck base **400** including a user detection system. This embodiment includes multiple user detection sensors. The multiple sensors may be located in various positions on the treadmill, such as one close to each cushioning support **208**. As shown in FIG. 4, two or more magnets **212** attach close to opposing edges of the deck **206**. As before, each magnet **212** pairs with an inductance coil **214**, attached across a gap created by the cushioning supports **208**.

[0030] As illustrated in FIG. 4, magnets **212** may not be placed within recesses of deck **206**. In the embodiment illustrated, the magnets **212** are not fully recessed, as may be dictated by manufacturing simplicity or the status of the sensors as an optional treadmill accessory. It is therefore advantageous to ensure that the cushioning supports **208** do not compress so much that the magnets **212** can impact inductance coils **214**. As such, any cut-out areas **216** are preferably sized to accommodate the maximum lateral and longitudinal motion of the deck **206** preventing or reducing the possibility of the cushioning supports **208** pressuring the magnets **212** during the deck's movement. In some embodiments, the sensors may preferably be located near the deck's corners (see FIG. 3B), as one of skill in the art will recognize that increased flex of the deck **206** is likely to be experienced at or near the corners and edges of the deck. This is due to the fact that the corners will generally be the farthest portions of the deck from those bearing the weight and impact of users who generally stay closer to the center of the deck. However, the sensors can also be placed suitably anywhere along the cushioning supports **208** (such as shown in FIG. 2). In an embodiment, the treadmill includes a reluctance sensor near the center of the deck **206**, such as when a treadmill includes crossing braces or the like under the deck **206** that may be used to strengthen the frame. In addition to the foregoing, input from one or multiple sensors may be compared to determine, for example, a noise floor, weight distribution, or other indications of use of the treadmill.

[0031] With embodiments of the arrangement and make-up of user detection sensors described, it is helpful to understand the operation of such a sensor. FIG. 5 illustrates an exemplary user detection process **560**. As disclosed above, when a user steps onto an exercise machine, such as a treadmill, in an embodiment of this disclosure, the deck **206** will move and/or flex in relation to the frame **207**. The magnet **212** will in turn move in relation to the inductance coil **214**. This motion changes the magnetic field experienced by the inductance coil **214** and induces an electrical signal (block **582**) that can be communicated, in an embodiment, through wires **311**. The process includes filtering the electric signal(s) to decrease

noise (block **584**). Internal components or the transmission of the signal along the wires, as well as external environmental factors, can all create noise which may reduce the clarity of the user detection signal. In an embodiment, the analog signal is conditioned and then converted into a digital signal for ease of processing (block **586**). In some embodiments, the process may include further filtering of the digital signal (block **586**). A processor uses the digital signal strength, duration, or comparison to a previous signal to determine whether a user is present (block **588**). For example, slight vibrations in the treadmill caused merely by the electric motor driving the belt may create small, "baseline" signals. A change from a small baseline signal to a large signal can indicate the presence of the user. The determination can be output to a display, passed to another process for use, or the like (block **590**).

[0032] FIGS. 6 and 7A illustrate exemplary block diagrams of a treadmill information processing system **500** according to an embodiment of the present disclosure. In some embodiments, the systems of FIGS. 6 and 7A are configured to perform the method disclosed in FIG. 5. As shown in FIG. 6, the system includes sensors **214**, **526**, **527**, monitoring various treadmill activities. The sensors each output signals to one or more signal processors at translator board **518**. The processors calculate various parameters based on the incoming signals and manage drive elements (such as motor driver **529**), output some or all of the parameters to one or more displays **524**, or the like.

[0033] In an embodiment, the sensors include a user detect sensor, such as the magnet and coil **214** disclosed herein, other magnetic sensors, optical sensors, or the like. In an embodiment, a motor/incline control board **528** includes an incline controller **526**, a speed sensor **527**, and a motor driver **529**. In an embodiment, the incline controller **526** provides indications of the current incline, as well as controls raising and lowering of the treadmill belt. In another embodiment, the incline controller functions may be handled by multiple components. One of skill in the art will recognize from the disclosure herein a wide variety of sensors and motor feedback systems capable of monitoring the incline and speed of a treadmill **100**, including for example, induction sensors, optical sensors, potentiometers, and the like. In some embodiments, the speed sensor **528** may include a reluctance sensor similar to the user detect magnet **212** and inductance coil **214**, where, for example, one or more magnets rotate operably with a driving motor to pass a stationary inductance coil. Those of skill in the art will understand that other sensor elements may also be used. For example, one or more metal components could rotate operably with a driving motor to pass a stationary magnet/sensor combination. The metal's interaction with the magnet can generate a readable signal.

