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(54) **APPARATUSES FOR RETROFITTING EXERCISE EQUIPMENT AND METHODS FOR USING SAME**

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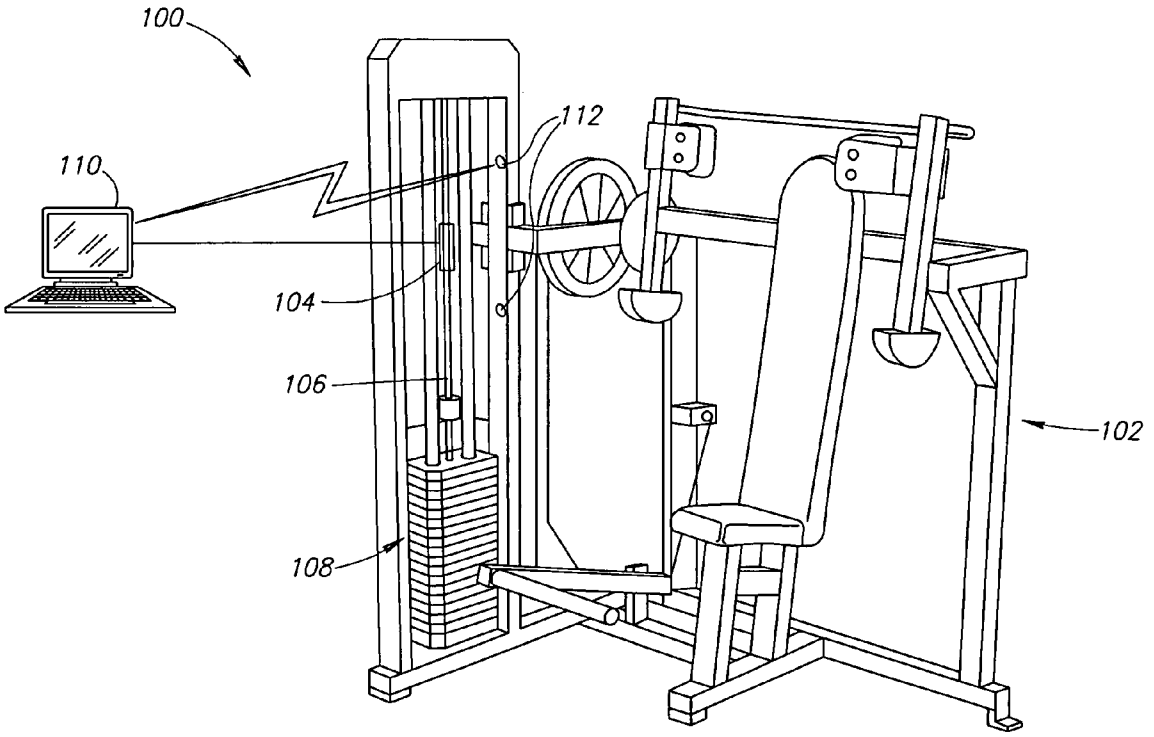
(57) **ABSTRACT**

An exercise apparatus, comprising: a resistance element, operative to supply a resistance to movement by a user of the apparatus; and, an actuator module operatively connected to the resistance element and operative to vary a resistance perceived by the user without changing the resistance element.



