(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
24 September 2015 (24.09.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/139089 A1

(51) International Patent Classification:
G06F 17/40 (2006.01) *A61B 5/00* (2006.01)
G06F 19/00 (2011.01)

(21) International Application Number:
PCT/AU2015/050116

(22) International Filing Date:
18 March 2015 (18.03.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2014900943 18 March 2014 (18.03.2014) AU
2014904908 4 December 2014 (04.12.2014) AU

(72) Inventor; and
(71) Applicant : **FACCIONI, Adrian** [AU/AU]; c/o Suite 4, Level 3, 20 George Street, Hornsby, New South Wales 2077 (AU).

(74) Agent: **ADAMS PLUCK**; Suite 3, Level 4, 20 George St, Hornsby, New South Wales 2077 (AU).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) Title: SYSTEM, METHOD AND APPARATUS FOR PROVIDING FEEDBACK ON EXERCISE TECHNIQUE

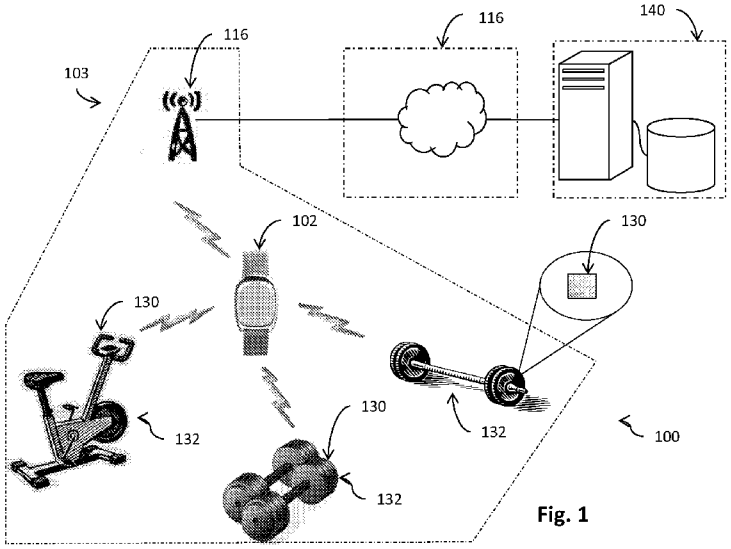


Fig. 1

(57) Abstract: A method for providing technique guidance to a user performing an exercise comprises: determining movement data associated with a movement of a user and/or exercise equipment manipulated by the user; determining an exercise being performed by the user which is associated with the physical movement; determining correct technique data associated with the 5 determined exercise; outputting technique guidance data to the user in real time, the real time technique guidance data being determined based, at least in part, on an evaluation of the movement data and the correct technique data.

WO 2015/139089 A1

System, Method and Apparatus for Providing Feedback on Exercise Technique

Technical Field

The present invention relates generally to a system, method and apparatus for providing guidance on exercise technique.

Background

There are many different wearable health monitoring devices currently available for providing users with data on a range of physiological parameters. Such devices include heart rate monitors, calorie monitors, blood pressure monitors, among others. In addition to providing physiological data, some wearable devices also provide the capability to track the user's movements, e.g. using a GPS tracking module.

More advanced wearable health monitoring devices also include the ability to wirelessly communicate the monitored data to a remote computing device for display, logging and/or further analysis. It is known for such devices to communicate with a personal smart phone for display of the monitored data.

Summary of the Invention

In accordance with a first aspect there is provided a method for providing technique guidance to a user performing an exercise, the method comprising: determining movement data associated with a movement of a user and/or exercise equipment manipulated by the user; determining an exercise being performed by the user which is associated with the physical movement; determining correct technique data associated with the determined exercise; outputting technique guidance data to the user in real time, the real time technique guidance data being determined based, at least in part, on an evaluation of the movement data and the correct technique data.

In an embodiment the movement data comprises a value for one or more parameters related to the movement.

In an embodiment the parameters comprise any one or more of the following: (a) a number of sets and/or repetitions of the movement; (b) a speed at which the movement is being carried out by the user; (c) a time that the user is performing the movement; (d) a time that the user is resting; (d) a time that the user is under load and/or tension when performing the movement;

(e) a musculo-skeletal loading for the user; (f) an amount of energy being expended by the user; (g) a load distribution.

In an embodiment the one or more parameters and wherein the technique guidance data is representative of whether the user is operating within or outside of the predefined range.

In an embodiment the predefined range is additionally determined based on user profile data.

In an embodiment the method further comprises outputting at least one of a visual, tactile and audible indication relating to whether the user is operating within or outside of the predefined range.

In an embodiment the method further comprises outputting at least one of a visual, tactile and audible indication of how the user's technique could be improved based on the evaluation.

In an embodiment the method further comprises generating the movement data from sensor data output by a sensor arrangement which is configured to sense data related to the one or more parameters.

In an embodiment the sensor arrangement is configured to output at least one of the following types of sensor data: (a) data representative of weights being manipulated by the user in performing the exercise; (b) data representative of a type of exercise equipment being manipulated by the user; (c) data representative of a movement profile for the user and/or exercise equipment.

In an embodiment the sensor arrangement comprises at least one of an accelerometer and gyroscope for generating the movement profile data.

In an embodiment the sensor arrangement comprises a first sensing means connected to the exercise equipment which is configured to store and output the data representative of the weight value(s) and/or type of exercise equipment. In an embodiment the first sensing means is an RFID tag.

In an embodiment the method further comprises automatically determining the exercise based on an evaluation of the movement profile data.

In an embodiment the sensing arrangement is electronically communicable with and/or provided by an electronic device which is operable to store the sensor data.

In an embodiment the electronic device includes a processor for generating the movement data and carrying out the real time evaluation of the movement data and technique data, the subsequently determined guidance being output via a display, speaker and/or vibration motor provided by the electronic device.

In an embodiment the electronic device is electronically communicable with a remote device for provision of the sensor data and wherein the remote device includes a processor for carrying out the real time evaluation of the movement data and technique data.

In an embodiment the remote device is a smartphone and wherein the guidance data is output via at least one of a display, speaker and vibration motor implemented by the smartphone.

In an embodiment the exercise is manually selectable from a list of predefined exercises through a menu provided by the electronic device/smartphone.

In accordance with a second aspect there is provided an apparatus for providing technique guidance to a user performing an exercise, the apparatus comprising: an electronic device comprising a processor which is arranged to: determine movement data associated with a movement of a user and/or exercise equipment manipulated by the user; determine an exercise being performed by the user which is associated with the physical movement; determine correct technique data associated with the determined exercise; and output technique guidance data in real time, the real time guidance data being determined based, at least in part, on an evaluation of the movement data and the correct technique data.

In an embodiment the movement data comprises a value for one or more parameters related to the movement.

In an embodiment the parameters comprise any one or more of the following: (a) a number of repetitions and/or sets of the movement; (b) a speed at which the movement is being carried out by the user; (c) a time that the user is performing the movement; (d) a time that the user is under load and/or tension when performing the movement; (e) a musculo-skeletal loading for the user; (f) an amount of energy being expended by the user; (g) a load distribution.

In an embodiment the technique data comprises a predefined value range associated with each parameter(s) and wherein the technique guidance data is representative of whether the user is operating within or outside of the predefined range.

In an embodiment the predefined range is additionally determined based on user profile data.

In an embodiment the electronic device is configured to output a visual, tactile and/or audible indication of whether the user is operating within or outside the predefined range.

In an embodiment the electronic device is configured to output at least one of a visual, tactile and audible indication of how the user's technique could be improved based on the evaluation.

In an embodiment the apparatus further comprises a sensor arrangement which is configured to sense relevant parameters associated with the movement and output sensor data, the processor being arranged to determine the movement data from sensor data.

In an embodiment the sensor arrangement is configured to output at least one of the following types of sensor data:
(a) data representative of weights being manipulated by the user in performing the exercise;
(b) data representative of a type of exercise equipment being manipulated by the user;
(c) data representative of a movement profile for the user and/or exercise equipment.

In an embodiment the sensor arrangement comprises an accelerometer and/or gyroscope for generating the movement profile data.