[0034] The signal processors may include a translator board **518**, a FIT (fitness) processor **520**, and a display processor **522**. In an embodiment, the translator processor board **518** comprises one or more circuits and/or microprocessors that, among other things, may condition signals and supply motor feedback functions. In the illustrated embodiment, the translator board receives feedback from the incline sensor **526** and can send commands to an incline motor to raise or lower the treadmill's incline. Similarly, the speed sensor **528** provides an indication of the treadmill belt speed to translator board **518**, and the translator board can send commands to a treadmill belt drive to increase or decrease the speed as necessary. In addition, translator board **518** may receive instructions from other components or supply various data thereto.

[0035] In an embodiment, the FIT processor **520** manages workout programs. This management may include duration, speed, intensity, incline, and segment length parameters, for example. Workout programs may include specific duration, distance, incline, and/or intensity parameters and the like, creating, for example, timed workouts, user controlled workouts, specific distance workouts, hill climbing workouts, interval workouts, fat burning or heart rate controlling workouts, or the like. The FIT processor **520** may also process or store information relating to heart rate, calories burned estimates, and the like. In an embodiment, the display processor **522** governs a display and/or its controls, such as an interactive display. The display processor **522** includes, in various embodiments, fan controls, a television interface, a display interface, an iPod® or other music, multimedia, or other player interface, or the like. In an embodiment, the display **524** includes an LCD screen, an interactive touch screen, a plasma display panel, LEDs, indicator lights, or the like. As illustrated, translator board **518**, FIT processor **520**, and display processor **522** may be one or more physically separate processors and/or electronics boards, or one or more can be combined within signal processor **519**.

[0036] In the illustrated embodiment, the user detection inductance coil **214** communicates with the translator board **518**. The translator board **518** interprets the signals from the inductance coil **214** and forwards them to the FIT processor **520**. The FIT processor **520**, in an embodiment, may use this indication to help control a workout program. For example, the FIT processor **520** may use the absence of a user to affect a workout program. The FIT processor communicates a signal to the translator board **518**, which in turn communicates signals that cause, for example, a treadmill belt drive to slow the treadmill belt and the incline motor to lower the incline. In an embodiment, FIT processor **520** may communicate a user presence parameter to the display processor **522**, which may command the display **524** to display indications of the presence or absence of a user. Some exemplary applications of the user detection indications are discussed below in more detail with relation to FIGS. 8-10 below.

[0037] FIG. 7A illustrates an exemplary embodiment of a portion of the translator board **518** of FIG. 6, according to an embodiment of the present disclosure. In an embodiment, the translator board accepts the signals communicated from the inductance coil **214** and interprets the signals. In an embodiment, the translator board includes an active low pass filter and buffer **630**, an amplifier and filter **632**, a passive low pass filter **634**, and a microcontroller **639**. The low pass filters **630**, **634** helps extract noise from the signal below the Nyquist frequency, and the amplifier boosts the signal for easier processing. The microcontroller **639** outputs a digital indication of a presence or absence of a user, and in some embodiments, may provide more detailed indications beyond a binary “present” or “absent” signal.

[0038] In an embodiment, microcontroller **639** includes an analog-to-digital converter **636** and a digital filter **638**. The passive low pass filter **634** smoothes the signal to help remove anomalies in the signal and provide the overall long-term trend of the signal. The analog-to-digital converter **636** allows the signal to be translated into a digital format to aid more accurate and precise filtering and manipulation. The digital filter performs mathematical operations on the sampling, discrete-time signal to create an output indicative of, among other potential information, the presence or absence of a user.