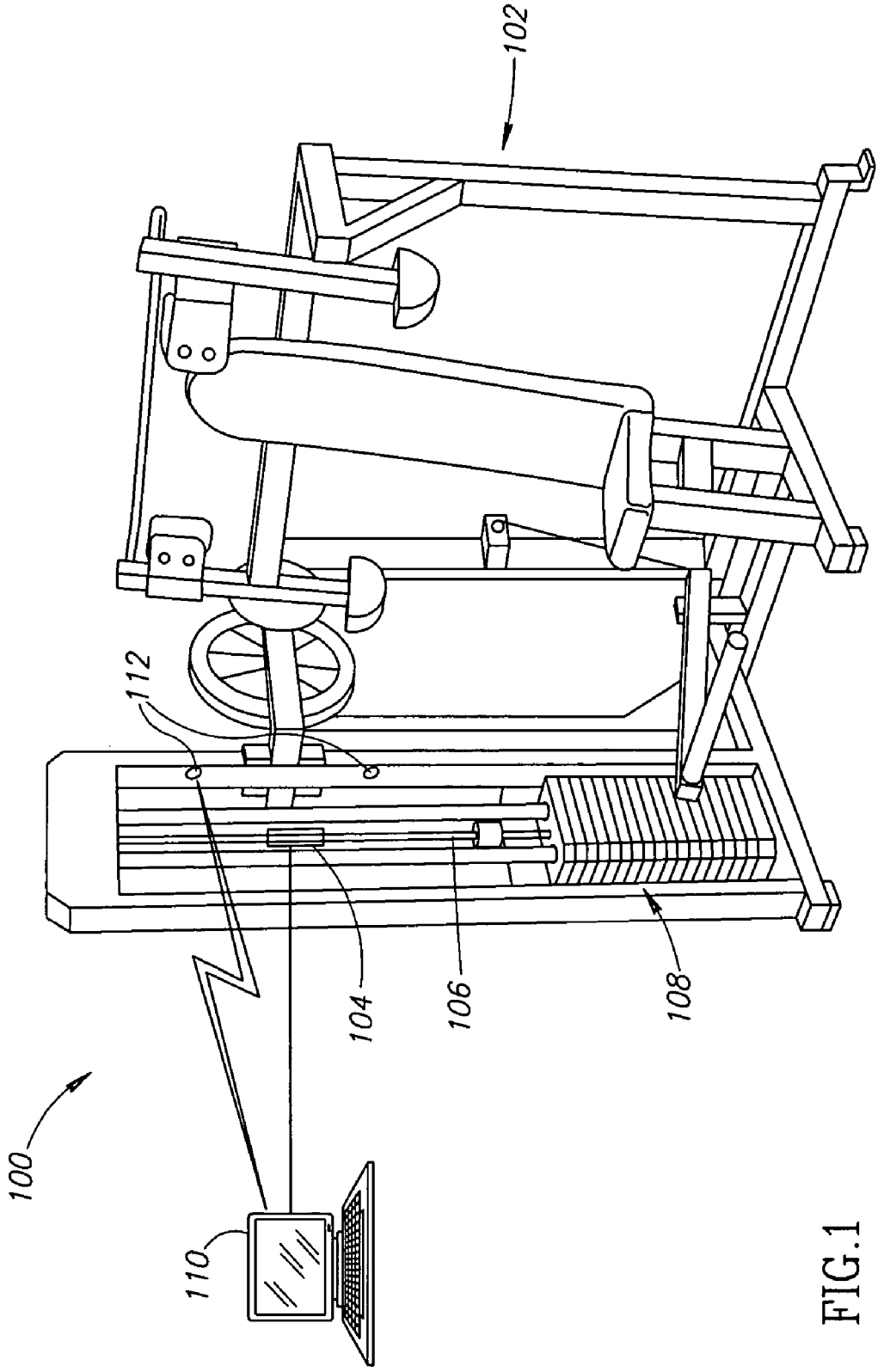


FIG.1

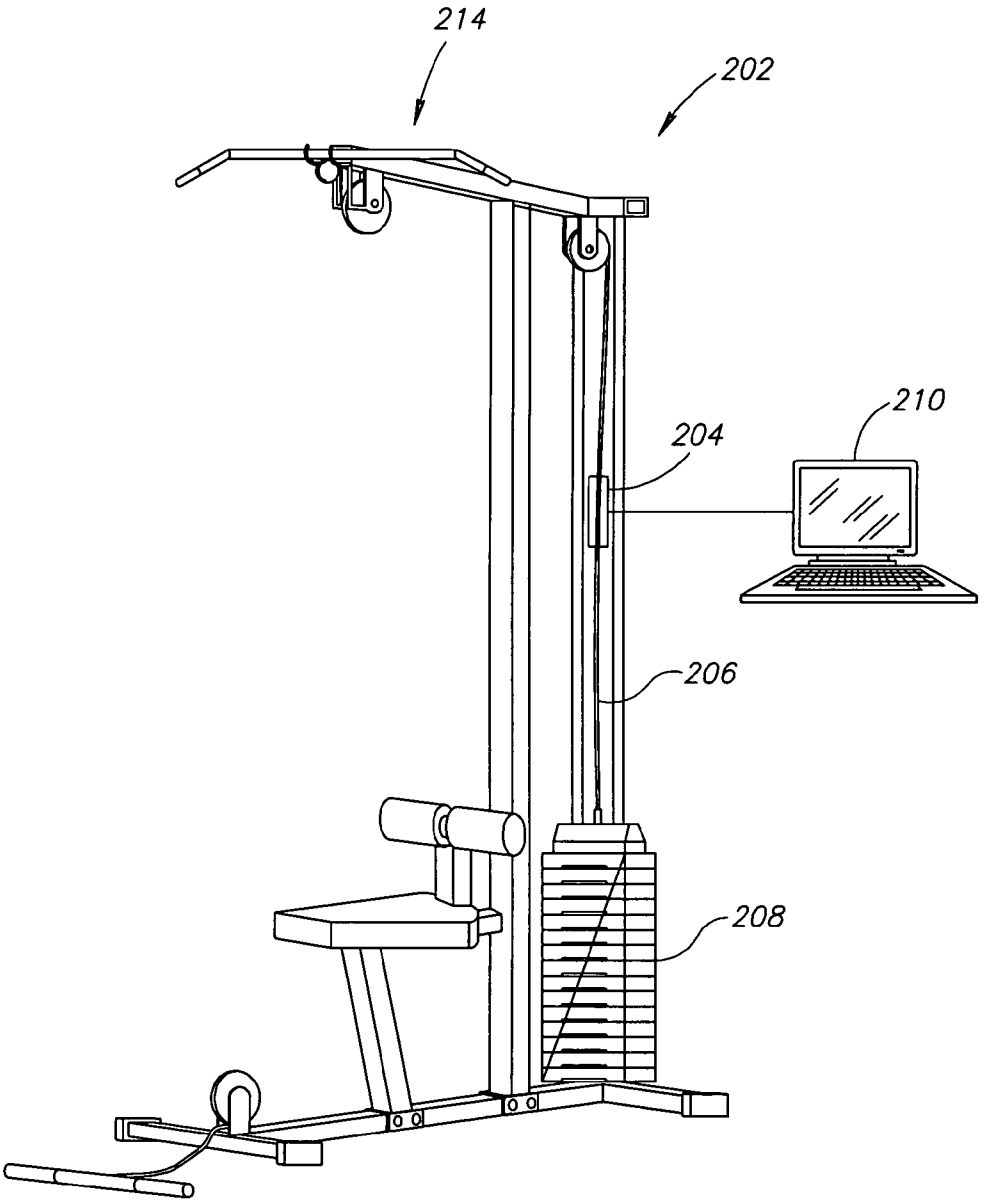


FIG.2

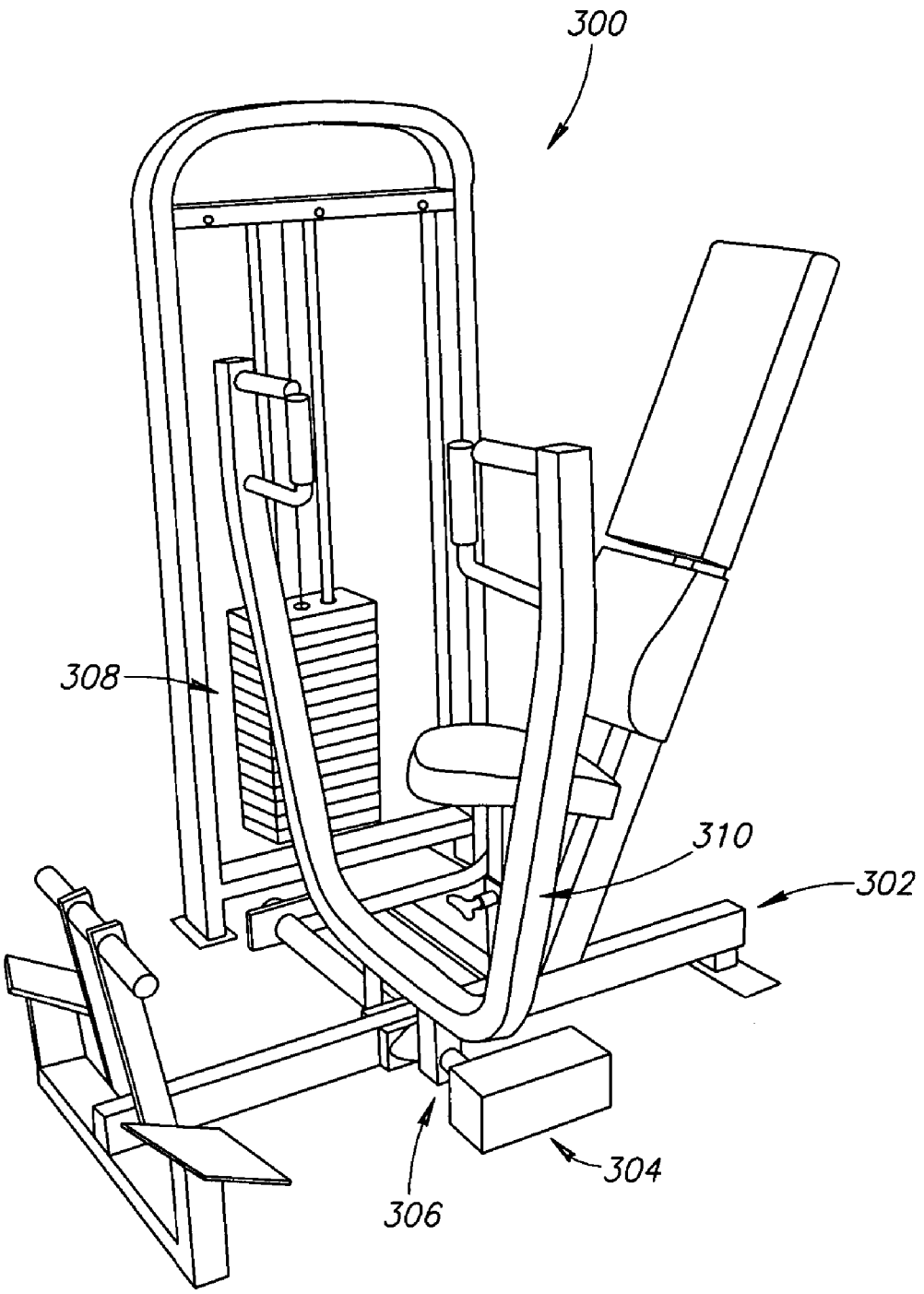


FIG.3

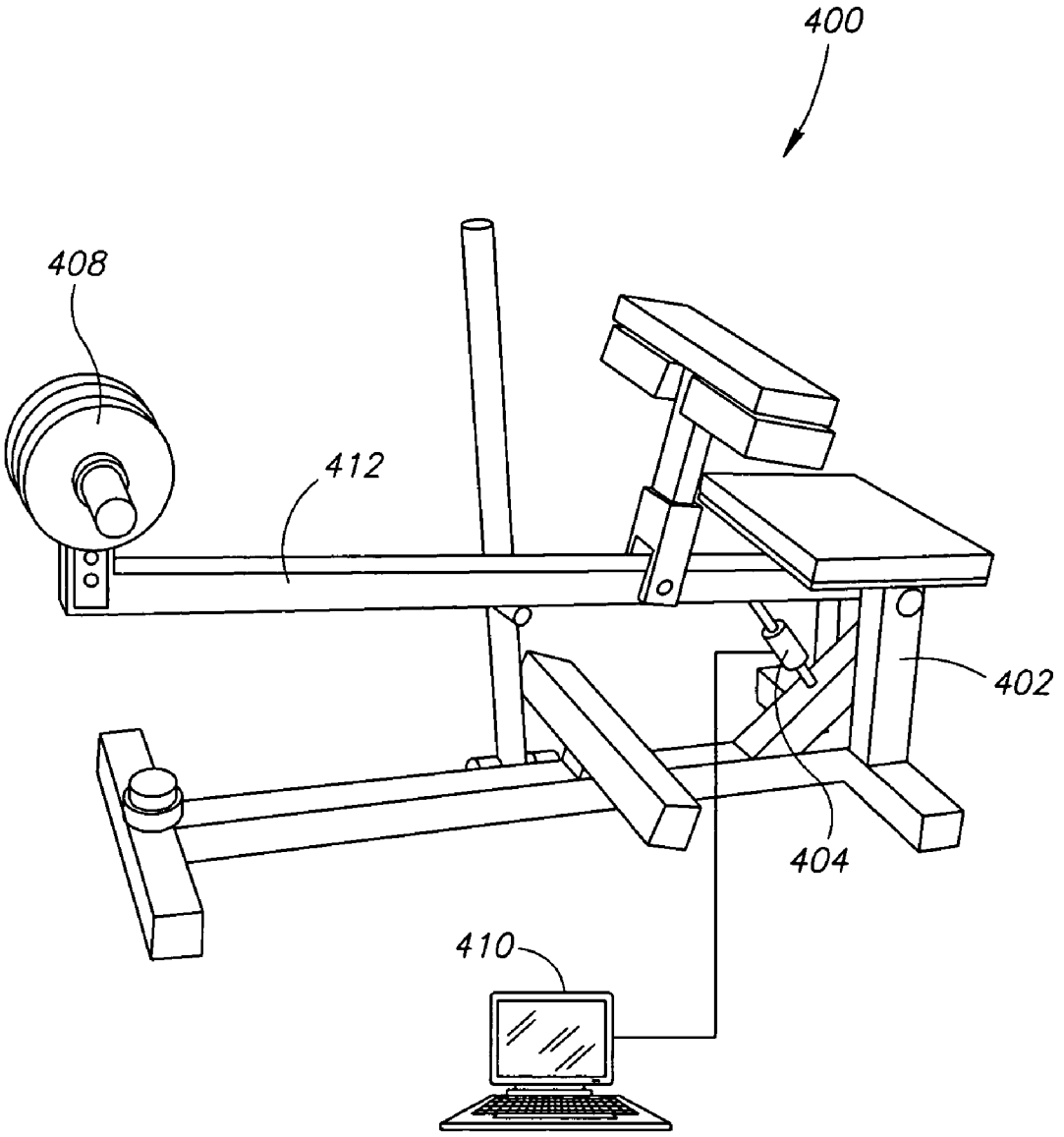


FIG.4

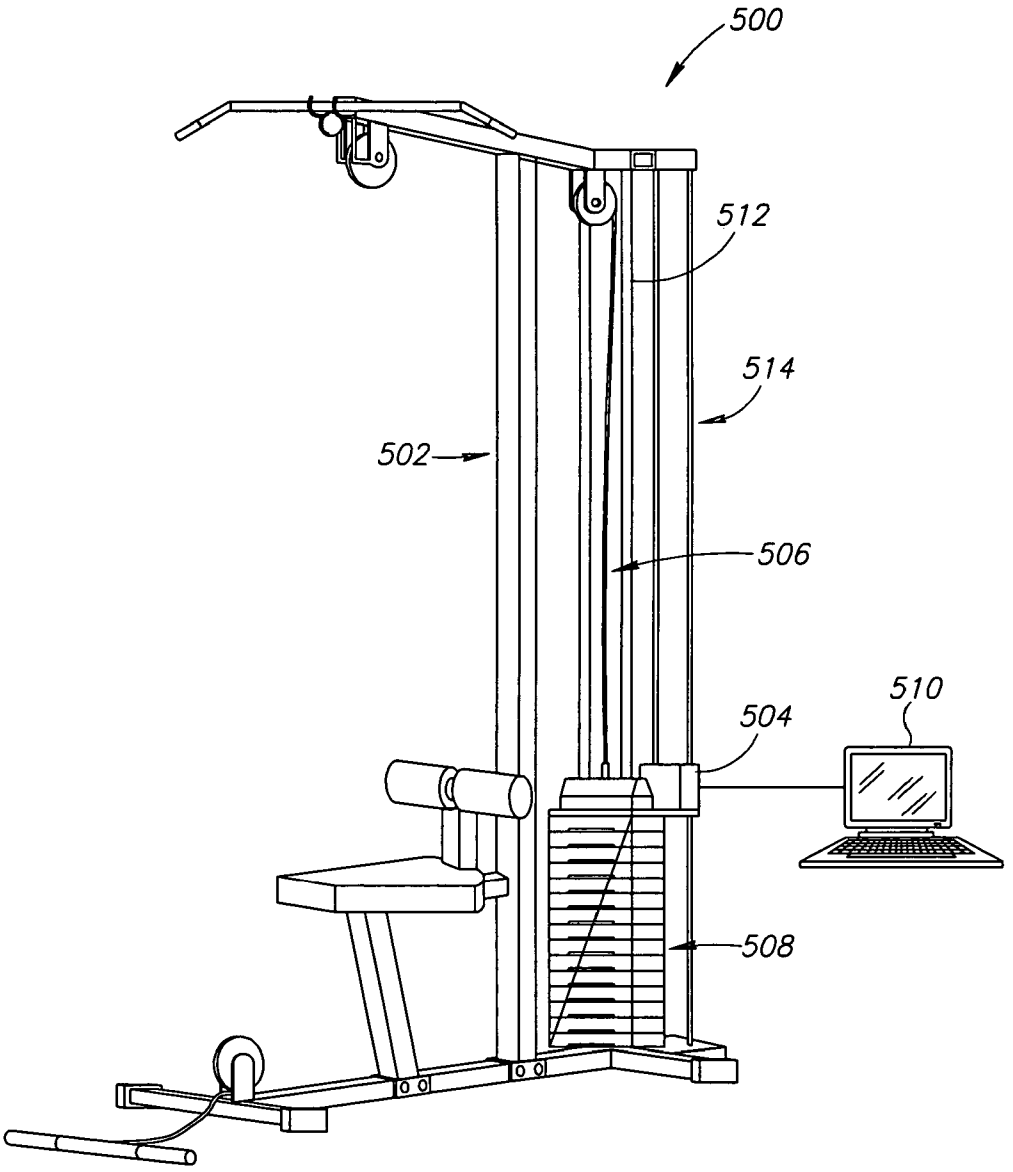


FIG.5

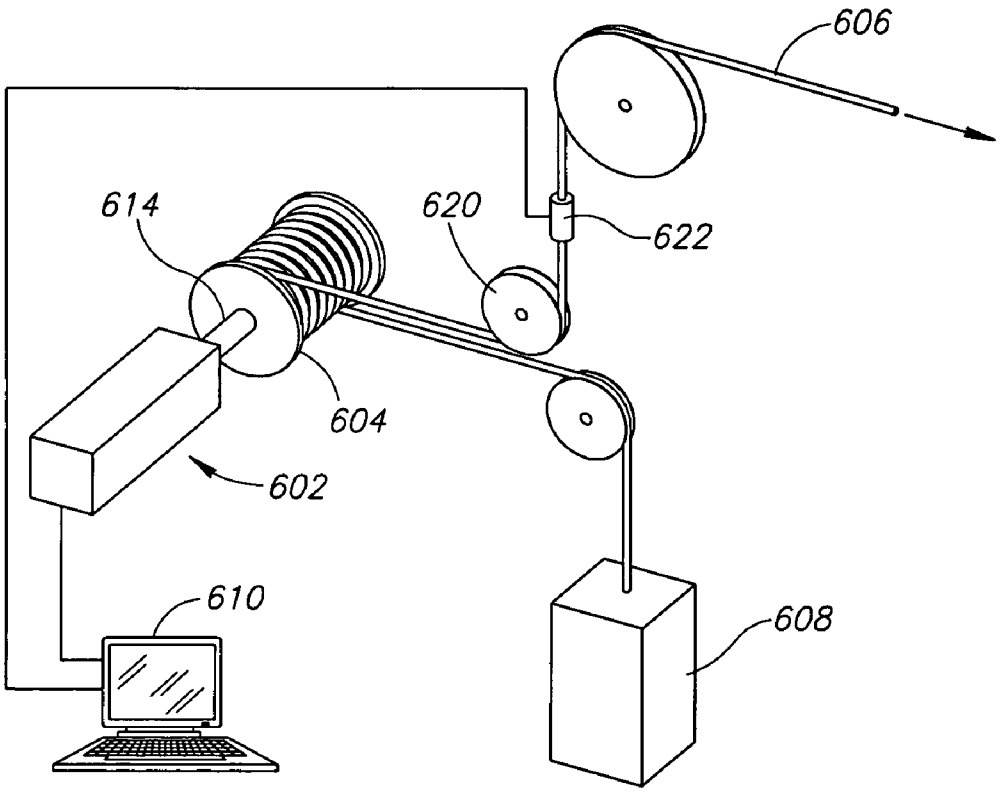


FIG.6

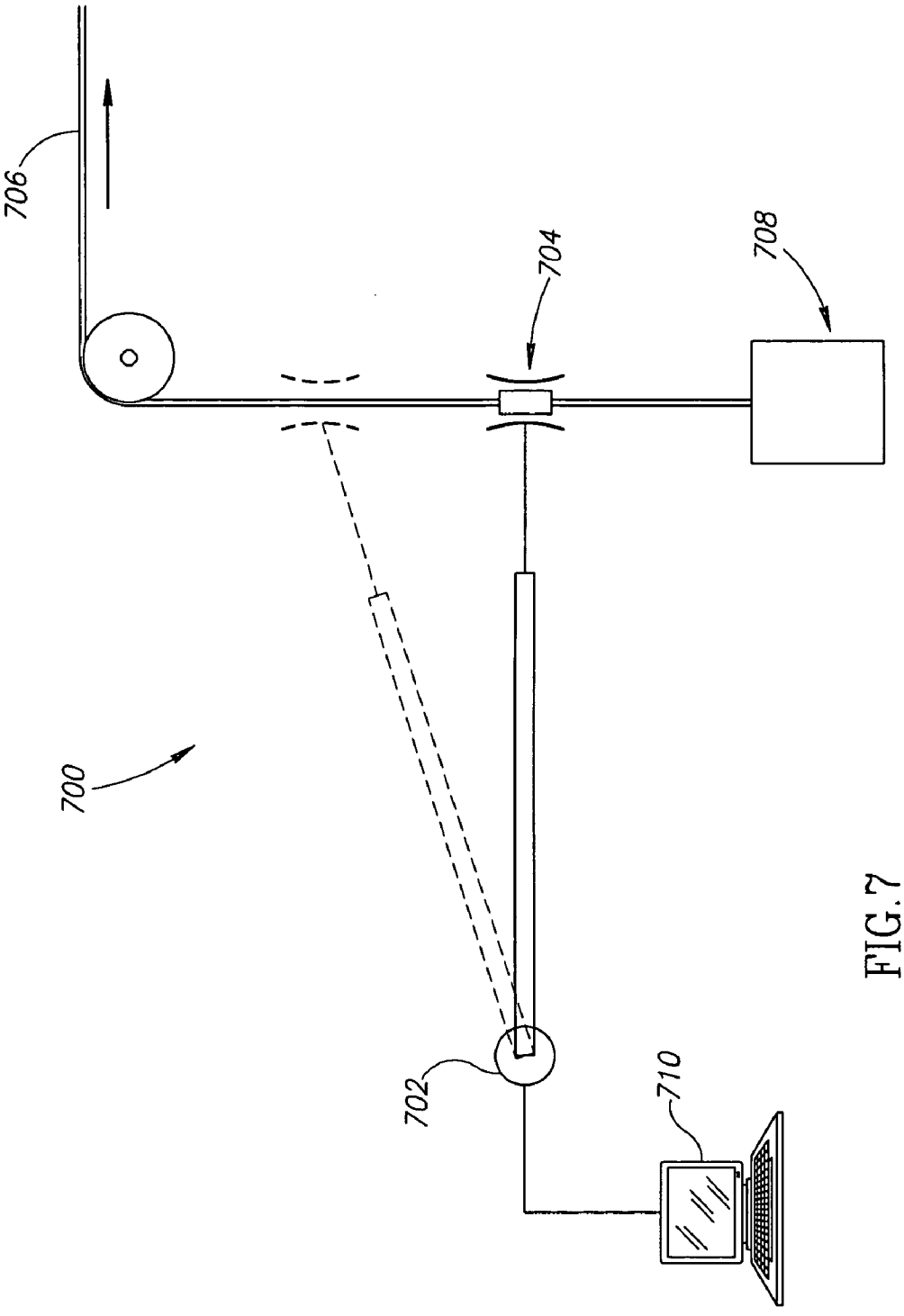


FIG. 7

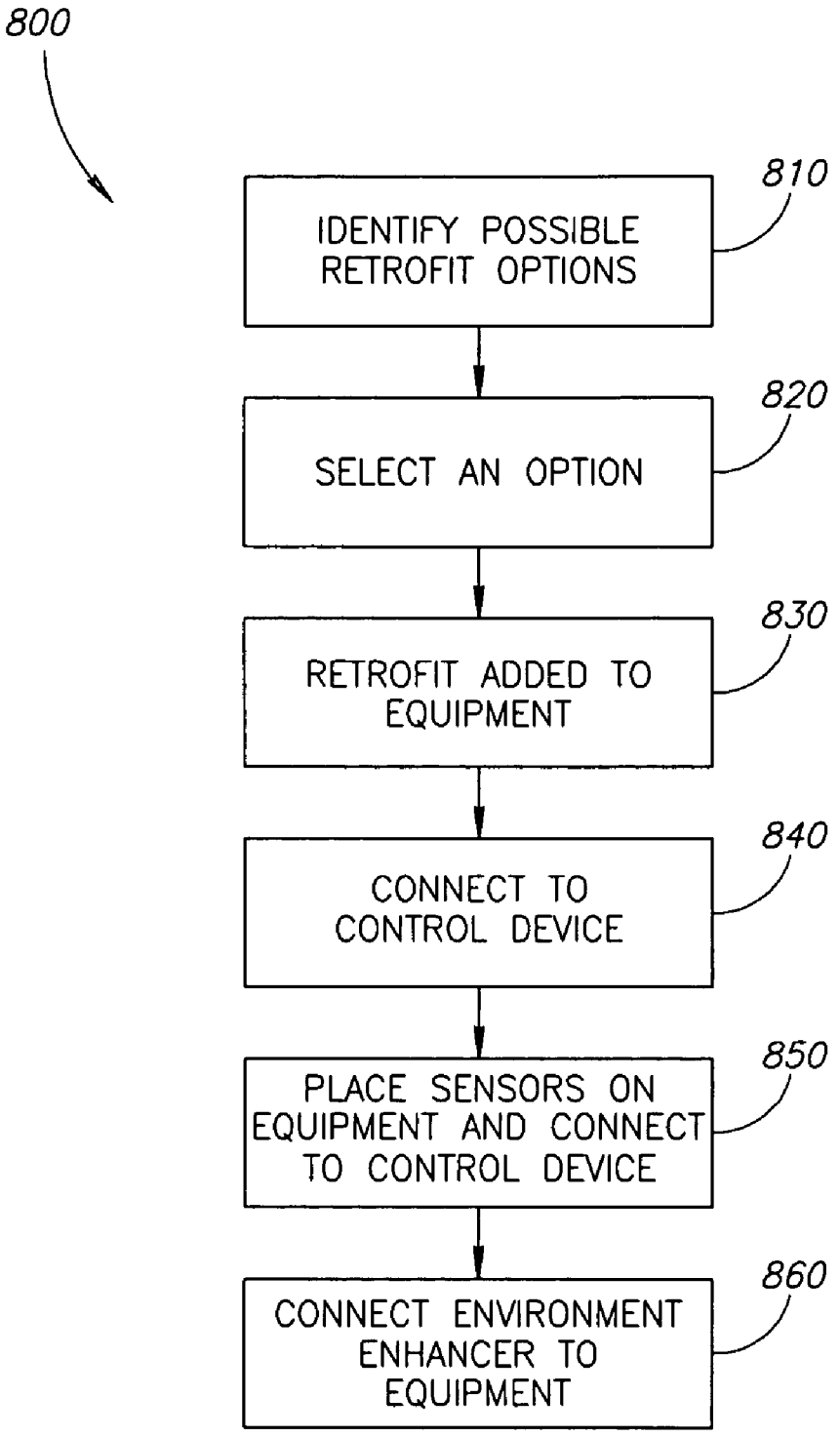

800
IDENTIFY POSSIBLE RETROFIT OPTIONS
810
SELECT AN OPTION
820
RETROFIT ADDED TO EQUIPMENT
830
CONNECT TO CONTROL DEVICE
840
PLACE SENSORS ON EQUIPMENT AND CONNECT TO CONTROL DEVICE
850
CONNECT ENVIRONMENT ENHANCER TO EQUIPMENT
860

FIG.8

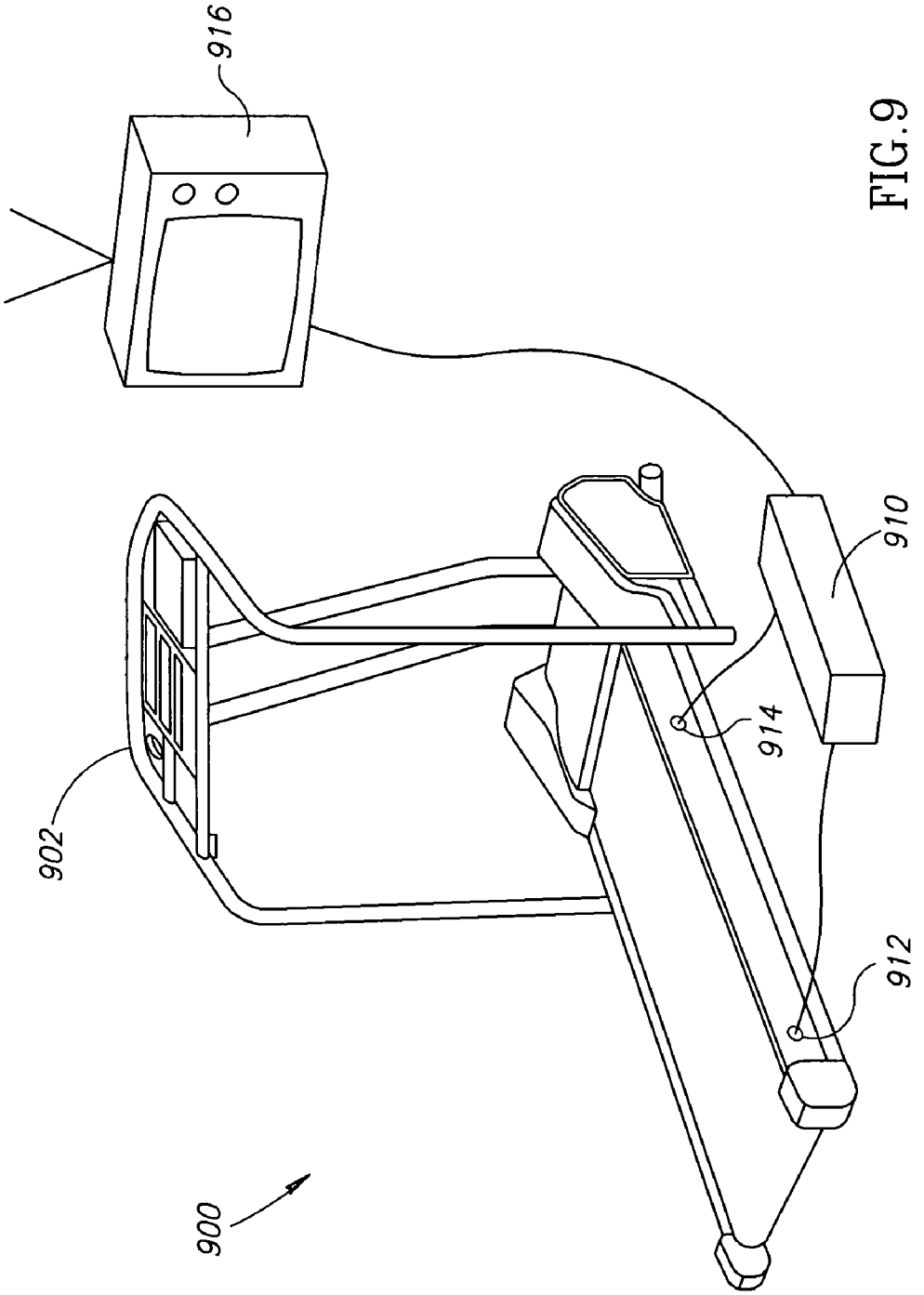


FIG.9

APPARATUSES FOR RETROFITTING EXERCISE EQUIPMENT AND METHODS FOR USING SAME

RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. provisional applications 60/665,886 filed on Mar. 28, 2005 and 60/666,136 filed on Mar. 29, 2005, the disclosures of which are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to adapting previously manufactured exercise equipment to enhance its utility and/or security and/or provide additional modes of operation.

BACKGROUND OF THE INVENTION

[0003] Modern technology has allowed the advancement of exercise equipment to include information such things as heart monitors, distance traveled, speed, average speed, etc. and devices for providing such information. However, exercise equipment in use today does not take full advantage of the technology available. In some cases, the exercise equipment is old and the technology was not well adapted for use with exercise equipment and/or was too expensive. In other cases, the manufacturers of the exercise equipment did not conceive of altering the time-tested designs being currently used. Unfortunately, not many options exist for retrofitting exercise equipment with modern technology devices.

[0004] Furthermore, while these conventional designs might be well suited for use with the majority of the population, they do not usually provide accommodation for the elderly, the disabled, and/or those who are rehabilitating after some sort of injury. Especially in the case of the elderly, demographic statistics tend to indicate that demand will be high for exercise equipment which is adapted for use by that population segment.

SUMMARY OF THE INVENTION