In an embodiment the sensor arrangement comprises a first sensing means connected to the exercise equipment which is configured to store and output the data representative of the weight value(s) and/or type of exercise equipment.

In an embodiment the first sensing means is an RFID tag.

In an embodiment the processor is further operable to automatically determine the exercise based on an evaluation of the movement profile data.

In an embodiment the sensing arrangement is electronically communicable with and/or implemented by the electronic device for receiving the sensor data.

In an embodiment the exercise is manually selectable from a list of predefined exercises through a menu provided by the electronic device.

In accordance with a further aspect of the invention there is provided a method for providing technique guidance to a user performing an exercise, the method comprising:

evaluating signals output from one or more physiological sensors worn by the user for determining movement data associated with a movement of a user and/or exercise equipment manipulated by the user;

determining an exercise being performed by the user which is associated with the physical movement;

determining correct technique data associated with the determined exercise;

outputting technique guidance data to the user in real time, the real time technique guidance data being determined based, at least in part, on an evaluation of the movement data and the correct technique data.

In accordance with yet another aspect there is provided a computer program including at least one instruction which, when implemented by a processor of a computing apparatus, causes the computing system to implement the method steps as described in accordance with the first or second aspects.

Brief Description of the Drawings

Features and advantages of the present invention will become apparent from the following description of embodiments thereof, by way of example only, with reference to the accompanying drawings, in which;

Fig. 1 is a schematic illustration of a system for carrying out embodiments of the present invention;

Fig. 2 is a schematic of the portable electronic device shown in Figure 1;

Fig. 3 is a process flow diagram according to an embodiment; and

Figure 4 is a diagram illustrating example movement profile waveforms.

Detailed Description of an Embodiment

Embodiments of the present invention find particular application in the fitness industry and more particularly for providing technique guidance in respect of weight training exercises. Accordingly, embodiments will hereafter be described in such a context. However, it will be understood that embodiments are not so limited and may be applicable for providing technique guidance, and overall training feedback, for any exercise or exercise regime that can be performed by a user. For example, embodiments may be applicable for providing technique guidance on sporting activities (e.g. cycling, running, rowing, etc.), gymnasium workouts, physiotherapy routines, among others.

With reference to Fig. 1, there is shown a schematic of a system 100 in accordance with a particular embodiment.

The system 100 comprises a wearable electronic device 102 which is wearable by a user performing a physical exercise during a training session or "workout" in a gymnasium 103 (although, as mentioned above, it will be understood that the device 102 could be operable in any environment where an exercise is being performed). According to the illustrated embodiment, the wearable electronic device 102 is worn on the wrist of the user and includes a display device in the form of an LCD/LED for visually outputting technique guidance information. The electronic device 102 also includes a speaker and a vibration motor which may additionally or alternatively be used for outputting audible and tactile technique guidance information, respectively.

With additional reference to Figure 2, the electronic device 102 includes various sensors, including a tri-axis accelerometer 109, tri-axis gyroscope 111, optical heart rate monitor 113, pulse oximeter 115, GPS sensor 117 and blood pressure/volume sensor 119for selective use in determining movement data, as will be described in more detail in subsequent paragraphs. The electronic device 102 is powered by a rechargeable battery.

The electronic device 102 comprises a number of internal modules which are implemented under the control of a processor 120, based on program code stored in memory 122. As shown in Figure 2, the processor 120 implements a timing module 124 for outputting timing related information (e.g. date, time, etc.); a communication module 126 for facilitating communication with remote devices/sensors; and an evaluation module 128 for determining technique guidance

information. It will be understood that the modules may be implemented as software, hardware or a combination of the two, depending on the desired implementation.

In more detail, the evaluation module 128 is programmed to evaluate correct technique data (stored in memory 122) and movement data for a movement of the user and/or exercise equipment being manipulated by the user when performing an exercise, to determine real time technique guidance information. The movement data may be derived from a number of sources, including from any one or more of the integrated movement sensors 109/111/113/115/117/119, as well as from data output by remote movement sensors, monitoring devices and equipment tags.

According to the illustrated embodiment the movement data comprises values for any one or more of the movement related parameters:

(a) a number of repetitions of the movement;

(b) a speed at which the movement is being carried out by the user;

(c) a time that the user is performing the movement (which can be further analysed to determining time and power output in both concentric and eccentric phase);

(d) a time that the user is under tension when performing the movement;

(e) a total weight being lifted or manipulated by the user;

(f) a musculo-skeletal loading for the user;

(g) an amount of energy being expended by the user;

(h) a load distribution;

(i) an acceleration profile;

(j) a deceleration profile;

(k) total quantification of workload;

(l) movement profile or waveform; and

(m) one repetition maximum (1RM)

By way of example, for a weight lifting exercise being performed by the user, the values for (a) and (b) may be derived from data output by the gyroscope/accelerometer 109/111 integrated into the portable electronic device 102, as will be described in more detail in subsequent paragraphs. Alternatively, or in addition, the number of repetitions can be determined by evaluating an output of the blood pressure/volume sensor 119. According to the illustrated embodiment, the sensor 119 takes the form of a wearable photoplethysmographic (PPG) optical sensor. The optical sensor 119 is located on the inside of the electronic device 102 in direct

contact to the user's skin. In this manner, the sensor 119 is operable to non-invasively detect changes in a user's blood volume (which is directly related to blood pressure) in vascular tissue, using well understood techniques. The present inventor has realised that spikes in blood pressure/volume during a workout may correlate to individual repetitions of an exercise (where the peak of the spike correlates to a maximum effort expended during the repetition). Thus, each spike detected by the optical sensor 119 can be determined by the electronic device 102 as representing a single repetition. Using the optical sensor 119 to determine repetitions may be advantageous where there is no arm movement required to complete the exercise (i.e. such that the sensors 109/111 on the wrist worn device 102 are unable to pick up any recognisable movement profile).

The sensor 119 output may also be processed to determine if the user is exerting themselves too much during certain exercises, by referencing a pre-programmed safe blood pressure level (stored in memory 122) for that particular exercise and/or user. The sensor 119 output could also be evaluated to determine the user's breathing rhythm, which can provide an indication of whether the user is applying a correct technique (e.g. is the client holding their breathe too long during any lift thereby excessively increasing their blood pressure during the exercise). It will be understood that any blood pressure/volume sensor 119 operable to detect a user's blood pressure/volume could be utilised and should not be seen as being limited to a PPG sensor as described herein.

The values for (c) and (d) may additionally be derived by evaluating both the output signals from the accelerometer 109 in a particular plane and a clock signal output from the timing module 124 at a relevant time (e.g. when the electronic device 102 recognises that the user has started/stopped a physical movement based on an evaluation of data output from the gyroscope/accelerometer, etc.). It will be understood by persons skilled in the art that the concentric and eccentric phases are recognisable by determining a certain acceleration/deceleration profile in a particular plane. By way of example, for a bicep curl, the electronic device 102 may be programmed to recognise concentric phase when the z-axis output from the accelerometer 109 records a positive acceleration and eccentric phase when, for the same axis, a negative acceleration is determined.

The total weight (e) is determined through communication with an equipment-side device 130 (hereafter equipment tag 130) which is connected to exercise equipment 132 being manipulated by the user. It will be understood that the exercise equipment 132 may include free weights,

exercise machines, sport equipment (e.g. tennis rackets, bicycles, punching bags), or any equipment that is capable of being manipulated by a user in order to perform a physical exercise.

In a particular embodiment, the equipment tag 130 is a radio frequency RF tag coupled to the equipment-side device which encodes its weight value (e.g. 10kgs) and which can be interrogated by the electronic device 102 using short range wireless/RF communication techniques (e.g. RFID, Bluetooth, etc.) which are well understood in the art. The electronic device 102 may be configured to only interrogate equipment tags 130 that are within some predefined close range, so as to avoid interrogating tags on equipment that is not being manipulated by the user.

