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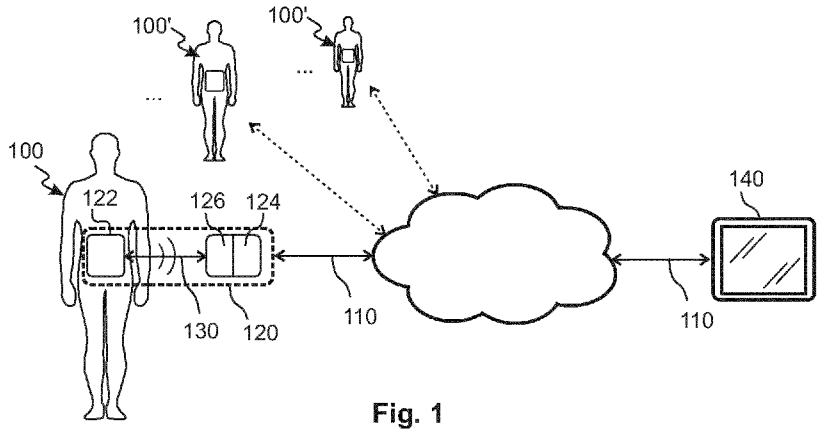

Fig. 1

(57) Abstract: The invention provides a method and system for obtaining reliable physiological or activity related data of at least one subject using a wearable sensor for sensing acceleration along three axes while performing physical exercises. By using the invention, the gathered data is less prone to measurement errors, as there is no need for the subjects themselves to manipulate the sensor. This renders the invention particularly useful for efficiently gathering measurement data during Adapted Physical Activity, APA, sessions involving physically impaired, disabled or elderly persons.

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METHOD AND SYSTEM FOR OBTAINING RELIABLE PHYSIOLOGICAL OR ACTIVITY RELATED DATA OF SUBJECTS

Technical field

The invention relates to methods and devices for evaluating physiological and/or activity related data relating to human subjects, for example during a sports effort or during rehabilitation training. In particular, the invention relates to methods and devices for reliably obtaining such data as muscular strength or standing balance of subjects using acceleration data during remotely monitored activity sessions.

Background of the invention

Adapted Physical Activity, APA, is known as a set of actions for developing, implementing, and monitoring a carefully designed physical education instructional program for a learner with a disability, based on a comprehensive assessment, to give the learner the skills necessary for a lifetime of rich leisure, recreation and sport experiences to enhance physical fitness and wellness.

While a personal meeting between a coach or trainer and a set of participants or subjects is the most common form of delivering an APA session, there are several circumstances that may render such a personal meeting difficult or impossible to implement. For example, the trainer may not be available to travel to the site of the participants, or the participants may be located in several different locations, so that accommodating a meeting among all people involved would encompass an important organizational or logistical burden.

It has been suggested to deliver Adapted Physical Activity, APA, sessions remotely to participants, usually to elderly persons, using a communication network such as the Internet. Typically, a video/audio communication session is established between a computer operated by the trainer and a computer operated by one or several of the participants. The trainer may instruct the participants to perform a physical exercise, inspect their performance visually on the digital video feed streamed from a participant's computer terminal, and provide feedback to the participant. However, it is difficult to visually assess whether each participant executes the physical routine correctly. Therefore, providing adequate and useful feedback in order to help the participant successfully complete the APA session is equally difficult.

In order to obtain objective data relating to the correct execution of the physical routines, one or more worn sensor devices may be used to monitor the muscular activity of each participant

remotely. Several highly accurate clinical sensor devices exist for monitoring the muscular strength and force development of a subject. However, these devices are designed for supervised measuring in a laboratory setting, and they are ill suited for self-usage by physically impaired or disabled persons at home, without the help of a supervising technician. It has been proposed to use less accurate and less onerous sensor devices such as tri-axial accelerometers to gather acceleration data of a subject. Adequate processing of the gathered data may provide an indication of the subject's muscular force.