[0005] An aspect of some embodiments of the invention relates to retrofitting exercise equipment to provide an intermediary between a user and the resistance provided to the user by the equipment.

[0006] In some exemplary embodiments of the invention, at least a partial coupling/decoupling between a user and the resistance provided to the user by the equipment is provided. Optionally, retrofit modules are provided to exercise equipment which assist a user in moving or otherwise overcoming the resistance. In some embodiments, retrofit modules are provided which act additionally and/or alternatively to the resistance provided by the equipment. Optionally, the modules vary the amount of assistance and/or resistance throughout the course of exercise. Optionally, an actuator module is added to a cable on exercise equipment for providing pulling or pushing motion on the cable.

[0007] In some exemplary embodiments of the invention, an actuator is added to a joint on exercise equipment for at least partially stimulating opening and/or closing of the joint. Optionally, an actuator module is provided along a shaft in order to provide rotational motion, optionally either clockwise and/or counterclockwise, about the long axis of the shaft. In some exemplary embodiments of the invention, the equipment is provided with an actuator capable of moving in parallel with or alternatively to the resistance as it is moved by a user. Optionally, a controller, such as a computer, is provided to coordinate movement of various elements of the equipment during exercise.

[0008] An aspect of some embodiments of the invention relates to retrofitting an exercise equipment to provide a user with feedback during and/or after exercise. In some exemplary embodiments of the invention, a computer interface is added to the exercise equipment. Optionally, sensors are added to the equipment and, additionally or alternatively, to the user of the equipment. Optionally, software is provided to control the equipment and for monitoring and/or recording performance of the equipment and/or the user.

[0009] An aspect of some embodiments of the invention relates to retrofitting exercise equipment to provide safety features not previously incorporated into the equipment. Optionally, retrofit modules are provided which are capable of locking the equipment in place to prevent injury to the user. Optionally, retrofit modules are provided which are capable of releasing on demand the resistance applied to a user of the equipment.