In a particular embodiment a microcontroller is communicable with both the equipment tag 130 and an accelerometer mounted on the equipment so as to determine whether the tag 130 is being moved. If a positive determination is made, the microcontroller may then enable the tag 130 to communicate with the electronic device 102, e.g. by energising the tag 130 or using other techniques that would be well understood by persons skilled in the art. A proximity sensing arrangement (e.g. as described above) may also be used such that the tag 130 will only communicate with an electronic device 102 when it is both within communicable range of the electronic device 102 and is being moved by the user. It will be understood that the tag 130 could also use the accelerometer to determine movement data that is communicable to the electronic device 102 for use in evaluating the user's technique.

In an alternative embodiment, the electronic device 102 employs an RF communication protocol (e.g. Bluetooth Low Energy, BLE communications protocol) to communicate with the equipment tags 130 (i.e. via appropriate communication circuitry implemented by the microcontroller). According to such an embodiment, where multiple equipment tags 130 are within communicable range of the device 102, the user may be asked to confirm which one or more associated items of equipment they are manipulating as part of the exercise (e.g. via a menu provided on the display of the electronic device 102).

It will be understood that the equipment tags 130 may store/encode other movement related information, including identifying information to assist with the above menu selection (e.g. 10kg barbell, 20kg dumbbell, etc.), as well as for use in determining suitable technique guidance information. It will also be understood that short range wireless communication

techniques other than Bluetooth and RFID may be employed for communication with the equipment tags 130, depending on the desired implementation.

For movement parameter (f), the loading is calculated by working out the G-forces applied to the user's body using the output from the accelerometer 109 and the weight of the user (e.g. pre-programmed into the device 102) and/or equipment being manipulated (entered by the user or determined from a communication with an equipment tag 130, as discussed above). This data may be broken down into a loading for particular periods (e.g. day/week/month) for subsequent evaluation, as will be described in more detail in subsequent paragraphs.

For parameter (g), an evaluation is made of any acceleration/deceleration measurements to calculate calories/kilojoules expended by the user using techniques known to those skilled in the art. By way of example, one algoritm that may be utilised for making the calculation is described in a paper entitled "An Experimental Study in Determining Energy Expenditure from Treadmill Walking using Hip-Worn Inertial Sensors" (see URL: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3179538/), the contents of which are incorporated herein by reference.

For movement parameter (h), the electronic device 102 may be programmed to determine how the user is loading one body part relative to another, based on any one or more sensor outputs. Parameters (i) and (j) are simply determined by evaluating outputs from the accelerometer 109, as will be understood by persons skilled in the art.

For movement parameter (k), as used herein, the term "total quantification of workload" will be understood as referring to the combination of the following parameters: weight lifted per exercise, range of motion per exercise (e.g. full range repetition or partial) and acceleration and/or deceleration profile of each exercise. The specific formulae and/or combination of parameters used in the formulae for calculating the quantification of workload may vary, depending on the desired implementation. In a particular embodiment, the user may select which parameters/formulae are relevant to the athlete/situation/sport. Alternatively the parameters/formula may be programmed by the electronic device 102 (i.e. for a particular athlete/situation/sport selected by the user, or automatically determined by the device). In addition, quantification of workload may take into consideration the rest time between exercises, which persons skilled in the art will appreciated has a bearing on the total workload (the less rest between sets the higher the perceived workload, i.e. weight lifted in a given time

period). By way of example two users may complete the same exercise but one moves the weight faster than the other which will result in a higher total workload. In another example, two users may complete the same training routine with one completing it in 20% shorter time than the other which will result in that user recording a higher total workload. As a further example, two users may complete the same weight training exercise with one using a deeper range (thus moving the weight through a longer path) which will result in that user recording a higher total workload.

For movement parameter (l), movement profiles may be determined based on the data output from the gyroscope 111 and/or accelerometer 109. In a particular embodiment, the data from each axis is plotted (over some predefined period of time) so as to generate respective waveforms which are characteristic of the movement profile. The waveforms can advantageously be compared against pre-stored waveforms for automatically determining which exercise a user is performing and/or determining appropriate user feedback. With reference to Figure 4, there are shown three example waveforms A, B, C generated from data output from respective axis of the gyroscope 111. In the illustrated example, a user has carried out 10 repetitions of four different exercises in sequence. As can be seen, for each of the four exercises (denoted by sections 402, 404, 406 and 408) their shown a distinct waveform profile for each axis.

For movement parameter (m), 1RM will be understood by persons skilled in the art as being the maximum amount of force that can be generated in one maximal contraction. This data can advantageously be used by the electronic device 102 to predict a user's upper limit for an exercise, without the user having to actually attempt their maximum (which can result in injury, particularly in the absence of an experienced training partner). In a particular embodiment 1RM can be determined from an evaluation of a user's acceleration profile during lifts approaching maximum. Evaluating the 1RM over time can also advantageously be used to measure improvement in strength training. By way of example, a user may have a maximum bench press lift in the bench press of 100kg. To lift maximally regularly is dangerous as overload and injury can occur. According to embodiments described herein, the acceleration profile of the bar being lifted can be recorded and over time changes in the profile (i.e. as weight is increased) can be used to predict the 1RM maximum during the repetitions being completed would change as the weight reaches maximal. An increased 1RM prediction may be made, for example, where the data shows that the user is demonstrating greater speed/control at higher lift loads.

It will be understood by persons skilled in the art that the movement data may include data derived from any suitable physiological sensing and/or positioning device, depending on the physical exercise and the type of technique guidance to be provided to the user. It will also be understood that any combination of the above movement parameters could be used to determine a holistic movement profile for the user, which is then evaluated for providing real time technique guidance, whether it be a change in performance (good or bad), with appropriate real time feedback being output by the device 102 (e.g. stop or change technique due to fatigue, decrease in strength, imbalance in strength, etc).

As previously mentioned, the electronic device 102 is configured to retrieve correct technique data from its internal memory 122 which is relevant to an exercise being performed by the user. According to embodiments described herein, the correct technique data comprises a range of values for each movement parameter to be evaluated in the technique guidance processing calculation, with the values being representative of a correct or desirable technique for the corresponding exercise. In a particular embodiment, the ranges may be further classified based on user profile data (e.g. age, sex, weight, height, etc.) and goal type (e.g. muscle building, weight loss, injury recovery, etc.), which the user enters into the electronic device 102. For example, the correct number of sets and repetitions for a particular exercise for a user aged between 15 and 30 years of age who is aiming to build muscle may be different than for a user aged over 70 aiming to lose weight.

In a particular embodiment, the electronic device 102 may automatically determine the particular exercise being performed by the user based on an evaluation of the movement profile for the exercise they are performing (e.g. determined from any one or more of the sensor 109/111/113/115/117 outputs, or from some external sensor output which is representative of a movement of the user/exercise equipment).

In a particular embodiment, this involves comparing waveform profiles (determined from sensor outputs as previously discussed) against waveform profiles corresponding to known exercises stored in memory 122. An example automated recognition process will now be described, in this case utilising outputs from both the tri-axis accelerometer 109 and tri-axis gyroscope 111 (although it will be understood that for some exercises only one of these sensors may need to be employed). In a first step, data output by the sensors 109, 111 is filtered to remove noise/inaccuracies. For example, the electronic device 102 may employ a Kalman filter to the output data. In a second step the filtered data is processed by the processor 120 of the

electronic device 102 to generate respective waveforms for all six axes. In a third step, the electronic device 102 runs a pattern matching algorithm to determine whether the waveforms match waveforms associated with any one or more pre-programmed exercises stored in memory 122. In a particular embodiment, the pattern matching algorithm may implement a vector analysis for determining like waveforms. It will be understood that for some exercises not all axis will output meaningful data and thus in some instances only some of the waveforms need to be matched for positively determining an exercise that the user is undertaking. It will also be understood that waveforms generated from data output by other electronic device sensors may additionally or alternatively be evaluated as part of the pattern matching process.

