AN EXERCISE APPARATUS SENSOR SYSTEM

TECHNICAL FIELD

[001] This invention relates to a sensor system for assisting a user in using an exercise machine, in particular to check the form of movement, count the repetitions, and track the weights being lifted. The sensors can be mounted on existing exercise machines with little or no modifications, and is free standing that can measure the number of weight plates being lifted as well as the distance.

BACKGROUND

[002] There are various electronic apparatuses that can be added to exercise machines to enhance the user experience, especially in counting the number of repetitions, as well as checking whether the range of movement is sufficient and the form correct. By providing this feedback to the user in real time, appropriate corrections and measures can be taken to ensure that the exercise is done safely and efficiently.

[003] Given the many exercise machines in the various gyms around the world, it would be too costly to redesign the exercise machines to incorporate a device that can count the repetitions, track the weights being lifted, and check the form of movement. And in terms of existing solutions that can be fitted onto a current exercise machine, they either count repetitions only, or involve manipulation of the sensors to ensure a change is registered. Further by requiring installation on the exercise machine itself,

the various existing solutions result in significantly greater wear and tear of both the device and exercise machine.

[004] Hence, there is a need for an exercise apparatus sensor system that is able to count repetitions, measure the amount of weight lifted, check the amount of extensions, calculate calories burnt, measure intervals between repetitions without being intrusive and without changing the user experience in terms of using the exercise machine, and without causing more wear to the exercise machine.

BRIEF SUMMARY

[005] The above and other problems are solved and an improvement in the art is made by an exercise apparatus sensor system in accordance with this invention. A first advantage of the exercise apparatus sensor system in accordance with this invention is that it enables a user to count and keep track of the number of repetitions performed without having to wear extra sensors. This allows for existing exercise equipment to be retrofitted with the system without requiring modifications. A second advantage of the exercise apparatus sensor system in accordance with this invention is that it is able to measure and compute multiple parameters including the amount of weight being lifted, the distance of extensions, calories burnt, intervals between extensions and provide this in a real time manner. This allows the user to adjust accordingly and exercise efficiently. A third advantage of the exercise apparatus sensor system in accordance with this invention is that it is able to adapt to the exercise patterns of the user. This means that users

will exercise at an optimal level without it being too difficult or too easy so as to make the exercise efficient.

BRIEF DESCRIPTION OF THE DRAWINGS

[006] The invention is illustrated by way of example with reference to the accompanying drawings which show an exercise apparatus sensor system in accordance with the invention. The accompanying drawings, which are incorporated herein and form part of the specification, illustrate various embodiments of the present disclosure and, together with the description, further serve to explain the principles of the disclosure and to enable a person skilled in the pertinent art to make and use the embodiments disclosed herein. In the drawings, like reference numbers indicate identical or functionally similar elements.

[007] Figure 1 is the overview system of the exercise apparatus sensor system when installed in three exercise machines;

[008] Figure 2 shows the various components in the exercise apparatus system;

[009] Figures 3A, 3B, and 3C show various views of the weight stack sensor in the exercise apparatus sensor system;

[0010] Figures 4A, 4B, 4C, and 4D show various views of the sensor base of the sensor in the exercise apparatus sensor system;

[0011] Figures 5A, 5B, 5C, 5D, 5E, and 5F show various views of the sensor top in the exercise apparatus sensor system;

[0012] Figures 6A, 6B, 6C, and 6D show various views of the weight distance sensor holder in the exercise apparatus sensor system;

[0013] Figure 7 shows a system flowchart of the repetition counting algorithm used in the exercise apparatus sensor system.

DETAILED DESCRIPTION

[0014] The various configurations discussed in these non-limiting examples can be varied and are used to illustrate at least one embodiment and are not intended to limit the scope thereof.

[0015] Referring to the drawings, Figure 1 shows an overview of the system 100 with the weights 101 of the weight stack machine or exercise machine 102 shown, along with its possible direction of movement of the weights 101. The time of flight (TOF) module 110 and weight stack sensor 120 can also be seen, in this embodiment shown installed inside the weight stack machine, although the sensor system can also be free standing outside and separate from the weight stack machine. Each weight stack sensor system 120 would then communicate with a gateway 140 and is connected to a Backend Database API 150.

[0016] The weight stack sensor can either be powered by battery or from power supply. The weight stack sensor 120 can have a base module and wireless communication is built into the base module. Whenever a repetition is detected by the weight stack module, the amount of weight lifted and the distance moved by the weight stack 101 can be transmitted wirelessly to a local gateway 140, before being transmitted to the cloud backend database 150 so that the data collected from the weight stack sensor 120 can be

stored, retrieved and visualized. As seen from Figure 1, the gateway 140 can support multiple connections from multiple weight stack sensors.

[0017] Details of the weight stack sensor 200 can be seen in Figure 2, with the weights 201 (and a weight of 30lbs shown being lifted) where there are three main modules: a time of flight (TOF) module 210, a proximity module 220, and a base module 230. The time of flight module 210 can be used to measure the movement of the weight stack 201 and this can determine the amount of work done in moving the weights or weight stack 201. The proximity module 220 can be used to detect the weight 201 being lifted, and this can be achieved through proximity sensors 222 that are installed within the proximity module 220, whereby each proximity sensor 222 can detect a corresponding weight in the weight stack 201 in rest stateThe base module 230 can be the interface between all the modules, and can also compute the workout data from multiple sensors and aggregate the data accordingly. The base module 230 is also able to communicate with the gateway 140 (not shown in Figure 2), and this can be wirelessly or using wires, or any other communication methods known to those skilled in the art.