[0010] An aspect of some embodiments of the invention relates to a method for retrofitting exercise equipment to provide enhanced functionality. Optionally, equipment is retrofitted for providing specific safety features. Optionally, equipment is retrofitted for providing desired feedback capabilities. In some embodiments of the invention, a retrofit module is selected for its compatibility with the manner in which the equipment operates.

[0011] An aspect of some embodiments of the invention relates to retrofitting exercise equipment to provide an environment which is adapted to enhance a user's exercise experience. In some exemplary embodiments of the invention, exercise equipment is retrofitted with a computer interface and software which is adapted to integrate exercise with visual and/or audio stimuli. In some exemplary embodiment the exercise equipment is retrofitted with visual and/or audio aids that support and or address cognitive difficulties as may be experienced by a post stoke patient. Optionally, a kit is provided which allows software output to be displayed on a monitor, such as a television. Optionally, a virtual reality experience is provided to the user. In some embodiments of the invention, the software provides video and/or audio stimuli to the user which is designed to enhance exercise performance.

[0012] There is thus provided an exercise apparatus, comprising a resistance element, operative to supply a resistance to movement by a user of the apparatus; and, an actuator module operatively connected to the resistance element and operative to vary a resistance perceived by the user without changing the resistance element. Optionally, the resistance element is a weight. Optionally, the resistance is transferred to the user via a transfer element and wherein the actuator module acts on the transfer element to vary the perceived resistance. Optionally, the actuator module is in series with the transfer element. Optionally, the actuator module acts directly on the resistance element. Optionally, the apparatus further comprises a control device adapted to issue operation commands to the actuator module. Optionally, the apparatus further comprises at least one sensor wherein the at least one

sensor provides data to the control device for analysis regarding operation commands to be given to the actuator module.