Alternatively, the exercise can be manually entered by the user, e.g. by selecting the exercise from a list of recognisable exercises programmed into the electronic device 102. If the exercise is not listed (or the automated determination did not recognise the exercise being undertaken by the user), the user is given the opportunity to create a new exercise movement profile. This involves the device 102 prompting the user to complete the exercise with the correct technique. The user may be asked to complete the exercise multiple times to ensure accurate movement profile data. The data from each movement sensor relevant to the exercise (which the user is asked to confirm) is captured while the user is undertaking the exercise. The user is then asked to input a name for the exercise and this exercise will then become part of their individualised training routine. In a particular embodiment the newly captured exercise data is also forwarded to a remote system (using techniques described in subsequent paragraphs) for review and if the movement profile parameters are acceptable the system database will be updated with the new exercise. If the parameters are not acceptable, then the system may modify the parameters (before updating the database) or simply ignore the new data.

During a workout, the electronic device 102 is operable to provide the user with real time guidance on their technique. In a particular embodiment this involves the evaluation module 128 continuously determining whether the movement parameter values relevant to the exercise are within the corresponding ranges prescribed by the correct technique data. Importantly, the evaluation module 128 will immediately output (i.e. in real time) an indication to the user as soon as it determines that one or more of the evaluated movement parameter values are outside the prescribed range. The indication may alert the user that their technique has faltered, that they have exhausted a particular muscle group, or any other desirable guidance in relation to their technique. The indication may take the form of an audible, visual or tactile (e.g. haptic) indication, depending on the desired application. In this regard it will be understood

that pre-programmed indications relevant to each exceeded movement parameter will be stored by the electronic device 102 so that the user is specifically aware of what they are doing incorrectly. At the end of the exercise, the user may be automatically shown coaching tips (e.g. images or short videos) on the display highlighting the technical focus the client needs to have for the next set to ensure that they complete the exercise correctly (i.e. selected based on the particular parameter values that were exceeded). Below are some example indications that may be provided to a user in relation to a number of different exercises:

Bench-press using barbells -

The movement parameters for this exercise may be set with small variation if the electronic device 102 starts to determine too great an increase in the eccentric phase (meaning the user is dropping the barbells too fast to the chest), or the user is generating too much lateral movement during each lift (as determined based on an evaluation of the accelerometer 109 outputs and correct technique data), which may indicate poor technique and that fatigue is starting to set in. An audible, tactile and/or visual indication is provided to the user to indicate that it is time to stop the exercise or take a rest.

Squats -

If values for the forward/backward plane (i.e. determined based on outputs from the accelerometer 109) during the exercise start to increase beyond the acceptable range (i.e. indicative of poor technique/fatigue), then the electronic device 102 outputs an audible, tactile and/or visual indication to the user that it is time to stop the exercise or take a rest. If the electronic device 102 determines that the user is moving too laterally during the up or down phase (i.e. indicative of the user favouring one leg over the other and potentially increasing the chance of injury or over use injury to one leg), then equally the device 102 outputs and indication to the user that it is time to stop or take a rest.

Lateral pull-downs -

If the speed of either the concentric or eccentric phase changes, is too fast, or if the users starts getting excessive lateral or extraneous movements throughout the main movement planes then the electronic device 102 is programmed to provide an indication to the user.

It will be understood that all exercises will have similar technical faults, speed issues, lateral/forward/backward excessive movements, etc. which can be evaluated by the device 102 for providing real time technique guidance.

During or post workout the user may also access an overview screen on their electronic device 102 which provides a summary of the total workout time, quantification of workout load (kgs/lbs/tons) and exercises performed during the workout (including total repetitions and sets). The user can choose to see a more detailed report on their performance by clicking an "advanced" button. The detailed report includes an:

"individual exercise report" showing:
A small image of the exercise
Number of repetitions/sets completed – which may be broken down by total load, intensity, tempo, total time per set, time between sets
Percentage weight improvement score.

"grouped exercise report" showings:
Group type (e.g. chest exercises, back exercises, arm exercises, leg exercises, core exercises, etc.)
Group percentage/weight improvement score. E.g. based on total weight lifted, number of repetitions completed, etc.

"training imbalances"
alerts the user if they are carrying out too much or too little work on a particular body part (e.g. front, back, upper, arms, lower body). This may be determined by periodically evaluating logged movement parameter values (e.g. time, weight, etc.). For example, the evaluation may result in the user being alerted to the fact that they are spending too much time doing a bench press exercise and not enough time performing seated pull-downs, rows, or the like to balance this muscle group.

In an alternative embodiment to that described above, the electronic device 102 may be operable to communicate with a smartphone (or other personal "smart" device, e.g. tablet, PDA, etc.) operated by the user, which in turn is operable to output any of the afore-described technique guidance information (i.e. in audible, visual and/or tactile form) and detailed report information. The smart device may implement a software program (e.g. an application downloadable to the smartphone) which implements computer code for allowing the smartphone to communicate with the electronic device 102 (i.e. using any one of the aforementioned wireless communication techniques). According to the illustrated embodiment, the smartphone is in the form of an Internet-enabled smartphone, such as the Google Nexus 3G

mobile handset. The handset is equipped with the necessary hardware and software to communicate with both the electronic device 102 and apparatus 140.

In one particular embodiment, the electronic device 102 may stream some or all of the relevant movement data, user data, goal data, etc. to the smartphone to enable it to perform the real time technique guidance evaluation (i.e. under the control of the resident application). According to such an embodiment the electronic device need not implement a display, thereby allowing it to take a much smaller form. Also, since all of the data evaluation is being performed by the smartphone, the electronic device 102 can implement a less powerful processor, thereby improving battery life.

In yet another embodiment, the electronic device 102 may be configured to provide limited real time feedback (e.g. a vibration or sound which is representative of the fact that the exercise is being performed poorly and should be terminated and which vibration/sound may continue until the user has regained the proper technique), while the smartphone provides the user with predefined information on how the technique may be improved, including visual and/or audible coaching tips (technique comment, reduce weight, change speed, etc). The user can then conduct the next set with the new technique information and the cycle is repeated until they are able to complete the exercise program or terminate it due to poor technique.

Returning again to Figure 1, there is shown a remote storage and evaluation apparatus 140. According to the illustrated embodiment, the apparatus 140 takes the form of cloud storage and evaluation application which is accessible by way of a communications network 116 in the form of the Internet. The electronic device 102 includes wireless circuitry which allows it to communicate with the apparatus 140, e.g. via a local wireless hotspot 118 (i.e. provided in the gymnasium 111), which is in turn connected to the apparatus 140 via the Internet 116. The smartphone is also communicable with the apparatus 140 via the hotspot 118 or alternatively may communicate via a mobile phone network (not shown). In an alternative embodiment, the apparatus 140 may be implemented by the gymnasium or the like such that the data can be streamed directly to the apparatus 140 (i.e. without needing to be routed over the Internet).

The movement data, user profile data and goal data for the user is periodically communicated to the apparatus 140 for logging, either directly by the electronic device 102 or indirectly by way of the smartphone. The apparatus 140 is programmed to evaluate the data against predefined correct training data to provide a holistic determination of the user's training regime, including,

for example, whether the user trained for long enough and hard enough over a particular period, whether the exercises they performed where appropriate for their training goal and whether there is any potential for injury based on their performance. It will be understood that the evaluation may take into consideration both current and historical logged data, depending on the holistic performance parameter(s) being evaluated. The apparatus 140 communicates back to the user, via the device 102 or smartphone, an overview of their performance, together with holistic guidance information.

- Advice on exercise type, reps, sets, tempo, recovery time between sets and exercises;
- Advice on symmetry of training – suggestions on more of X, Y, Z based on historical training data;
- Advice on periodization of the client's training – days/week, loading cycles, Easy/Medium/Hard/Recovery cycle options;
- Advice on lifting technique (how your "typical" technique changes through daily/weekly/cycle fatigue);
- Advice on nutrition based on your individualized training results;
- Advice for different ages/training backgrounds, sex, etc.
- Advice based on the user's goals (e.g. strength, mass, power, symmetry, leanness, injury rehab, etc.)
- Risk alerts indicating that the client has done too much of an exercise (or too intense) and there is risk of future injury if done within a calculated number of days.