[0039] In FIG. 7A, signals from a user detect sensor are passed through a low pass filter and buffer **630** to an amplifier **632** and then to another low pass filter **634**. Microcontroller **639** then receives the signals, in an embodiment, and uses an analog-to-digital converter **636**, and a final digital filter **638** to clean up and interpret the signals. The filters help eliminate the background noise and the higher frequency readings that may be caused from normal vibrations of the treadmill's operation. A person of skill in the art will recognize from the disclosure herein that such conditioning, filtering, amplifying, and the like functionality can be done using any of signal processing techniques.

[0040] In an embodiment, the translator board **518** ignores any DC offset caused by the amplifier circuits and interprets a peak-to-peak amplitude of the inductance coil **214** signals. If the peak-to-peak value determined in the microcontroller **518** is greater than a specific threshold, then a user is determined to be present. In an embodiment, the threshold value may be based on a speed-dependent calibration of the inductance coil **214** readings without a user present to automatically set the threshold. In an embodiment, the translator board **518** may interpret the user detection signals to provide only periodic or intermittent data to the FIT processor, such as, for example, every 0.5 seconds or every 0.25 seconds. Additionally, or in the alternative, the translator board may incorporate an interrupt from the sensor. Any interrupt is preferably in a range from about zero to about two seconds. In an embodiment, the interrupts are faster than two second intervals to aid in rendering more accurate readings. While the user detect sensor can function at longer intervals, safety features implemented with the user detection may have reduced effectiveness. Similarly, more advanced uses of the signals (see FIG. 10 below, for example) from the sensor(s) **214** may require shorter interrupt intervals. In an embodiment, interrupt features may depend on the use of the exercise machine. For example, user detection sensor readings may be evaluated more often while a treadmill belt is moving than while the treadmill is not in use.

[0041] FIG. 7B illustrates exemplary components of the translator board circuitry of FIG. 7A. In an embodiment, the circuitry prepares the analog signal from the sensor **214** to be processed by the microcontroller **639**. Often, such conditioning includes, but is not limited to, application of gain and/or filtering of the original signal. As shown in FIG. 7B, the exemplary circuitry includes a connector **702**, a noise filter **703**, safety resistors and buffer **704**, first and second optional gain and filter stages **706**, **708** (individually or collectively, amplifier and low pass filter **632**), and a passive, anti-aliasing filter/charge storage capacitor, low pass filter **634**. In an embodiment, the connector **702** and noise filter **703** correspond to the low pass filter and buffer **630** of FIG. 7A. Although disclosed as including the foregoing components, a person of skill in the art will recognize from the disclosure herein that the components of the conditioning circuitry may include a wide variety of analog signal conditioning elements chosen, for example, based at least in part on the characteristics of signal expected from the sensor **214** and the characteristics of the expected noise in the system.

[0042] In an embodiment, the sensor **214** produces a signal as the magnetic field changes with respect to a coil. Therefore, the expected characteristics of the signal may include a pulse train-like signal cycling within the normal expected cadence

of a person walking, jogging, running or sprinting. Signal characteristics above and below those thresholds may advantageously be interpreted as noise. Thus, in an embodiment including the foregoing expected pulse train signal, the discussed circuitry conditions the signal for further processing by the microcontroller 639 by filtering the signal to within expected cycles and applying some gain.

[0043] Accordingly, the signal from the sensor 214 is communicated to the conditioning circuit at connector 702 for conditioning. The circuitry employs the capacitor 703 to filter common noise producers, such as, for example, a power supply (60 Hz in the U.S., often 50 Hz elsewhere), although other filters may be used. The circuitry employs a safety resistor to protect against, for example, electrostatic discharge or power spikes and employs the one or more optional gain and filter stages 706, 708 to further amplify and condition the signal. In an embodiment, the gain and filter stage 708 sufficiently amplifies and filters the signal from the sensor 214 that the second stage 706 is not used. The circuitry then employs the capacitor 710 as an anti-aliasing low pass filter before the signal is output from the conditioning circuit and communicated to the microcontroller 639.