[0013] There is thus provided an exercise apparatus, comprising a resistance element, operative to supply a resistance to movement by a user of the apparatus; at least one sensor, wherein the at least one sensor is added to the apparatus after-market and wherein the at least one sensor measures parameters associated with the apparatus or said user; and, a control device, wherein the control device added to the apparatus after-market, is in communication with the at least one sensor, and wherein parameters are received from the at least one sensor for analysis by the control device. Optionally, the apparatus further comprise an actuator module, the actuator module added to the apparatus after-market and wherein the actuator module is connected to the resistance element and operative to vary a resistance perceived by the user without changing the resistance element. Optionally, at least one sensor provides parameters to the control device for analysis regarding operation commands to be given to the actuator module.

[0014] There is thus provided an exercise apparatus, comprising a resistance element, operative to supply a resistance to movement by a user of the apparatus; an actuator module operatively connected to the resistance element and operative to vary a resistance perceived by the user without changing the resistance element; and, a control device, wherein the control device is added to the apparatus after-market, is in communication with the actuator module, and wherein the control device issues commands to the actuator module to act on the resistance upon indication of an unsafe situation. Optionally, the apparatus further comprises at least one sensor, wherein the at least one sensor measures parameters associated with the apparatus and the user and communicates the parameters to the control device for analysis pertaining to an unsafe situation.

[0015] There is thus provided an exercise apparatus, comprising at least one sensor, wherein the at least one sensor measures parameters associated with the apparatus; an enhanced environment control device, wherein the device relates the parameters to a program contained on the device and produces an output integrating the parameters and the program; and, a display, wherein the display is in communication with the device and displays the output to a user of the apparatus. Optionally, the apparatus further comprises an intermediate device positioned between the enhanced environment control device and the display, but which still provides communication between the enhanced environment control device and the display.

[0016] There is thus provided a method of after-market retrofitting an exercise apparatus, comprising at least a resistance element, operative to supply a resistance to movement by a user of the apparatus, comprising adding at least one sensor, wherein the at least one sensor is added to the apparatus and wherein the at least one sensor measures parameters associated with the apparatus or the user; and, adding a control device, wherein the control device added to the apparatus, is in communication with the at least one sensor, and wherein parameters are received from the at least one sensor for analysis by the control device. Optionally, the method further comprises adding an actuator module. Optionally, the method further comprises adding an environment enhancer control device.

[0017] There is thus provided a method of after-market retrofitting an exercise apparatus, at least a resistance element, operative to supply a resistance to movement by a user of the apparatus, comprising adding an actuator module operatively connected to the resistance element and operative to vary a resistance perceived by the user without changing the resistance element; and, adding a control device, wherein the control device is added to the apparatus after-market, is in communication with the actuator module, and wherein the control device issues commands to the actuator module to act on the resistance upon indication of an unsafe situation. Optionally, the method further comprises adding at least one sensor for measuring parameters associated with the apparatus. Optionally, the method further comprises adding an environment enhancer control device.

BRIEF DESCRIPTION OF THE FIGURES

[0018] Non-limiting embodiments of the invention will be described with reference to the following description of exemplary embodiments, in conjunction with the figures. The figures are generally not shown to scale and any sizes are only meant to be exemplary and not necessarily limiting. In the figures, identical structures, elements or parts that appear in more than one figure are preferably labeled with a same or similar number in all the figures in which they appear, in which:

[0019] **FIG. 1** is a schematic illustration of a retrofitted exercise equipment system, in accordance with an exemplary embodiment of the invention;

[0020] **FIG. 2** is a schematic illustration of an exemplary push/pull cable actuator for providing a coupling/decoupling between exercise equipment resistance and a user, in accordance with an exemplary embodiment of the invention;

[0021] **FIG. 3** is a schematic illustration of an exemplary actuator for providing a shaft driven coupling/decoupling between exercise equipment resistance and a user, in accordance with an exemplary embodiment of the invention;

[0022] **FIG. 4** is a schematic illustration of an exemplary actuator for providing a joint-based coupling/decoupling between exercise equipment resistance and a user, in accordance with an exemplary embodiment of the invention;

[0023] **FIG. 5** is schematic illustration of an exemplary actuator for providing a parallel support coupling/decoupling between exercise equipment resistance and a user, in accordance with an exemplary embodiment of the invention;

[0024] **FIG. 6** is a schematic illustration of an exemplary actuator for providing a shaft assisted coupling/decoupling between exercise equipment resistance and a user, in accordance with an exemplary embodiment of the invention;

[0025] **FIG. 7** is a schematic illustration of an exemplary actuator for providing a clutch assisted coupling/decoupling between exercise equipment resistance and a user, in accordance with an exemplary embodiment of the invention;

[0026] **FIG. 8** is a flowchart describing a method of retrofitting an exercise machine, in accordance with an exemplary embodiment of the invention; and,

[0027] **FIG. 9** is a schematic illustration of a retrofit setup box system, in accordance with an exemplary embodiment of the invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Exemplary Overall System

[0028] Referring now to **FIG. 1**, a schematic of a retrofitted exercise equipment embodiment **100** is shown, in accordance with an exemplary embodiment of the invention. It should be noted that retrofitting occurs after original equipment manufacture and typically after the product has been offered for sale to the public. Hence, such retrofits are often described as "after-market" add-ons. It should also be noted, that in some exemplary embodiments of the invention, features described herein are incorporated into exercise equipment during original manufacture.

[0029] Exercise equipment **102**, in this case a pull-over machine, is provided for exemplary purposes only. It should be understood that virtually any exercise equipment could be a candidate for retrofitting using the embodiments and principles of retrofitting described herein. In the exemplary embodiment of the invention shown in **FIG. 1**, exercise equipment **102** is retrofitted with an actuator module **104**. For this example, this actuator module **104** is designed to exert pushing and/or pulling on a cable **106** which attaches a resistance **108** (weights are shown), in this case weights, provided by equipment **102** to an exercising user. While a cable push/pulling actuator is shown, any of the actuator modules suggested or described herein can be used to retrofit exercise equipment **102** in order to provide enhanced utility and/or security. Details regarding an embodiment of the cable push/pull actuator are described more fully in the context of **FIG. 2** below. In the illustrated exemplary embodiment, a control device **110** is in operative communication with module **104**. Optionally, the control device **110** is a computer.

[0030] Control device **110** uses software loaded thereon to control the actions imparted to exercise equipment **102** by actuator module **104**. For example, control device **110** can direct actuator module **104** to assist the user with exerting force on the resistance. Alternatively, control device **110** can command actuator module **104** to impart more resistance to the user than is provided by resistance **108**. In some embodiments of the invention an actuator such as actuator **104** allows for the provision of resistance amounts intermediate to set amounts provided by resistance **108**. Optionally, the actuator module does not add or subtract resistance imparted to the user, allowing for the equipment to be used in a conventional operative mode. In some embodiments of the invention, actuator module **104** is used in lieu of resistance **108**, equipment **102** optionally not provided with resistance at all.

[0031] Control device **110** is optionally connected to one or more sensors **112** located on exercise equipment **102**. In an exemplary embodiment of the invention, sensors **112** are used to monitor the movement of the various components of equipment **102**. Sensors **112** are optionally wirelessly connected to control device **110**. Equipment **102** is optionally retrofitted with at least one sensor and/or an array of sensors in order to measure various parameters about equipment **102**. For example, sensors can be used to measure the position of components of equipment **102**. Optionally, sensors measure force, direction of movement, tension, acceleration, angle of rotation, speed and/or other parameters of components of equipment **102**.

[0032] In some embodiments of the invention, sensors are located on the user of equipment **102**. The sensors located on the user are optionally used to measure performance of the user. Optionally, the user's exercise performance and physiological response to exercise is monitored using sensors. Using the data collected from equipment **102** and the user, performance profiles and exercise regimens can be generated for example. In an exemplary embodiment of the invention, sensor measurements taken of equipment are related to sensor measurements taken of the user. Such comparison could indicate poor form during exercise, for example. Optionally, such a comparison correlates level of exerted effort from the user with particular movements or positions of equipment **102**. These aspects of the invention are described more fully in the "Feedback" section below.

[0033] In some exemplary embodiments of the invention, control device **110** also provides safety features to equipment **102** through actuator module **104**. One such example is an emergency release of the resistance imparted by equipment **102** against a user of the equipment **102**. In another exemplary embodiment of the invention, actuator module **104** locks resistance **108** in place, such that it no longer applies resistance to the user. These aspects of the invention are described more fully in the "Safety" section below.

[0034] It should be noted that many of the components described herein are retrofitted onto conventional exercise equipment. In some exemplary embodiments of the invention, actuator module **104**, control device **110**, and sensors **112** are components which are retrofitted onto exercise equipment **102**. Optionally, the retrofit components are offered individually and/or jointly in kits assembled to retrofit specific models of exercise equipment. Optionally, different combinations of retrofit components are offered in kits depending on the object of the retrofit and the needs of the user.

[0035] In some embodiments of the invention, additional user supports, such as arm rests, are retrofitted to the equipment. Optionally, stimulators are added to exercise equipment to assist in guiding user motion (e.g., by nudging a limb to remind it to move) or for other uses, for example pain control or therapies. Optionally, equipment **102** is retrofitted to provide massage capability and/or vibration treatment. Supports optionally include pneumatic or other cushions.

[0036] In some exemplary embodiments of the invention, control device **110** provides cognitive exercising, for example using a display and/or virtual reality system and user inputs, such as one or more input devices (e.g., a mouse, joystick or keyboard) and a voice input.

[0037] Exercise equipment **100** is optionally retrofitted to include one or more tools to assist in socialization of the user. In one example, equipment **102** optionally is retrofitted to include a built-in telephone system. In another example, equipment **102** is retrofitted to include at least one camera, which can be used for video conferencing. In another example, a speaker (e.g., located in a head rest) is added to amplify ambient sound instead of using a hearing-aid by user. Alternatively, the speaker provides music to the user of equipment **102**.