In a particular embodiment, the apparatus 140 is programmable to provide advice on prehabilitation/rehabilitation exercises which are most suited to the user's age, background, training goals, injury status, etc. For example, the apparatus 140 may determine that a user is spending a lot of time bench pressing (which is determined to be a pushing exercise) and recommends not only that the user do more pulling exercises but also recommends that 1-2 days per week that they complete some rotator cuff exercises for shoulder stability, stretching, massage, etc to keep the shoulder complex balanced, flexible, mobile, etc.

Either or both of the electronic device 102 and apparatus 140 may be programmed to measure and provide feedback on a user's mobility/stability. There is significant research highlighting that a decrease in mobility/stability increases the likelihood of falling over (typically in the over 65 age bracket), leading to hip/leg breaks, hospitalisation and ultimately many of the elderly

never fully recover being either bed/wheelchair ridden or develop further complications that may result in an early death.

Such an embodiment takes advantage of the fact that each person has a distinctive walking pattern which may, for example, be made up of at least one of the following parameters: gait symmetry, gait length, stationary stability, stability walking up/down stairs, hills, backwards, sideways, etc. In a particular embodiment, the device 102 utilises its inertial sensors (i.e. accelerometer 109 and gyroscope 111) to generate a three dimensional picture of the user's distinctive movement pattern. The device/apparatus 102, 140 can advantageously be programmed to store the user's movement pattern as correct technique data, and output an alert whenever a subsequent evaluation of their movement pattern (e.g. as determined from the inertial sensors) shows a deviation this pattern. In this manner, the user may be alerted to the fact that their overall mobility/stability has deteriorated thereby providing a form of early warning for individuals that may be at risk of injury. The alert could also potentially detect a change in the user's weight which could be detrimental to the user. For example, where the deviation is indicative of a weight loss in an older user, the alert could serve to warn the user that they are potentially loosing muscle mass which can increase their risk of injury (due to a potential decrease in stability). An increase in weight, as determined from the movement profile evaluation, could trigger the apparatus to alert the user that they should improve their diet, increase exercise, etc..

It will be appreciated that the device/apparatus 102,140 may be programmed to output an alert only in response to determining a deviation (either instantaneous, or over some predefined time period) which exceeds some predefined threshold amount for the relevant movement pattern parameter(s). Further, in a slightly alternative embodiment, the correct technique data may additionally or alternatively be programmed with data representative of a walking pattern or general mobility that is desirable for a user of that age and/or sex (i.e. as opposed to a pattern corresponding to their normal/distinctive walking pattern).

It will also be appreciated that a device/apparatus 102/140 programmed in the above manner may also be advantageously used for assisting users that have sustained an injury or undergone a medical procedure (e.g. to their limbs/hip/back) in attaining a pre-injury/procedure stability pattern, through the output of suitable guidance information. Further, the data recorded by the device/apparatus could be used to measure the stability of the environment that the user is moving in, with the ability to generate a "Stability Rating" for environments that the user is

regularly operating within. This rating may, for example, be used by a health professional to suggest the client challenge themselves regularly on certain difficult terrain (research has also shown that by challenging your stability function you can improve it over time at any age). For example, take an older male user. The professional may recognise that for such a user it is important that they challenge their proprioception/stability by walking on surfaces other than flat, smooth surfaces (as is typically what we are all exposed to nowadays). In a particular embodiment a rating system is applicable for different surfaces (e.g. 0 for concrete, tiles or floorboards; 1 for walking on a grassy oval; 2 for walking on a dirt road/path; 3 for walking on a hiking trail, etc.). The health professional may suggest that the user record, say, 10 stability points over some set time period (e.g. achieved by the user tackling tracks/paths/walks around the user's home that have the above ratings). If the user is recognised as being particularly unstable, the professional may set a lower stability point score to be achieved by the user for the time period to avoid injury. In a particular embodiment, the device/apparatus may automatically determine an activity that the user is performing (using techniques as described herein) and a corresponding rating for the surface that they are currently traversing. More particularly a GPS unit fitted to the device may record a user's current location. A database implemented by the apparatus 140 stores ratings for that location and can be accessed by the device 102 to determine a rating for a current located of the user, which is then recorded against the user profile. The database may be updated over time with ratings for previously unrecorded locations. In a particular embodiment, a user of the device 102 can select a rating for a current location not recorded in the database (via a suitable user device interface), which rating is then automatically uploaded to the apparatus for storing in the database.

Where a detailed view of the user's historical performance and guidance is required, the user may login to a dedicated user webpage provided by the apparatus 140, via a suitable computer browser. It will be understood that the apparatus 140 should not be seen as being limited to a cloud storage application. For example, the apparatus 140 may take the form of a local server computer accessible over a WAN, LAN, etc., which includes the appropriate processing power and storage capability to perform the holistic evaluation and tracking.

With reference to Figure 3 there is shown a basic process flow for providing technique guidance information to a user, using the system of Figure 1.

At step S1, the evaluation module 128 of the electronic device 102 determines an activity performed by the user. As previously stated, this may be determined automatically based on a user's movement profile or manually selected by the user.

At step S2, the evaluation module 128 retrieves from memory 122 correct technique data associated with the determined exercise, measurement parameters and any other relevant data (e.g. goal data, user profile data, etc.).

At step S3, the evaluation module 128 determines movement data (specifically one or more values for relevant movement parameters) associated with a movement of the user and/or equipment 132 manipulated by the user.

At step S4, the evaluation module 128 determines whether to output technique guidance information based on an evaluation of the movement parameter values and correct technique data. If the user requires guidance on their technique (based on the evaluation), a suitable notification is output via one or more of the display, speaker and vibration motor (step S5). If not, the evaluation module continues to monitor for changes in movement parameter values for determining (step S6).

It will be understood that the device 102 could implement any suitable physiological sensor or combination of sensors to determine movement data, depending on the real time technique feedback to be provided to the user. Additional sensors may include, for example, magnetometers, non-invasive skin patches operable to measure glucose, pH, Lactate levels, among others.

At the elite end of the spectrum, the device 102 will be able to evaluate the strength attributes of the elite athlete during key lifts, including:

a. Maximum strength
b. Speed Strength
c. Reactive Strength (e.g. ground reaction time during plyometric training).
d. Strength endurance
e. Power profiles

This device 102 may be highly effective in the dynamic environment of a circuit class where there is no time to pre-select exercises; users can simply jump from one exercise to the next

with minimal or no rest and the device/apparatus records all exercises for the session – providing total exercises, reps, sets, loads, intensity, heart rate measurements.

In a particular embodiment the device 102 may additionally implement or be communicable with a blood pressure sensor for recording a user's blood pressure during a workout (i.e. as a measurement parameter value). It is known that Systolic blood pressure can raise well above 200mmHg and that breath holding is one of the factors that affects blood pressure during exercise. Thus, by evaluating blood pressure during the workout, (against stored correct technique data) the device 102 warn the user if they are breath holding too much, or indicate that the user shouldn't train at all if their blood pressure is too high to start with.

Embodiments described herein may advantageously provide automated detection of exercises and associated metrics; provide storage and programming of exercise routines for a user (past, present and future); and offer individualised virtual personal coaching/training tips/advice/modifications to ensure that the client continues to strive towards their goal(s).

While the invention has been described with reference to the present embodiment, it will be understood by those skilled in the art that alterations, changes and improvements may be made and equivalents may be substituted for the elements thereof and steps thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt the invention to a particular situation or material to the teachings of the invention without departing from the central scope thereof. Such alterations, changes, modifications and improvements, though not expressly described above, are nevertheless intended and implied to be within the scope and spirit of the invention. Therefore, it is intended that the invention not be limited to the particular embodiment described herein and will include all embodiments falling within the scope of the independent claims.

Furthermore, the functionality of various components, such as the electronic device 102, have been described as being performed by distinct devices/modules, such as dedicated integrated circuits. However, in preferred embodiments, all or any combination of their functionality is instead performed by multi-purpose integrated circuits or implemented in software executed on a microprocessor. Particularly in such cases, the invention is additionally embodied in a computer program or in a computer program in a data signal or stored on a data carrier

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprise" or variations such as "comprises" or "comprising" is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method for providing technique guidance to a user performing an exercise, the method comprising:

determining movement data associated with a movement of a user and/or exercise equipment manipulated by the user;

determining an exercise being performed by the user which is associated with the physical movement;

determining correct technique data associated with the determined exercise;

outputting technique guidance data to the user in real time, the real time technique guidance data being determined based, at least in part, on an evaluation of the movement data and the correct technique data.