[0044] Now, with reference to FIGS. 8-10, user detection process are shown and described. FIG. 8 illustrates an user attraction process 800 where the treadmill 100 may be powered but not in use. The FIT processor, for example, accepts signals from the user detection inductance coil 214 through the translator board 518 to determine if a user has stepped onto the machine (block 740). In an embodiment, when a user is not detected, the display processor 522 may cause display 524 to show a user attraction message (block 742). The message can be words or phrases (such as, "Have you gotten your run in today?" or "Burn [X] calories an hour with a good jog!"), pictures, sounds, video, combinations of the same, or the like—in general, anything that may attract a user's attention or get them to use the machine. In an embodiment, the display 524 may also, or alternatively, include advertisements, such as for other exercise equipment, a commercial gym's running or other class schedules, nutrition products, or any other product or service desired. When a user is detected, the FIT processor 520 causes the display processor 522 and display 524 to commence a start-up procedure, such as by displaying a welcome message (block 744). Additionally, the FIT processor initiates a program (block 746), such as by seeking input from a user (for example, height, weight, age, program type, and/or program distance or duration). The program initiation, in an embodiment, can also trigger the treadmill to exit a lower "power save" state and power up one or more components of the treadmill 100 in preparation for use. For example, a treadmill including a television display may turn on the television display only when a user is present.

[0045] FIG. 9 illustrates an exemplary embodiment of an "in use" process 900 for using the user detection features during a user's workout. Constantly, at periodic intervals (such as through an interrupt 848), at random intervals, or the like, the user detection inductance coil 214 readings may be interpreted to determine whether or not a user is still present (block 850). When a user is detected, the program will not be interrupted for user detect issues (block 862). A user timeout counter is reset or remains at a baseline (block 864), and the routine ends. When a user is not detected (block 850), the FIT

processor alters the display, such as by asking that the user return to his or her workout (block 852). For example, the display may read "Please return to the treadmill to complete your workout or stop the machine." The user timeout counter increments (block 854), and the processor checks the counter to see if it has surpassed a threshold (block 856). If not, the process exits and is rerun upon receipt of the next user detect signal after the interrupt (block 848), and repeats the process. If the user returns, the display returns to normal, and the program proceeds. If the user does not return in time, the user timeout counter will ultimately meet the time delay (block 856) and trigger a controlled slowdown (block 860) to stop the treadmill. Such a process may include saving the program data for a specific amount of time (such as a "pause" state) before ultimately resetting the machine and/or returning to a user attract mode, such as that described with respect to FIG. 8. The timeout counter threshold is preferably of sufficient duration to allow a user to see the user return message, understand it, and react by returning to the treadmill. In an embodiment, this time delay is preferably at least about 6-8 seconds. In an embodiment, the user detect interrupt allows a signal to be processed every 0.5 seconds, so a counter could be incremented with a time delay threshold of $X=16$. When the user timeout is then greater than 16, the time delay will have been approximately 8 seconds, and can trigger the slowdown. Although disclosed with reference to an example, a person of skill in the art will understand from the disclosure herein that many processes could be used to determine an appropriate amount of time before taking remedial action.

[0046] In another embodiment, the routine may be one or more threads of a processor (such as FIT processor 520) that loops from block 864 or the NO condition of block 856 back to the user detect block 850 rather than utilizing interrupts. In such a case, the FIT processor may well manage the break and resumption of the thread. Such an alternative method may also utilize a system clock or other timing metric to implement the time delay rather than one or more counters. This may allow more accurate time delays based on the threading as the processing of the user detect thread may not be uniform if other threads must also be processed at various times.