[0038] In an exemplary embodiment of the invention, convenience is provided by retrofitted equipment **102** sup-

porting daily activities so that the user does not need to get up, forget or avoid doing important activities. For example, equipment **102** can be retrofitted to include a pillbox for dispensing medication, a food dispenser for dispensing snacks (in particular candy for diabetics), a remote control for one or more home entertainment systems and a link to smart home functions, for example remote closing of doors and activation of alarm systems. Automatic dispensing of medication may include, for example, a reminder, a sensor to detect if medication was taken and/or a query to the user regarding was the medication taken and/or did it have side effects.

[**0039**] In an exemplary embodiment of the invention, one or more environmental sensors are retrofitted onto the equipment, for example, to detect fire, smoke, a draft, heat and/or cold. If a problem is detected, someone may be alerted.

[**0040**] In an exemplary embodiment of the invention, a smart card reader (e.g., contact or contact-less) is used to ensure that the person using the equipment **102** is known. For example, various parameters may be tailored to an individual and using them for another individual may cause problems. This feature can be utilized for home use by a couple sharing the same equipment (but keeping different daily routines) or at a facility for multiple users.

[**0041**] In some exemplary embodiments of the invention, retrofit embodiment **100** is used for fitness inducing exercise. Optionally, retrofit embodiment **100** is used for rehabilitation. Optionally, retrofit embodiment **100** is used for exercising the elderly. Optionally, retrofit embodiment **100** is used for rehabilitation and/or exercise of at least partially disabled people. Optionally, retrofit embodiment **100** is used for training of cognitive and motor skill coordination tasks

Exemplary Embodiments of Retrofit Apparatuses

[**0042**] Various exemplary embodiments of the invention are described herein. It should be noted that features which are described in association with particular embodiments and exercise equipment are not restricted to use only with those embodiments and equipment. Moreover, some of the features and/or constructions are considered novel even when used in originally manufactured equipment and not only in retrofitting.

[**0043**] **FIG. 2** shows an embodiment of a retrofit actuator module **204** in accordance with an embodiment of the invention. The actuator module **204** is located on a cable **206** which operationally connects a resistance **208** (weight) to the user of equipment **202** through a pair of handle bars **214**. In this exemplary embodiment, actuator module **204** pushes and/or pulls on cable **206** depending on the needs of the user and in response to commands from a control device **210**. Optionally, actuator module **204** can release resistance **208** imparted to the user in the event of emergency, or for any reason the user wants to stop exercising. Optionally, sensors (not pictured) are located on equipment **202** and/or the user of the machine in order to monitor performance and position.

[**0044**] In an exemplary embodiment of the invention, a user exercising on equipment **202** exerts force against resistance **208** provided by the equipment. Typically, resistance **208** is incremented in convenient partitions, for example, 10 kg, 15 kg, 20 kg and so on. However, sometimes even the lowest increment is too much for the person exercising on the equipment. This is especially true in the case of the elderly, the disabled, and those who have been injured and are exercising for rehabilitation. In an exemplary embodiment of the invention, control device **210** commands actuator module **204** to provide only a desired portion of the force up to 10 kg, or the first increment of resistance **208** provided by equipment **202**. In this example, resistance **208** provided by the equipment **202** stays on the ground but as the user pulls on the cable **206** to commence exercise, actuator module **204** spools additional cable out with a desired level of resistance that is less than the resistance of the first partition (in this example 10 kg). Optionally, an additional pulley wheel (not pictured) is provided in order to increase the possible length that can be traveled by the cable **206**. Optionally, a tension sensor is incorporated onto cable **206**. In some embodiments of the invention, actuator module **204** can raise and/or lower itself on cable **206** in relation to resistance **208**.

[**0045**] Optionally, actuator module **204** can be attached to the frame of exercise equipment **202**. In such an exemplary embodiment of the invention, an increment of resistance between two values provided by resistance **208** can be optionally provided. In such an embodiment, actuator module **204** relies on the resistance provided by equipment **202** but adds a difference in tension to cable **206** (in the direction of the user) up to the desired resistance, which is only a fraction of the difference between the values provided by resistance **208**.

[**0046**] Using the above mentioned supplied resistance values as examples, 13 kg would be a fractional resistance as it falls between 10 kg and 15 kg. To provide a 13 kg resistance, resistance **208** would be set to 10 kg and controller **210** would instruct actuator **204** to add tension to cable **206** that is equivalent to 3 kg of resistance **208**. Alternatively, resistance **208** could be set to 20 kg and actuator **204** could reduce the tension by 7 kg, for example, using the method described above.

[**0047**] In addition to being able to provide fractional resistances, actuator module **204** can be instructed to assist the user with exerting force against resistance **208**. This would be useful to help a user overcoming a "sticking point" for example. Optionally, actuator module **204** can provide variable force either in assistance or against the user, depending on the needs and desires of the user. An additional benefit of attaching actuator module **204** to frame of the equipment **202** would be that as a safety feature, actuator module **204** can clamp down on cable **206** in the event that resistance **208** needs to be lifted from the user. Alternatively, actuator **204** can release the weight of resistance **208**, by letting cable out of a reserve, in a controlled manner. These aspects of the invention are described more fully in the "Safety" section below.

[**0048**] Turning now to **FIG. 3**, an embodiment **300** is shown which retrofits a motor driven shaft to add and/or subtract resistance imparted to a user of exercise equipment **302**. In an exemplary embodiment of the invention, an actuator module **304**, such as a motor, is provided which is operationally attached to a shaft **306** which is located at a point of rotation of the equipment **302**. As shown in **FIG. 3**, movement of a weight resistance **308** is effectuated by force being applied to a pair of arms **310**. In an exemplary embodiment of the invention, actuator module **304** is

capable of providing resistance additionally or alternatively to the resistance provided by resistance **308**. Optionally, actuator module **304** assists a user in exerting force against the resistance. Optionally, the amount of assistance and/or resistance provided by actuator module **304** is varied over the course of exercise. Optionally, the actuator module **304** allows a fraction of a partition of resistance, such as described with respect to **FIG. 2**, to be used in exercise. In some embodiments of the invention, actuator module **304** neither assists nor provides resistance allowing the equipment to be operated in a conventional mode (for example, by a user who does not need/desire assistance and/or resistance by the actuator). In such an exemplary embodiment of the invention, a convenient switch can be provided, on equipment **302** for example, which disables assistance/resistance of actuator module **304** allowing for normal operation. Such a feature is optionally used with any of the embodiments described or suggested herein.

[**0049**] For example, in the case of a user who cannot successfully move the lowest increment of resistance **308** provided by the machine, actuator module **304** can be used alternatively to the equipment's resistance to supply resistance to the user. In such an exemplary embodiment, control device commands actuator module **304** to provide only a desired portion of the force up to 10 kg, or the first increment of resistance **308** provided by equipment **302**. In this example, resistance **308** provided by the equipment **302** stays on the ground but as the user pulls on the arms **310** to commence exercise, actuator module **304** spools additional cable out with a desired level of resistance that is less than the resistance of the first partition (in this example 10 kg).

[**0050**] Optionally, actuator module **304** is used to assist the user in moving resistance **308**, which without the assistance the user would not have been able to move it. If, in an exemplary embodiment of the invention, a user has chosen to exercise with 10 kg of resistance, but can only exert 6 kg of force on the resistance, the actuator module **304** can supplement the user's force with slightly greater than 4 kg, allowing for exercise movement of the resistance. As described herein, sensors located on equipment **302** and the user can provide the data necessary for the supplemental force determination to be made by control device. In some embodiments of the invention, actuator module **304** is used to provide variable assistance and/or resistance to the user. For example, actuator module **304** could assist the user at the beginning of the exercise, to get things moving, then taper off assistance thereafter. Optionally, actuator module **304** provides both assistance and resistance to the user at different times during the same exercise.

[**0051**] In an exemplary embodiment of the invention, safety is enhanced by providing the shaft-based retrofit of **FIG. 3**. Using the ability of actuator module **304** to control disposition of the arms **310**, actuator module **304** can alleviate the resistance imparted to the user by equipment **302** at any time. Additionally or alternatively, the placement of arms **310** can be locked by actuator module **304**. These aspects of the invention are described more fully in the "Safety" section below.

[**0052**] As with other exemplary embodiments described herein, the actual machine portrayed in **FIG. 3** by way of example only, the shaft-based retrofit capable of being used to enhance any exercise equipment which relies on an axis of rotation to provide exercise. Optionally, the equipment and/or user are provided with sensors (not pictured), as described below in the "Feedback" section.

[**0053**] **FIG. 4** illustrates a retrofit embodiment **400** wherein an exercise equipment **402** is retrofitted with an actuator module **404** optionally located at the crux of a joint of the exercise equipment **402**. Being located at the crux of the joint, actuator module **404** is afforded an advantageous location for exercising force on certain moving parts of equipment **402**. In an exemplary embodiment of the invention, actuator module **404** is mechanical. Optionally, actuator module **404** is hydraulic. Optionally, actuator module **404** is pneumatic. Optionally, actuator module **404** is a ball-screw mechanism. Optionally, actuator module **404** is a jack-style mechanism. Command of the actuator module **404** is optionally provided by a control device **410**, the control device having functions similar to those described for devices **110**, **210** and **310**, in the other embodiments described above and control devices mentioned in the following embodiments. In an exemplary embodiment of the invention, actuator module **404** is capable of assisting the user in lifting a resistance **408** provided by equipment **402** by exerting force upwards on a lever arm **412** of equipment **402**. Optionally, actuator module **404** increases the resistance offered by equipment **402** by pulling lever arm **412** down towards the base of equipment **402**. Optionally, actuator module **404** provides varied resistance and/or assistance during the course of exercise. Optionally, the equipment and/or user are provided with sensors (not pictured), as described below in the "Feedback" section. Safety can be provided to equipment **402** by retrofitting actuator module **404** as it has the ability to lock lever arm **412** in place and prevent it from moving or alternatively move it to a safe harbor position. These aspects of the invention are described more fully in the "Safety" section below.

[**0054**] In an exemplary embodiment of the invention, a linear actuator is used to provide actuation of a linear joint (e.g. a rowing machine where the chair moves on a track). In other exemplary embodiments of the invention, a chain and a sprocket are used to provide a rotary actuation. It should be appreciated that various actuating devices can be used as known in the art, these are optionally controlled by a controlling device and are optionally are fitted with various sensors.