[0018] The result is a free-standing sensor unit that can measure the number of weight plates being lifted and the distance moved by the lifted weight plates. The free-standing sensor can be retrofitted onto existing weight stack machines or exercise machines without contact with any moving parts while the weight stack machine is being used.

[0019] The time of flight module 210 can have a printed circuit board (PCB) that holds the various circuitry to perform its function, and this PCB can be

mounted on a holder that also has slots for magnets that can be used to attach the time of flight module 210 to the metal body of the weight stack machine. The time of flight module is in communication with the base module 230, and this communication can be wireless or via wire.

[0020] The proximity module 220 can have a printed circuit board (PCB) for holding the components to perform its function. This can be in the form of a series of proximity sensors mounted on a PCB that would detect the corresponding weight being lifted on the weight stack 201. Thus in Figure 2, the proximity module can detect the weight being lifted to be 30. As shown, each proximity sensor 222 can correspond to a weight plate in the weight stack 201, and hence detect movement in the weight plate as well as the amount of weights being lifted when the relevant weights are lifted.

[0021] The overall structure of the weight stack sensor 300 can be seen in Figures 3A-C. The weight stack sensor 300 can be composed of metal beams 312 mounted a base 314 and hat 310. The base 314 and hat 310 can be made using additive printing for ease of design. The base module PCB and Proximity module PCB can be mounted on acrylic plates 316 which are then mounted on the metal beams 312. The frame of the weight stack sensor 300 would be placed next to the weight stack (not shown in Figure 3).

[0022] The side, end, top and perspective views of the base module can be seen in Figures 4A-D, while the various views of the sensor top can be seen in Figures 5A-F. The various views of the weight distance sensor holder can be seen in Figures 6A-D.

[0023] Within the base module, there is a processor that collates the inputs from the sensor(s) and produces a result. For example, in counting the repetitions, there may be false counts or miscounting due to the variations in usage of the weight stack machine. Either or both the accelerometer and/or distance (proximity module) can be used to count the number of repetitions. The accelerometer can be found in the base module. In some examples, the distance sensor is preferred as it provided higher accuracy and required less complex algorithm as signal filtering was not needed. The direct measurement of the weight stack position also provided more accuracy, and also allowed for the computation of calories burned based on the data collected. In other examples, the base module is placed on top of the weight stack such that it moves together with the weight stack. Otherwise, a free standing design for the base module as shown in Figure 3 can also be used.

[0024] An example of a repetition counting algorithm used with the weight stack sensor can be seen in Figure 7. The repetition counting algorithm can reside in the processor on the base module, and this can be a 32-bit ARM cortex m4 processor.

[0025] It is able to adapt to the exercise patterns of the user by learning from previous iterations. For instance, the threshold can be increased for users who make large arm extensions, and likewise it can also be decreased for user who make small arm extensions. This can help to reduce the cases of missed counts and false counts. The repetition counting algorithm was found to achieve 99% accuracy using data collected from 93 participants.

The repetition algorithm can compute the number of repetitions performed by the user in real-time.

[0026] Thus, the present invention has been fully described with reference to the drawing figures. Although the invention has been described based upon these preferred embodiments, to those of skill in the art, certain modifications, variations, and alternative constructions would be apparent, while remaining within the spirit and scope of the invention.

CLAIMS

1. A system for use with an exercise apparatus, the system comprising:

a support arrangement;

a proximity module which is carried by the support arrangement, the proximity module comprising a plurality of spaced apart proximity sensors, each proximity sensor being configured to detect a corresponding weight in a weight stack of an exercise apparatus when the weight is within a predetermined distance of the proximity sensor;

a base module which is coupled for communication with the proximity module, the base module being configured to receive proximity signals from the proximity module which are indicative of an output of at least one of the proximity sensors, wherein the base module is configured to determine the weight of the weight stack which is configured to move based on the proximity signals from the proximity module; and

a time of flight (TOF) module which is configured to measure the movement of the weight stack and to determine the amount of work done in moving the weight stack;

wherein the base module comprises a processor and a memory, the memory storing instructions which, when executed by the processor, cause the processor to:

count repetitions of the weight stack, wherein each repetition is counted when the processor receives a signal from the TOF module which is indicative of the weight stack moving a threshold distance from a rest position;

store a history of the repetitions in the memory; and

adjust the threshold distance based on the history of the repetitions to reduce the risk of further repetitions being miscounted.

2. The system of claim 1, wherein the support arrangement comprises:

a base; and

at least one support member which projects outwardly from the base.

3. The system of claim 2, wherein the support arrangement comprises two support members which are spaced apart from one another and which are each connected at one end to the base.

4. The system of any one of claims 2-3, wherein the base is configured such that, when the base is resting on a surface, the system is freestanding with the at least one support member projecting upwardly from the base.7. The system of claim 1, wherein the base module is configured to determine the number of weights in the weight stack of the exercise apparatus based on a movement of one or more of the weights beyond

predetermined threshold distance between each weight in the weight stack and a respective one of the proximity sensors.

5. The system of claim 1, wherein the weights in the weight stack of the exercise apparatus is indicated by a weight value representing the total weight that is moved when the exercise apparatus is in use.

6. The system of claim 1, wherein the base module is configured to count the number of repetitions..

7. The system of any one of the preceding claims, wherein the system further comprises:

an accelerometer which is configured to be carried by a part of the exercise apparatus and to move with the part of the exercise apparatus when the exercise apparatus is in use, the accelerometer being coupled for communication with the base module to provide acceleration signals to the base module which are indicative of an acceleration of the part of the exercise apparatus when the exercise apparatus is in use.

8. The system of any one of the preceding claims, wherein the base module is configured to communicate with each proximity module via a wired interface.

9. An exercise apparatus comprising the system of any one of the preceding claims.