[0047] FIG. 10 illustrates another use for the user detect sensors described herein, a user analysis process 1006. Although the signals can be interpreted generally to illustrate the binary presence or absence of a user, the signals can also be of sufficient detail to provide more exacting information. For example, the signals from an embodiment including multiple sensors, such as, for example, having a left and right sensor (see, e.g., FIG. 4), front and back sensors, or other combinations of sensors, can be used to help diagnose running technique, aid in patient rehabilitation, and the like. Starting with block 970 of the user analysis process 1006, signals from the sensors are interpreted to detect a first footfall during program operation. In an embodiment, the sensor signals can indicate which foot made the step (because the signals between a right and left sensor will provide different readings), the relative force of the step, the duration of the step, and so on. The sensors are similarly monitored to detect a second footfall (block 972) and a third footfall (block 974). This will provide data about two full strides from a user. The first and third footfalls (being with the same foot) are likely to be fairly comparable, but can be compared with the second footfall (block 976) to determine the difference in impact between one foot and the other, determine the stride time for

a left step and a right step, and the like. A processor, such as the FIT processor **520**, can then analyze the data to help provide a user with running tips, help rehabilitate a user, or the like (block **978**). In some embodiments, the processor will also take into account the speed and incline data from incline sensor **526** and speed sensor **527**. Tips and analysis can then be displayed to the user (block **980**), stored for later feedback, output to a separate computer, or the like.

[0048] For example, this process could be used to determine that a user's stride is too long and to output a message to shorten the stride for a given speed. The process could also determine if one leg is favored over another to help diagnose or even prevent possible injuries. In another example, the system could detect whether a runner is landing too flat-footed or running well on the balls of their feet and provide tips on how to alter this. In an embodiment, a workout program may be customized based on some or all of this information. For example, the workout may be slowed for a brief period to help a user feel a recommended change in stride before building back to a quicker pace. Similarly, if the interpreted data indicates that a user's technique deteriorates when an incline is too steep, the FIT processor **520** may send a command to the incline motor **526** (through translator board **518**) to lower the incline until the user's technique recovers.

[0049] The foregoing processes **800**, **900**, **1006** are just a few examples of the types of uses for the user detection systems described herein. In another embodiment, the duration and amount of impact could be monitored for additional safety or exercise form considerations. For example, if a user collapsed on the treadmill and was not using a kill switch tether or could not reach a stop button, the user detection system could determine that an impact was different from normal step impacts (for example, a much longer duration) and trigger an emergency stop of the treadmill belt to help reduce burns, scrapes, or other injury that could result from a still moving treadmill belt.

[0050] Moreover, the methods illustrated above indicate that exercise equipment may present information to a user through a display. It is understood that messages for a user could be messages displayed on a screen, indicator lights, or the like. Messages could also be audible tones, beeps, synthesized or recorded voice messages, or the like output through a speaker. Messages and user presence or footfall data can also be output to a computer or saved in memory for later access, additional processing and evaluation, analysis of user trending over time, and the like.

[0051] FIG. 11 illustrates an exemplary display panel **1182** that may be used in connection with the user detection systems disclosed herein. The display contains one or more control buttons **1190** and one or more exercise program information panels **1192** including information such as pace, heart rate (when available), incline, distance, program profile, and/or the like. FIG. 11 also illustrates an exemplary form feedback panel **1184**. In an embodiment, the duration of a signal, the signal strength, and/or the like of the output of one or more user detection sensors, such as inductance coil(s) **214**, can be processed and interpreted as a force of impact for a user's footfalls. Such information may be dependent upon other available information, such as a user's weight, the treadmill speed, the incline, and the like from, for example, programs or user input. The form feedback panel can then display the force feedback in various forms, such as in a graph **1186**.

[0052] Many trainers and exercise equipment manufacturers believe that user form should seek to minimize footfall force so as to reduce strain on joints, muscles, and the like. A lighter force for a footfall is likely to register as a smaller signal from a user detection sensor with a longer duration, while a heavier force will likely be indicated by a stronger signal over a shorter amount of time, in an embodiment based on the vibrations caused by the user's impact on the treadmill belt.

[0053] In an embodiment, a force footfall graph **1186** provides indications such as "Ideal," "Moderate," and "Heavy." In an embodiment, the force graph **1186** may include one or more indications of force, such as increased bar length of the graph, color changes, and the like for heavier footfall forces. Similarly, a user's cadence—generally expressed as steps per minute—can be measured based on the detection of each impact over a period of time. Many trainers and exercise equipment manufacturers believe that proper running form should include approximately 80-90 steps per minute. Form feedback display may thus include a cadence rate display **1188**. Such a cadence rate display **1188** can help avoid strides that are too long, too short, aperiodic, or the like and may provide teaching instruction for a user to attain a more efficient form.