[**0055**] Referring now to **FIG. 5**, a retrofit embodiment **500** is shown which moves in parallel with the natural motion of an exercise equipment **502** caused by exercise activity of a user. It should be noted that this embodiment is also by way of example only. Depending on the exercise equipment, the retrofit components used in order to parallel the motion of the equipment will vary. Furthermore, this is but one example of how to provide a retrofit module which parallels motion of the exercise equipment.

[**0056**] In an exemplary embodiment of the invention, a mirror image track **514** is provided behind an original track **512** along which a resistance **508** travels, in response to motion by a cable **506**. Located on mirror image track **514** is an actuator module **504** which travels up and down on mirror image track **514** moving in parallel with or alternatively to resistance **508** as it is moved by a user during exercise. Resistance **508** and actuator module **504** are mechanically connected. Optionally, actuator can provide a

resistance to its movement along mirror image track **514** and/or can provide some lift, if it is motorized. Optionally, actuator module **504** assists the user in moving resistance **508** in order to compensate for the slight additional resistance created by attachment of module **504** to resistance **508**, thereby allowing the user to exercise as normal.

[**0057**] As with others of the embodiments described herein, actuator module **504** can assist the user with applying force to resistance **508**, by applying a set upward force on resistance **508** or can act as resistance additionally or alternatively to the equipment's resistance **508**, by pushing down on resistance **508**. It can also be set, as described above not to influence exercise at all. Optionally, actuator module **504** varies its assistance and/or resistance applied to the user throughout the course of exercise. Actuator module **504** is optionally connected to a control device **510**. Optionally, the equipment and/or user are provided with sensors (not pictured), as described below in the "Feedback" section. Safety can be provided to equipment **502** by retrofitting actuator module **504** as actuator module **504** has the ability to lock the resistance in place and prevent it from moving or move it to a safe harbor location. These aspects of the invention are described more fully in the "Safety" section below.

[**0058**] An illustration of an exemplary retrofit embodiment is depicted in **FIG. 6**. Rather than showing the entire exercise equipment, **FIG. 6** portrays a cable **606** which operationally connects the user to a resistance **608** provided by the equipment. Located at an intermediate location between the user, located at a terminus of cable in the direction of the arrow, and resistance **608** is a spool **604** of cable which is in turn operationally connected to an actuator module **602** via a shaft. Actuator module **602** operates similarly to the shaft-based actuator module **304** depicted in **FIG. 3**, in that it can impart a variety of motion on spool **604**, and therefore to cable **606** and eventually the user. For example, actuator module **602** can reel cable **606** in the direction of the user providing the user with assistance in lifting resistance **608**. In the alternative, actuator module **602** can reel cable **606** away from the user thereby imparting additional resistance to the user.

[**0059**] Optionally, cable **606** is a chain and spool **604** is provided with teeth which interdigitate with slots located on the chain. In such a manner, the control of slippage between cable **606** and spool **604** can be enhanced. Optionally, cable **606** is provided with at least one sensor **622** which can, for example, measure tension on cable **606**. Sensor **622** optionally assists with slack detection and correction of the tension value in the cable **606**, by providing feedback to actuator **602** or a control device **610**. In some embodiments of the invention, cable **606** is provided with an additional pulley wheel **620**, increasing the effective length of travel of cable **606**, and providing more flexibility with the positioning of the various components of the equipment and retrofit. Optionally, at least one sensor **614** is located on the shaft to detect rotational speed of the shaft. Optionally, control device **610** is connected to actuator module **602** and/or sensors. Safety can be provided since actuator module **602** has the ability to lock the resistance in place and prevent it from moving or to move it to a safe harbor location in a controlled manner. These aspects of the invention are described more fully in the "Safety" section below.

[**0060**] **FIG. 7** is an illustration of an exemplary embodiment **700** which provides a clutch **704** located at an intermediate position on a cable **706** between a resistance **708** provided by an exercise equipment and a user, located at a terminus of cable **706** in the direction of the arrow. Operationally attached to clutch **704** is an actuator module **702** which is optionally adapted to provide motion to the clutch **704** so that the clutch is capable of movement up and down cable **706**. Optionally, clutch **704** moves correspondingly to the cable **706** as cable moves. Optionally, clutch **704** does not move. In some exemplary embodiments of the invention, actuator module **702** is connected to a control device **710**. In an exemplary embodiment of the invention, actuator module **702** is rotary (as shown). Optionally, actuator module **702** is linear. Control device **710** is capable of performing at least the functions described herein with respect to control devices of the other embodiments.

[**0061**] Clutch **704** is adapted to releasably affix to cable **706**. Affixation can optionally occur via grippers, for example or by friction. Optionally, affixation is accomplished using electromagnetism, such as through attracting magnets positioned opposite one another with cable **706** in between. Optionally, calipers are used to affix clutch **704** to cable **706**. In some embodiments of the invention, the clutch is partially closed such that transit of cable **706** through clutch **704** is not halted, but impeded via friction. Such impedance increases the resistance experienced by the user of the equipment during exercise. Alternatively, clutch **704** is affixed to cable **706** and the cable is imparted with motion either towards or away from the user by actuator module **702**. In some embodiments of the invention, the clutch is provided with at least one sensor. Various data is optionally collected by the sensor, for example on speed of the cable. In an exemplary embodiment of the invention, tension is measured by adding a sensor to the cable, as in **FIG. 6**. As with other embodiments, safety is enhanced by providing the clutch with the ability to stop motion of cable **706**, move cable **706** to a safe harbor position or release resistance **708** completely. Through the partially closed operation of clutch **704**, resistance **708** can also be lowered at varied and/or variable speeds, including free fall and/or a highly controlled speed. These aspects of the invention are described more fully in the "Safety" section below. Optionally, the cable is provided with an extra pulley wheel (not shown) in order to increase the possible distance of travel for cable **706**.

Retrofitting Exercise Equipment

[**0062**] The various embodiments of retrofitting apparatuses described herein are described as add-ons to previously manufactured exercise equipment, although at least some could advantageously be part of original equipment. **FIG. 8** shows a flowchart **800** describing a method of retrofitting an exercise machine, in accordance with an exemplary embodiment of the invention. At **810**, optionally at least one possible retrofit option is identified. For example, if the exercise equipment has a joint, an actuator module such as described in the context of **FIG. 4** is optionally a candidate for use. In an exemplary embodiment of the invention, exercise equipment which includes rotation about an axis could optionally be retrofitted with an embodiment such as described in **FIG. 3**. Optionally, exercise equipment is retrofitted with any of the exemplary retrofit embodiments described or suggested herein. Optionally, exercise equip-

ment is retrofitted with more than one retrofit embodiment. At **820**, specific retrofit options are optionally chosen based on various criteria including the demographics of the users, the possible types of motion which are desired, safety features offered by the particular retrofit, feedback options offered by the retrofit, cost, available space in the area of operation, etc. Optionally, more than one retrofit option is selected.

[**0063**] At **830**, the selected retrofit options are added to the exercise equipment. As described herein, there are a variety of retrofit embodiments, many of which are attached to exercise equipment using variety of techniques. Using the embodiment depicted in **FIG. 4**, a joint is identified where the retrofit is to be added. The retrofit is then mounted, using screws or bolts, for example, between the two arms on either side of the joint in order to provide enhanced features to the exercise equipment. Optionally, the retrofit is mounted by welding it onto the exercise equipment. Taking another example, the embodiment depicted in **FIG. 2** relies on adding a component onto the cable. In an exemplary embodiment of the invention, the component is added to the cable by taking the cable off of the equipment and threading the component onto the cable. In an exemplary embodiment of the invention, the cable is cut and each loose end is attached to the component which is positioned between the two severed ends of the cable.

[**0064**] Retrofitting exercise equipment for use with an embodiment such as depicted in **FIG. 3** optionally involves removing the shaft around which motion is conducted and replacing it with a longer shaft which is adapted to be received and controlled by an actuator module. In an exemplary embodiment of the invention, the retrofit of **FIG. 5** (parallel motion retrofit) is accomplished by providing additional structure to the equipment which allows parallel motion of an actuator capable of imparting movement to the resistance of the equipment. In the case of **FIG. 5**, a retrofit would optionally involve providing the mirror image track for the actuator module and connecting the resistance to the actuator module. Other retrofits, such as depicted in **FIG. 6** benefit from the optional replacement of the original cable with a longer cable. Some exemplary embodiments, such as depicted in **FIG. 7** do not require any special modifications to the exercise equipment.

[**0065**] At **840**, at least an actuator module of the retrofit is optionally connected to a control device. Connection can optionally be wireless. In an exemplary embodiment of the invention, the actuator module is provided with a data transfer port which is adapted to receive an operative connection from at least the control device. At **850**, sensors are optionally added to the exercise equipment and connected to the control device. In an exemplary embodiment of the invention, sensors are also provided, optionally connected to the control device, and ready for placement on a user of the equipment. At **860**, an optional exercise environment enhancer is connected to the control device in order to synchronize the environment enhancement with the equipment. The exercise environment enhancement is described below in the "Enhanced Environment Control Retrofit" section below.

Feedback

[**0066**] In an exemplary embodiment of the invention, sensors are provided to collect data on various aspects of exercise optionally including motion of the equipment and user and physiological status of the user. Sensors optionally measure one or more parameters of equipment and/or user motion, for example, position, speed, force, tremor, synchronization and other parameters. Sensors are optionally located at any position on the equipment and/or user depending on what parameters are desired to be measured.

[**0067**] Data collected from the sensors is optionally processed and/or stored by a control device. In some embodiments of the invention, the control device is connected to a communications network, such as the Internet, for transmission and reception of data. In an exemplary embodiment of the invention, collected data is analyzed in order to evaluate the exercise performance of the user. Graphical and/or audio and/or video feedback can be given to the user during exercise. Analysis by the control device is optionally used to modify a user's exercise program and/or to move various retrofit modules and/or provide other feedback to the user.

[**0068**] Sensors used to measure equipment parameters generate data which is optionally analyzed and acted upon by the control device. A variety of types of sensors and/or arrays of sensors are optionally used to identify position, speed, force, direction, angle of rotation, acceleration, tension and other such parameters. In an exemplary embodiment of the invention, analysis of such data prompts the control device to issue commands to retrofit modules, such as described herein, in order to enhance the exercise regimen of the user. In an exemplary embodiment of the invention, feedback data enables the maintenance of optionally pre-set force/tension equipment values.