2. A method in accordance with claim 1, wherein the movement data comprises a value for one or more parameters related to the movement.

3. A method in accordance with claim 2, wherein the parameters comprise any one of the following:

(a) a number of sets and/or repetitions of the movement;

(b) a speed at which the movement is being carried out by the user;

(c) a time that the user is performing the movement;

(d) a time that the user is resting;

(d) a time that the user is under load and/or tension when performing the movement;

(e) a musculo-skeletal loading for the user;

(f) an amount of energy being expended by the user;

(g) a load distribution.

4. A method in accordance with claim 2 or 3, wherein the correct technique data comprises a predefined parameter value range for each of the one or more parameters and wherein the technique guidance data is representative of whether the user is operating within or outside of the predefined range.

5. A method in accordance with claim 4, wherein the predefined range is additionally determined based on user profile data.

6. A method in accordance with claim 4 or 5, further comprising outputting at least one of a visual, tactile and audible indication relating to whether the user is operating within or outside of the predefined range.

7. A method in accordance with claim 6, further comprising outputting at least one of a visual, tactile and audible indication of how the user's technique could be improved based on the evaluation.

8. A method in accordance with claim 6 or 7, further comprising generating the movement data from sensor data output by a sensor arrangement which is configured to sense data related to the one or more parameters.

9. A method in accordance with claim 8, wherein the sensor arrangement is configured to output at least one of the following types of sensor data:
(a) data representative of weights being manipulated by the user in performing the exercise;
(b) data representative of a type of exercise equipment being manipulated by the user;
(c) data representative of a movement profile for the user and/or exercise equipment.

10. A method in accordance with claim 9, wherein the sensor arrangement comprises at least one of an accelerometer and gyroscope for generating the movement profile data.

11. A method in accordance with claim 9 or 10, wherein the sensor arrangement comprises a first sensing means connected to the exercise equipment which is configured to store and output the data representative of the weight value(s) and/or type of exercise equipment.

12. A method in accordance with claim 11, wherein the first sensing means is an RFID tag.

13. A method in accordance with any one of claims 9 to 12, further comprising automatically determining the exercise based on an evaluation of the movement profile data.

14. A method in accordance with any one of claims 8 to 13, wherein the sensing arrangement is electronically communicable with and/or provided by an electronic device worn by the user which is operable to store the sensor data.

15. A method in accordance with claim 14, wherein the electronic device includes a processor for generating the movement data and carrying out the real time evaluation of the movement data and technique data, the subsequently determined guidance being output via a display, speaker and/or vibration motor provided by the electronic device.

16. A method in accordance with claim 14, wherein the electronic device is electronically communicable with a remote device for provision of the sensor data and wherein the remote device includes a processor for carrying out the real time evaluation of the movement data and technique data.

17. A method in accordance with claim 16, wherein the remote device is a smartphone and wherein the guidance data is output via at least one of a display, speaker and vibration motor implemented by the smartphone.

18. A method in accordance with any one of claims 14 to 17, wherein the exercise is manually selectable from a list of predefined exercises through a menu provided by the electronic device/smartphone.

19. An apparatus for providing technique guidance to a user performing an exercise, the apparatus comprising:

a portable electronic device comprising a processor which is arranged to:

determine movement data associated with a movement of a user and/or exercise equipment manipulated by the user;

determine an exercise being performed by the user which is associated with the physical movement;

determine correct technique data associated with the determined exercise; and

output technique guidance data in real time, the real time guidance data being determined based, at least in part, on an evaluation of the movement data and the correct technique data.

20. An apparatus in accordance with claim 19, wherein the movement data comprises a value for one or more parameters related to the movement.

21. An apparatus in accordance with claim 20, wherein the parameters comprise any one of the following:

(a) a number of repetitions and/or sets of the movement;

(b) a speed at which the movement is being carried out by the user;

(c) a time that the user is performing the movement;

(d) a time that the user is under load and/or tension when performing the movement;

(e) a musculo-skeletal loading for the user;

(f) an amount of energy being expended by the user;

(g) a load distribution

22. An apparatus in accordance with claim 20 or 21, wherein the technique data comprises a predefined value range associated with each parameter(s) and wherein the technique guidance data is representative of whether the user is operating within or outside of the predefined range.

23. An apparatus in accordance with claim 22, wherein the predefined range is additionally determined based on user profile data.

24. An apparatus in accordance with any one of claims 22 or 23, wherein the electronic device is configured to output a visual, tactile and/or audible indication of whether the user is operating within or outside the predefined range.

25. An apparatus in accordance with any one of claims 22 to 24, wherein the electronic device is configured to output at least one of a visual, tactile and audible indication of how the user's technique could be improved based on the evaluation.

26. An apparatus in accordance with claim 24 or 25, further comprising a sensor arrangement which is configured to sense relevant parameters associated with the movement and output sensor data, the processor being arranged to determine the movement data from sensor data.

27. An apparatus in accordance with claim 26, wherein the sensor arrangement is configured to output at least one of the following types of sensor data:

(a) data representative of weights being manipulated by the user in performing the exercise;

(b) data representative of a type of exercise equipment being manipulated by the user;

(c) data representative of a movement profile for the user and/or exercise equipment.

28. An apparatus in accordance with claim 27, wherein the sensor arrangement comprises an accelerometer and/or gyroscope for generating the movement profile data.

29. An apparatus in accordance with claim 27 or 28, wherein the sensor arrangement comprises a first sensing means connected to the exercise equipment which is configured to store and output the data representative of the weight value(s) and/or type of exercise equipment.

30. An apparatus in accordance with claim 29, wherein the first sensing means is an RFID tag.

31. An apparatus in accordance with any one of claims 27 to 30, wherein the processor is further operable to automatically determine the exercise based on an evaluation of the movement profile data.

32. An apparatus in accordance with any one of claims 26 to 31, wherein the sensing arrangement is electronically communicable with and/or implemented by the electronic device for receiving the sensor data.

33. An apparatus in accordance with any one of claims 27 to 30, wherein the exercise is manually selectable from a list of predefined exercises through a menu provided by the electronic device.

34. A method for providing technique guidance to a user performing an exercise, the method comprising:

evaluating signals output from one or more physiological sensors worn by the user for determining movement data associated with a movement of a user and/or exercise equipment manipulated by the user;

determining an exercise being performed by the user which is associated with the physical movement;

determining correct technique data associated with the determined exercise;

outputting technique guidance data to the user in real time, the real time technique guidance data being determined based, at least in part, on an evaluation of the movement data and the correct technique data.