[0054] One of skill in the art will understand that there are many ways to display one or more program information panels **1192** and one or more form feedback panels **1184**. For example, one or more LED fields can be used, a single LCD display may be partitioned to show different exercise program and form information, and the like. A limited number of such displays can cycle program and/or form feedback information with a limited number of displays, and the like. Similarly one of skill in the art will understand that there are many input options for various embodiments, which can include control buttons **1190**, touch screens, dials, switches, a microphone for voice recognition, and/or the like. One of skill will also understand that various running parameters, such as footfall force and cadence, can be adjusted to conform to current industry understanding of proper technique. For example, in an embodiment, a treadmill manufacturer, owner, operator, or the like can upgrade the programming of a FIT processor **520** to alter parameter limits.

[0055] FIGS. 12A-C illustrate exemplary alternative form feedback panels **1184**. For example, as shown in FIG. 12A, force can be displayed as a single gas bar **1290**, with one column that raises and lowers among a number of degradations, such as "light," "moderate," and "heavy." Similarly, cadence can be displayed by an arrow or other indicator that is displayed along a continuum. Here, a numerical readout **1188** of 60 is further illustrated as in a "slow" range. Such a dual display may be particularly useful for users who are unfamiliar with theory in running technique. FIG. 12B illustrates yet another force display **1294** that includes concentric shapes (here shown as feet). In an embodiment, the smallest shape is illuminated or displayed for light forces, with the display getting larger to correspond to larger footfall forces detected. Preferably each larger shape is of a different color to provide additional indication of proper force. In an embodiment of the user detection systems described herein that includes multiple user detection sensors, a display may further distinguish between left foot force and right foot force. As illustrated in FIG. 12B, a user seeing the indicated display may notice that they are favoring their left foot by placing it with less force than their right.

[0056] FIG. 12C illustrates another exemplary gas bar 1290, where larger force degradations correspond to larger display areas to provide multiple visual cues to a user. Moreover, in an embodiment, a human analog display 1296 may be included to help illustrate a user's style. Proper technique, as currently understood by many trainers and exercise equipment manufacturers, includes that a user's upper body should remain relatively stationary during jogging or running. A user that notices bouncing in their vision is likely running with too much vertical force with his or her steps, rather than mainly exerting effort to move the foot forward. Such bounce is generally associated with a heavier than ideal footfall force.

[0057] The human analog display 1296 may mimic this bouncing motion when user detection indicates heavier than ideal footfall forces and provide text or other illustration on how to minimize this bounce. Similarly, the display may illustrate other technique tips. For example, an embodiment of a treadmill with multiple user detection sensors may provide indications if a user is likely bouncing from side to side or the like. Such a human analog display 1296 may incorporate an avatar within a virtual world, as described below.

[0058] Yet another use for user detection features as described herein is to provide input for program interactions in some embodiments. For example, in an embodiment with multiple user detection sensors, a FIT processor 520 may drive a workout program that includes a virtual reality aspect, such as a graphical world provided to a display 524. Such a graphical world can help entertain a user during his or her workout. At various times within a workout, the user may have the option of altering the program, changing a virtual path within the graphical world, and/or the like. In an embodiment, a user may stomp harder with his or her left or right foot to select among the options. For example, the display 524 may show a forested path so that it appears that a user is running along it. At some point, the path may branch to the left and right, such as with an indication that going left will be a mountain path and right will be a path along a river. In the example, the user may stomp with his or her left foot to choose the mountain path or stomp with his or her right foot to choose the river path, and the FIT processor 520 can adjust the display 524 accordingly. In an embodiment, this user input may also—or alternatively—drive an effect within the user's workout. For example, choosing a mountain path may also increase the treadmill's incline as if the user was actually climbing a mountain. Other input determinations may also be possible apart from a "stomp." For example, the user may favor stepping closer to a left edge or a right edge of the treadmill belt to signal making a left or right decision. In such a case, signal strengths from multiple user detection sensors of steps could be compared against average signal strengths of a user stepping in a central location. If the user favors the left side of the treadmill for a few steps, in an embodiment, a left side user detection sensor will likely generate greater than average signal strengths, while a right side user detection sensor will likely generate lower than average signal strengths. One of skill in the art will understand many other potential uses of the user detection as an input device apart from those illustrated as examples herein.