[**0069**] In some exemplary embodiments of the invention, sensors are used to measure and optionally provide control to limit the range of motion for a user of the equipment, or to limit force and or speed experienced by the user.

Safety

[**0070**] An aspect of some exemplary embodiments of the invention is to provide enhanced safety to retrofitted exercise equipment. As can be understood from the description of some exemplary embodiments herein, retrofit modules are added to exercise equipment which provide enhanced safety functionality of the equipment. In some exemplary embodiments of the invention, retrofit modules are provided which lock the equipment, preventing motion of certain moving parts.

[**0071**] In some exemplary embodiments of the invention, retrofit modules are provided which enable the safe, quick release of the resistance being provided by the equipment to the user. For example, there are occasions where the user starts to fade in exerting force against the resistance of the equipment, however due to the position of the hands or parts of the equipment, it would be unsafe to simply let go (e.g. part of the equipment could strike the user with extreme force due to the resistance being released suddenly). In such a case, the retrofit module, which is located between the resistance (it can also provide cushioning that can prevent fracture due to abrupt motion, for example) and the user releases the resistance such that the resistance assumes an at rest condition, while maintaining the positioning of the parts of the equipment in relation to the user.

[**0072**] Optionally, the retrofit module is adapted to move the exercise equipment such that potentially threatening

components of the equipment will be positioned in a safe harbor location, allowing the user to safely stop exercise and/or exit the equipment. Optionally, the retrofit module is adapted to move the exercise equipment such that potentially threatening components of the equipment gradually transition to an at rest position.

[0073] The various safety modes described herein are optionally triggered by any number of stimuli. In an exemplary embodiment of the invention, a safety mode is implemented upon an audible cue, such as a scream or voice command. Optionally, a button or trigger is provided to the user such that when activated, the control device activates a safety mode for the equipment. In an exemplary embodiment of the invention, a safety mode is automatically triggered based on analysis of data gathered by the sensors. Optionally, the control device performs the automatic triggering.

Enhanced Environment Control Retrofit

[0074] **FIG. 9** is a schematic of an enhanced environment retrofit embodiment **900**, in accordance with an exemplary embodiment of the invention. Shown in **FIG. 9** is an exercise equipment **902**, in this example a treadmill. It should be understood that with all the embodiments of retrofit modules described herein, illustration of use with a particular piece of exercise equipment is by way of example only. Optionally retrofitted to equipment **902** is an enhanced environment control device **910**. In some exemplary embodiments of the invention, sensors are attached to equipment **902** in order to gather data, as described above. In this example, sensors **912**, **914** are optionally used to gauge the "velocity" of the user of the treadmill by tracking the speed of the treadmill belt. Optionally, control device **910** is connected to sensors already provided by the equipment. Optionally, control device **910** is interfaced with the equipment electronics which itself gathers data from sensors located on equipment **902**. Control device **910** is in turn operationally connected to a display device **916** whereby movement or motion on the exercise equipment **902** translates to a perceived change in position on display **916**. Optionally, control device **910** is connected to display device **916** through an intermediate device, such as a set-top cable box or a VCR. Optionally, display device **916** is positioned on the user's head, for example with a helmet or projection-screen glasses. Optionally, the display is virtual reality based.

[0075] In an exemplary embodiment of the invention, usage of an enhanced environment retrofit with exercise equipment allows the combination of both motor and cognitive exercise. Furthermore, the provision of attractive scenery, games, or the like is likely to increase user compliance with an exercise regimen.

[0076] The following provisional and PCT applications, the disclosures of which are incorporated herein by reference, describe devices and/or methods that may be used in conjunction with embodiments of the present invention.

[0077] U.S. provisional application No. 60/604,615 filed on Aug. 25, 2004 describes taking the effects of brain plasticity into account. The methods described herein may use EEG or MRI as an input for deciding, for example, on feedback or type of device mode to use.

[0078] A PCT application titled "Methods and Apparatus for Rehabilitation and Training", serial number PCT/IL2005/000142, describes devices and methods which may be used for rehabilitation.

[0079] A PCT application titled "Methods and Apparatuses for Rehabilitation Exercise and Training" serial number PCT/IL2005/000136, describes chair based rehabilitation and balance rehabilitation.

[0080] A PCT application titled "Gait Rehabilitation Methods and Apparatuses", serial number PCT/IL2005/000138, describes rehabilitation of gait, in parts and in total.

[0081] A PCT application titled "Rehabilitation with Music", serial number PCT/IL2005/000137, describes using music as a feedback and/or to guide rehabilitation.

[0082] A PCT application titled "Neuromuscular Stimulation", serial number PCT/IL2005/000135, describes stimulating a paretic limb while moving the limb or otherwise supporting the motion of the limb. EMG measurements, for example of healthy limbs are optionally used as part of the teaching of the present application for deciding on stimulation and/or supported motion of a paretic limb.

[0083] A PCT application titled "Fine Motor Control Rehabilitation", serial number PCT/IL2005/000139, describes rehabilitation of fine motor control and using a robotic arm as an assistant in daily living, for example, to help feeding.

[0084] It should be noted that the rehabilitation devices described herein are optionally usable not only at a home but also at care centers, such as old age homes, hospitals and rehabilitation centers.

[0085] It will be appreciated that the above described apparatuses for retrofitting may be varied in many ways, including, omitting or adding steps, changing the order of steps and the types of devices used. In addition, a multiplicity of various features, both of method and of apparatuses have been described. In some embodiments mainly methods are described, however, also apparatus adapted for performing the methods are considered to be within the scope of the invention. It should be appreciated that different features may be combined in different ways. In particular, not all the features shown above in a particular embodiment are necessary in every similar embodiment of the invention. Further, combinations of the above features are also considered to be within the scope of some embodiments of the invention.

[0086] Also within the scope of the invention are kits which include sets of a device, one or more sensors, one or more attachments and/or software. Also, within the scope is hardware, software and computer readable-media including such software which is used for carrying out and/or guiding the steps described herein, such as control of resistance position and providing feedback. Section headings are provided for assistance in navigation and should not be considered as necessarily limiting the contents of the section. When used in the following claims, the terms "comprises", "includes", "have" and their conjugates mean "including but not limited to". It should also be noted that the device is suitable for both males and female, with male pronouns being used for convenience.

[0087] It will be appreciated by a person skilled in the art that the present invention is not limited by what has thus far been described. Rather, the scope of the present invention is limited only by the following claims.

1. An exercise apparatus, comprising:

a resistance element, operative to supply a resistance to movement by a user of said apparatus; and,

an actuator module operatively connected to said resistance element and operative to vary a resistance perceived by said user without changing the resistance element.

2. An exercise apparatus in accordance with claim 1 wherein said resistance element is a weight.

3. An exercise apparatus in accordance with claim 1 wherein said resistance is transferred to said user via a transfer element and wherein said actuator module acts on said transfer element to vary the perceived resistance.

4. An exercise apparatus in accordance with claim 3 wherein said actuator module is in series with said transfer element.

5. An exercise apparatus in accordance with claim 1 wherein said actuator module acts directly on said resistance element.

6. An exercise apparatus in accordance with claim 1 further comprising a control device adapted to issue operation commands to said actuator module.

7. An exercise apparatus in accordance with claim 6 further comprising at least one sensor wherein said at least one sensor provides data to said control device for analysis regarding operation commands to be given to said actuator module.

8. An exercise apparatus, comprising:

a resistance element, operative to supply a resistance to movement by a user of said apparatus;

at least one sensor, wherein said at least one sensor is added to said apparatus after-market and wherein said at least one sensor measures parameters associated with said apparatus or said user; and,

a control device, wherein said control device added to said apparatus after-market, is in communication with said at least one sensor, and wherein parameters are received from said at least one sensor for analysis by said control device.

9. An exercise apparatus in accordance with claim 8 further comprising an actuator module, said actuator module added to said apparatus after-market and wherein said actuator module is connected to said resistance element and operative to vary a resistance perceived by said user without changing the resistance element.

10. An exercise apparatus in accordance with claim 9 wherein at least one sensor provides parameters to said control device for analysis regarding operation commands to be given to said actuator module.

11. An exercise apparatus, comprising:

a resistance element, operative to supply a resistance to movement by a user of said apparatus;

an actuator module operatively connected to said resistance element and operative to vary a resistance perceived by said user without changing the resistance element; and,

a control device, wherein said control device is added to said apparatus after-market, is in communication with said actuator module, and wherein said control device issues commands to said actuator module to act on said resistance upon indication of an unsafe situation.

12. An exercise apparatus in accordance with claim 11 further comprising at least one sensor, wherein said at least one sensor measures parameters associated with said apparatus and said user and communicates said parameters to said control device for analysis pertaining to an unsafe situation.

13. An exercise apparatus, comprising:

at least one sensor, wherein said at least one sensor measures parameters associated with said apparatus;

an enhanced environment control device, wherein said device relates said parameters to a program contained on said device and produces an output integrating said parameters and said program; and,

a display, wherein said display is in communication with said device and displays said output to a user of said apparatus.

14. An exercise apparatus in accordance with claim 13, further comprising an intermediate device positioned between said enhanced environment control device and said display, but which still provides communication between said enhanced environment control device and said display.

15. A method of after-market retrofitting an exercise apparatus, comprising at least a resistance element, operative to supply a resistance to movement by a user of said apparatus, comprising:

adding at least one sensor, wherein said at least one sensor is added to said apparatus and wherein said at least one sensor measures parameters associated with said apparatus or said user; and,

adding a control device, wherein said control device added to said apparatus, is in communication with said at least one sensor, and wherein parameters are received from said at least one sensor for analysis by said control device.

16. A method in accordance with claim 15, wherein said retrofitting further comprises adding an actuator module.

17. A method in accordance with claim 15, wherein said retrofitting further comprises adding an environment enhancer control device.

18. A method of after-market retrofitting an exercise apparatus, comprising at least a resistance element, operative to supply a resistance to movement by a user of said apparatus, comprising:

adding an actuator module operatively connected to said resistance element and operative to vary a resistance perceived by said user without changing the resistance element; and,

adding a control device, wherein said control device is added to said apparatus after-market, is in communication with said actuator module, and wherein said control device issues commands to said actuator module to act on said resistance upon indication of an unsafe situation.

19. A method in accordance with claim 18, wherein said retrofitting further comprises adding at least one sensor for measuring parameters associated with said apparatus.

20. A method in accordance with claim 18, wherein said retrofitting further comprises adding an environment enhancer control device.

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