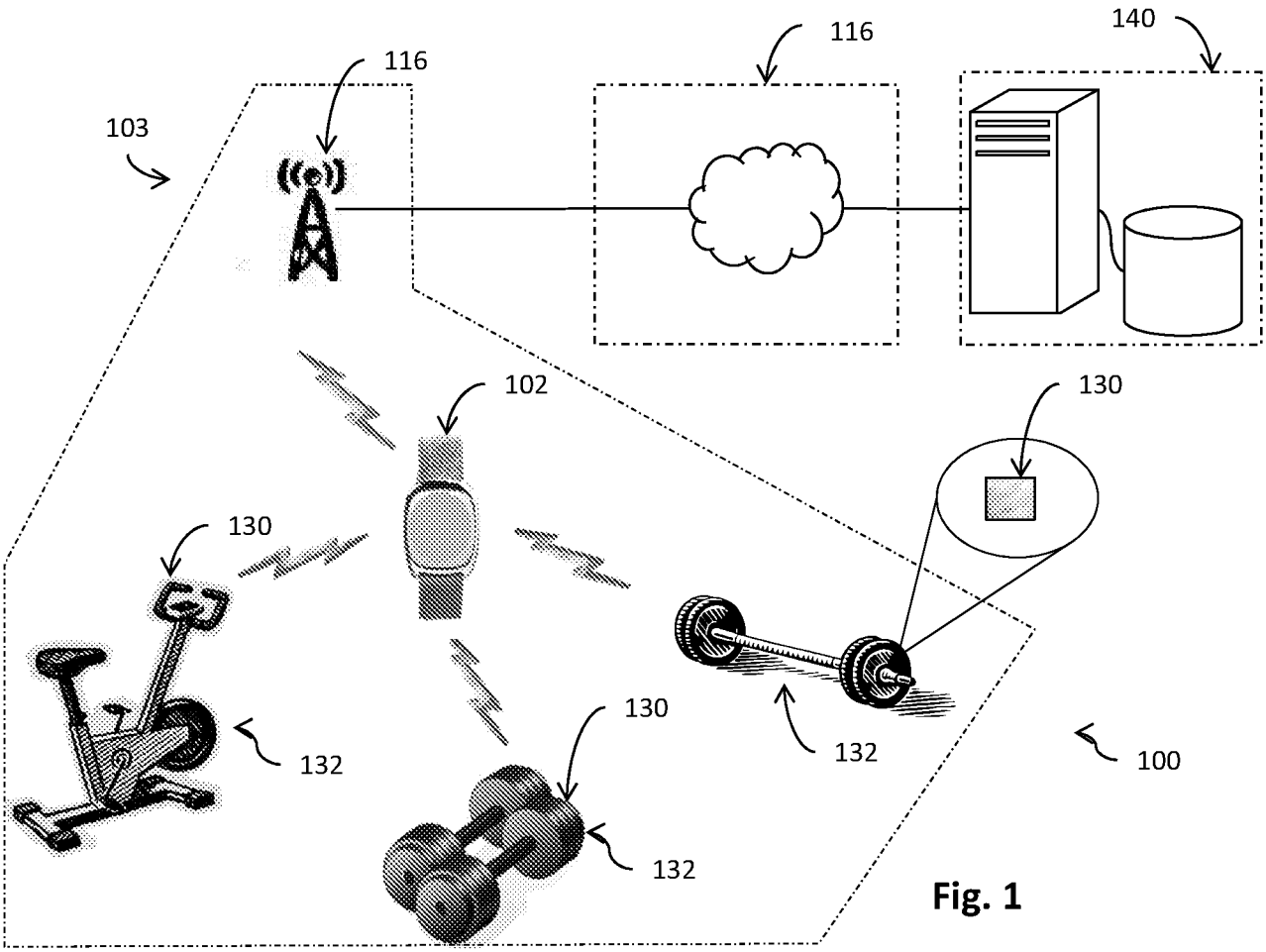
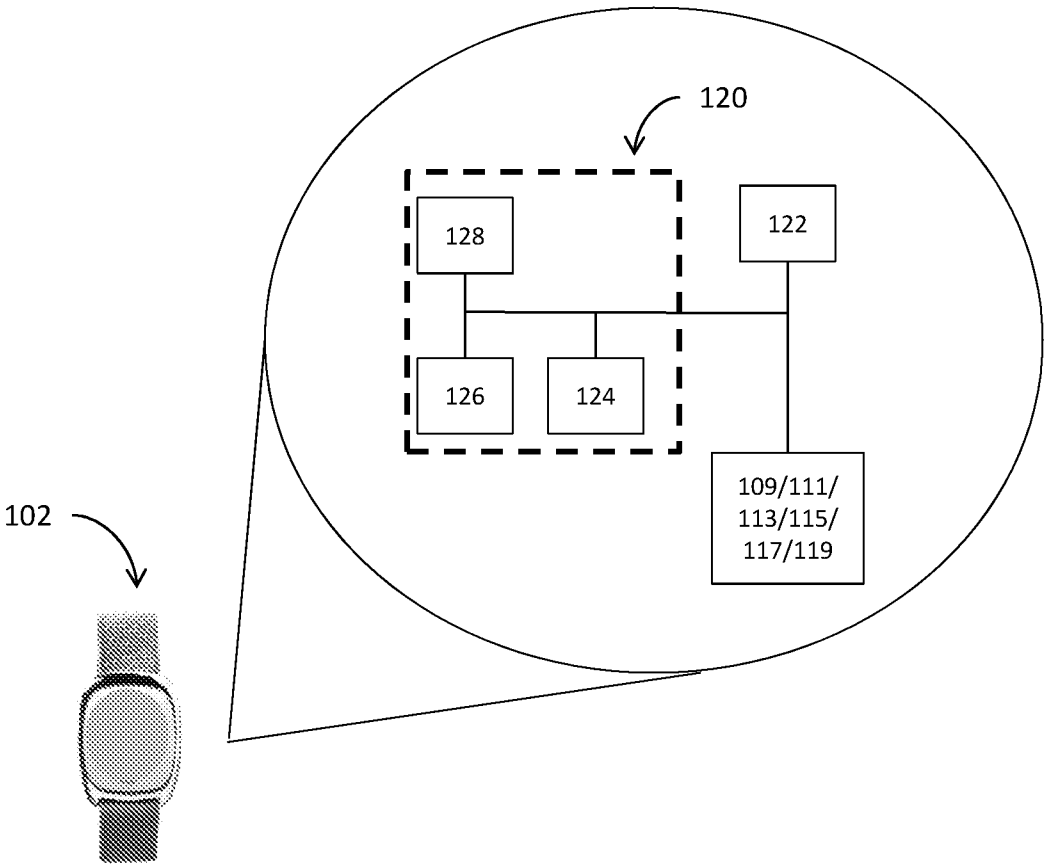


Fig. 1


120
128
122
126
124
109/111/
113/115/
117/119
102

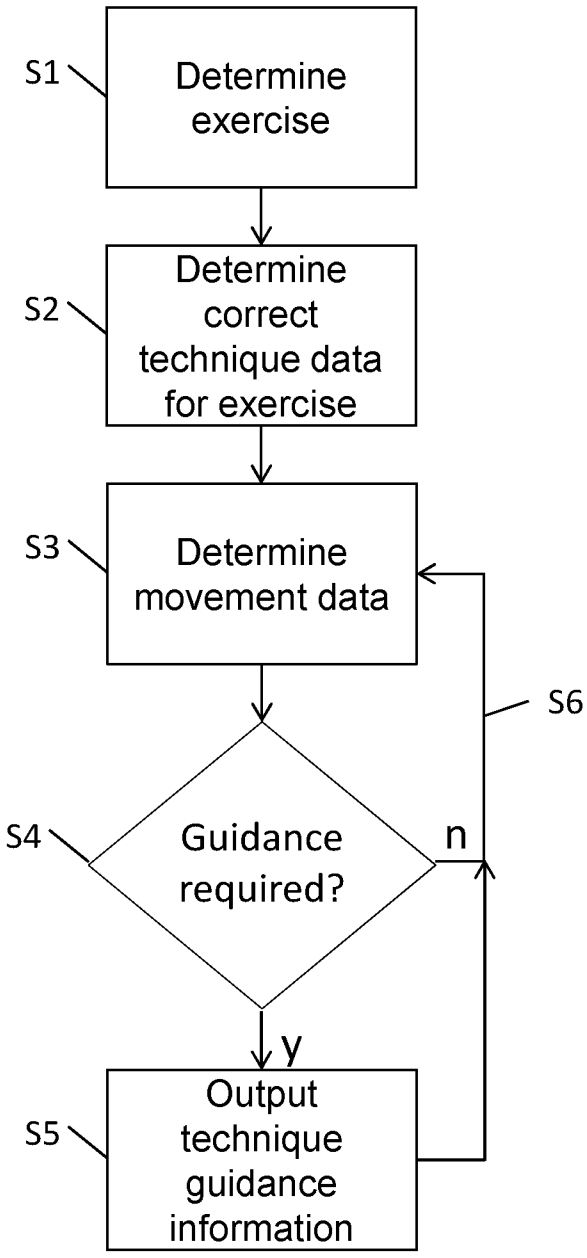

S1
Determine exercise
S2
Determine correct technique data for exercise
S3
Determine movement data
S4
Guidance required?
n
S6
y
S5
Output technique guidance information