[0059] Although the foregoing has been described in terms of certain specific embodiments, other embodiments will be apparent to those of ordinary skill in the art from the disclosure herein. Moreover, the described embodiments have been presented by way of example only, and are not intended to

limit the scope of the disclosure. Additional uses for the user detection system are possible, including equipment diagnostics. For example, a treadmill's motor and/or rollers could cause detectable vibration in the sensor over normal operating parameters if the treadmill becomes unbalanced or any of the parts are out of alignment. The user detection sensor, such as magnet 212 and inductance coil 214, can detect these vibrations to help in diagnosing repair issues. Indeed, the novel methods and systems described herein may be embodied in a variety of other forms without departing from the spirit thereof. Accordingly, other combinations, omissions, substitutions, and modifications will be apparent to persons of skill in the art in view of the disclosure herein. Thus, the present disclosure is not limited by the preferred embodiments, but is defined by reference to the appended claims. The accompanying claims and their equivalents are intended to cover forms or modifications as would fall within the scope and spirit of the disclosure.

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16. (canceled)
17. (canceled)
18. (canceled)

19. A method of operating a treadmill to determine when a moving belt likely does not include a user of the treadmill, the method comprising:

receiving in a processor a signal indicative of a displacement sensor detecting displacement of (i) a first treadmill member movable when said user loads at least a portion of their weight on a treadmill belt, with respect to (ii) a second treadmill member substantially unmovable when said user loads said belt;

electronically determining whether the signal likely represents that said user is present; and
when said determining indicates said user is not present, electronically altering operation of said treadmill.

20. The method of claim 19 comprising:

receiving in a coil a change in a magnetic field when said first member moves with respect to said second member; and
outputting said signal based on said change in said magnetic field.

21. The method of claim 19 wherein the altering step comprises displaying a message to a user.

22. The method of claim 21 wherein the message comprises a countdown to a slowdown of the belt.

23. The method of claim 21 wherein the message comprises a request for the user to return.

24. The method of claim 19 wherein the altering step comprises a slowdown of the belt.

25. The method of claim 19 wherein the altering step comprises an emergency shutdown.

26. The method of claim 19 wherein the altering step comprises adjusting an exercise program.

27. The method of claim 26 wherein the altering step comprises adjusting at least one exercise parameter.

28. The method of claim 27 wherein the altering step comprises adjusting one or more of: speed limits or incline limits.

29. A treadmill configured to determine when a moving belt likely does not include a user, the treadmill comprising:

a treadmill belt;

a first treadmill member movable when said user loads at least a portion of their weight on said treadmill belt;

a second treadmill member substantially unmovable when said user loads said belt;

one or more processors configured to receive a signal indicative of a displacement sensor detecting displacement of (i) said first treadmill member, with respect to (ii) said second treadmill member, said processors configured to electronically determining whether the signal likely represents that said user is present; and when said determining indicates said user is not present, configured to electronically altering operation of said treadmill.

30. The treadmill of claim 29 comprising a coil configured to receive a change in a magnetic field when said first member moves with respect to said second member, wherein said one or more processors are configured to output said signal based on said change in said magnetic field.

31. The treadmill of claim 29 wherein said one or more processors are configured to display a message to a user.

32. The treadmill of claim 31 wherein the message comprises a countdown to a slowdown of the belt.

33. The treadmill of claim 31 wherein the message comprises a request for the user to return.

34. The treadmill of claim 29 wherein said one or more processors are configured to slowdown the belt.

35. The treadmill of claim 29 wherein said one or more processors are configured to perform an emergency shutdown.

36. The treadmill of claim 29 wherein said one or more processors are configured to adjust an exercise program.

37. The treadmill of claim 36 wherein said one or more processors are configured to adjust at least one exercise parameter.

38. The treadmill of claim 37 wherein said adjustment comprises one or more of: speed limits or incline limits.

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