Fig. 3

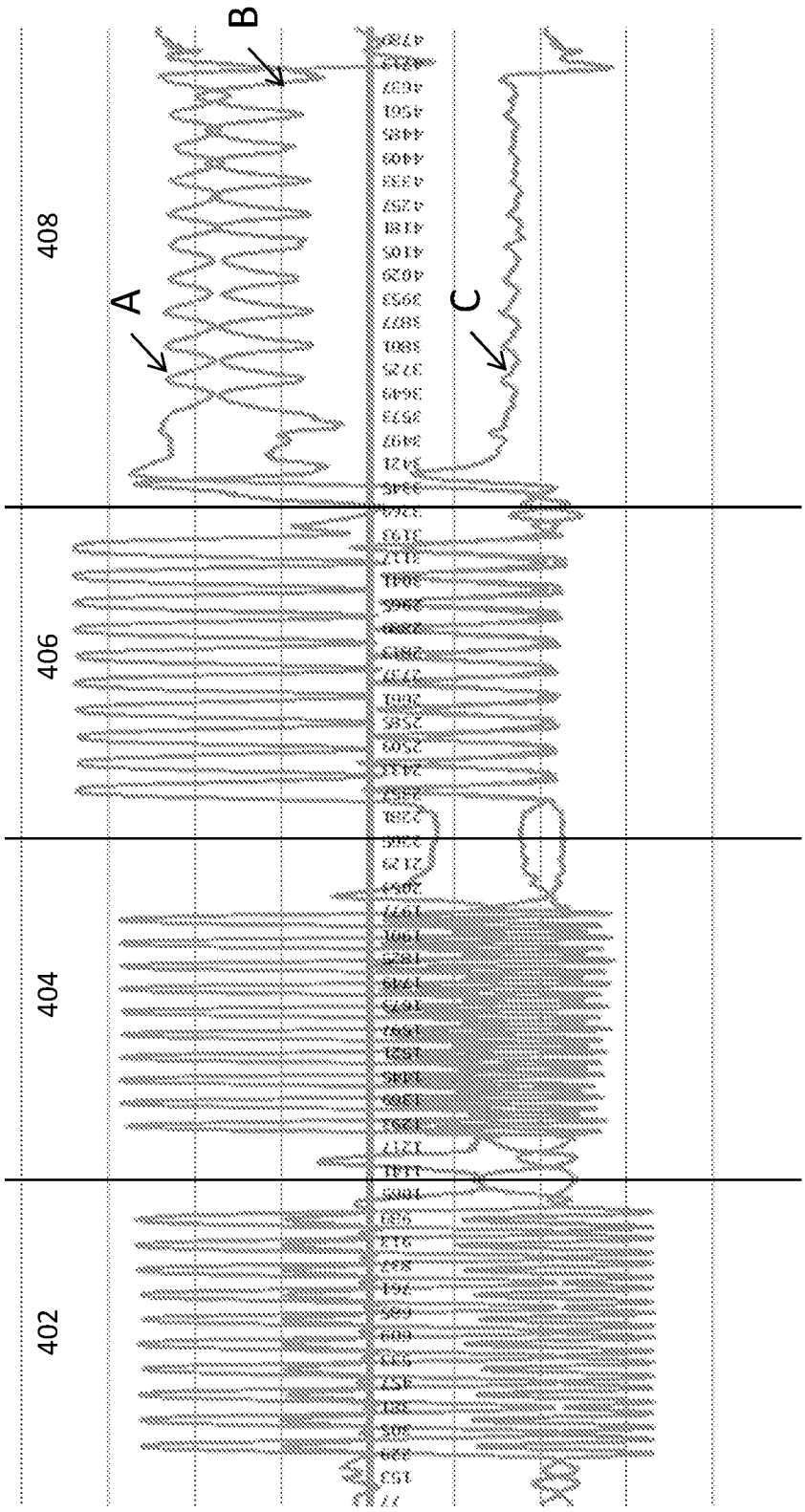


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2015/050116

A. CLASSIFICATION OF SUBJECT MATTER

G06F 17/40 (2006.01) G06F 19/00 (2011.01) A61B 5/00 (2006.01)

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

EPOQUE INTERNAL (TXTE databases: TXPEA, TXPEB, TXPEC, TXPEE, TXPEF, TXPEH, TXPEI, TXPEP, TXPES, TXPEPEA, TXPUSE0A, TXPUSE1A, TXPUSEA, TXPUSEB, TXPWOEA): (monitor, sensor, technique, exercise, correct, worn, menu, user interface, real time, rfid, accelerometer, equipment) & like terms; GOOGLE PATENT: performance, sports, gym, weight, aerobic, isometric, sensors, correct, exercise, movement, techniques, real time, run, computer, coaching, feedback, monitor, track; GOOGLE PATENT: exercise, movement, technique, real time, computer, coaching, feedback, monitor, track; GOOGLE PATENT: exercise, incorrect, feedback, coach, correction, rfid, sensor, accelerometer, real time; GOOGLE PATENT: weights, strength, training, correct, technique, sensors, rfid, exercise, teach, real time; ESPACENET: Inventor name search; AUSPAT: Inventor name search; IP Australia's internal database (NOSE): Inventor name search.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 June 2015	23 June 2015
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	Peter Thong AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262832128

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	**PCT/AU2015/050116**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013/0018493 A1 (AMINI) 17 January 2013 Paragraph 14, paragraph 17, paragraph 34 lines 9 to 11, paragraph 36, paragraph 38, paragraph 42, paragraph 43 lines 5 to 16, paragraphs 54 to 56, figures 2, 3, 9, 11, 14 and page 7 (claim/item 7) in particular.	1-34
X	US 2011/0270135 A1 (DOOLEY et al.) 03 November 2011 Paragraph 34, paragraphs 39 to 41, paragraph 49, paragraphs 52 to 53, paragraph 66, paragraph 72, paragraph 91, paragraphs 93 to 94 and paragraph 102 in particular.	1-34
X	US 2007/0219059 A1 (SCHWARTZ et al.) 20 September 2007 Paragraph 49, paragraph 69, paragraph 73, paragraph 75, paragraph 79, paragraphs 84 to 85, paragraphs 94 to 95, paragraph 102, paragraphs 178 to 180, figures 3a to 3c, 4, 7 and 8 in particular.	1-34
X	US 2008/0220941 A1 (SHAW et al.) 11 September 2008 Paragraph 9, paragraphs 11 to 13, paragraph 26, paragraphs 29 to 30, paragraph 36, paragraph 38, paragraph 44, paragraphs 40 to 41 and figure 1 in particular.	1-34
X	WO 2011/105914 A1 (ACKLAND) 01 September 2011 Page 2 lines 27 to 30, page 11 lines 14 to 32, page 13 lines 7 to 10, page 14 lines 1 to 5, page 15 lines 24 to 25, page 32 lines 22 to 23, page 45 lines 15 to 21, page 50 line 32 to page 51 line 12, page 54 lines 19 to 27, page 66 lines 15 to 21, page 68 lines 1 to 27, page 70 lines 8 to 10, page 71 lines 21 to 28, page 74 lines 5 to 17, page 75 lines 8 to 18, page 80 lines 5 to 7, page 80 lines 16 to 18, page 86 line 20, page 82 lines 20 to 21 and page 87 lines 31 to 35 in particular.	1-34
P,X	US 2014/0135593 A1 (JAYALTH et al.) 15 May 2014 Paragraphs 33, 38, 43, 48, 51, 53, 75, 107 and figures 1A to 1B in particular.	1-34

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2015/050116**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
US 2013/0018493 A1	17 January 2013	US 8419560 B2	16 Apr 2013
US 2011/0270135 A1	03 November 2011		
US 2007/0219059 A1	20 September 2007		
US 2008/0220941 A1	11 September 2008	US 7931563 B2	26 Apr 2011
WO 2011/105914 A1	01 September 2011	AU 2011219093 A1	18 Oct 2012
		EP 2539837 A1	02 Jan 2013
		US 2013053990 A1	28 Feb 2013
US 2014/0135593 A1	15 May 2014	US 2014142459 A1	22 May 2014

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.