However, due to the physical impairments or disabilities of the participants in an APA session, it is not always possible for the participant to accurately set up such a sensor device for a given physical routine. If the sensor is not correctly set up, the data collected by the sensor does not accurately represent the participant's activity, so that the no meaningful assessment may be extracted from it, even after further digital processing of the collected data. Similar problems arise with sensors in other applications, that are not related to APA sessions.

Technical problem to be solved

It is an objective of the present invention to provide a method and system which overcomes at least some of the disadvantages of the prior art. The invention aims at providing a method and system that allow for remotely gathering accurate acceleration data of several human subjects performing a physical exercise or activity. The so-collected data is digitally processed to extract information relating to the muscular strength, the balance and other physiological or activity related properties of the subjects.

Summary of the invention

In accordance with a first aspect of the invention, a method for obtaining physiological or activity related data of at least one subject using sensing means is provided. Each subject is associated with one sensing means. The sensing means each comprise a wearable sensor for sensing acceleration along three axes, and data transmission/reception means for communicating with a common remote data collecting device. The method comprises the following steps:

- at the wearable sensor, measuring a sequence of acceleration data;
- using data processing means, processing all or part of said acceleration data into physiological or activity related data, indicative of a property of the subject wearing the wearable sensor;
- at the remote data collecting device, using data reception means thereof, collecting and storing said physiological or activity related data in a memory element.

Each wearable sensor starts measuring acceleration data upon reception of a start signal transmitted from said remote data collecting device, and each wearable sensor stops measuring if a predetermined termination condition is met.

In accordance with a another aspect of the invention, a method for obtaining physiological or activity related data of at least one subject using sensing means is provided. Each subject is associated with one sensing means. The sensing means each comprise a wearable sensor for sensing acceleration along three axes, and data transmission/reception means for communicating with a common remote data collecting device. The method comprises the step of measuring a sequence of acceleration data. Each wearable sensor starts measuring acceleration data upon reception of a start signal transmitted from a remote data collecting device, and each wearable sensor stops measuring if a predetermined termination condition is met.

In accordance with a further aspect of the invention, a method is provided. The method comprises the following steps:

- at a remote data collecting device, transmitting, using data transmission means, a start signal to at least one sensing means associated with a subject;
- at the remote data collecting device, using data reception means thereof, collecting and storing physiological or activity related data received from at least one sensing means associated with a subject, in a memory element.

The physiological or activity related data of a plurality of subjects may preferably be obtained using sensing means, wherein each subject is associated with one sensing means, and wherein each sensing means communicates with said common remote data collecting device.

Preferably, the sensing means may communicate with said common data collecting device via a data communication channel. The data communication channel may preferably comprise a wireless data communication channel.

The processing means may comprise a data processor such as a central processing unit. The data reception/transmission means may comprise a known wireless/wired networking interface for implementing a communications protocol stack.

Preferably, the wearable sensor may communicate said measurement data using a wired or wireless data transmission channel to the transmission/reception means of the sensing means, said transmission/reception means being physically remote from the wearable sensor. The wearable sensor and data transmission channel may preferably part of the same personal area network, PAN.

The sensing means may preferably comprise said data processing means. The data transmission/reception means may transmit the physiological data to said common data collecting device.

The wearable sensor may preferably be worn close to the center of mass of the subject, so that the measured acceleration data is representative of the acceleration of the subject's center of mass. Preferably, the sensor may be worn using a belt strapped around the subject's waist. More preferably, the sensor is worn so that it contacts the subject's body.

Preferably, the data transmission/reception means may transmit the measured acceleration data to said common remote data collecting device, which may comprise said data processing means.

The sensing means may preferably comprise said data processing means. Preferably, the data processing means may be located in a wearable enclosure or housing together with said wearable sensor. The wearable sensor may preferably communicate said physiological or activity related data to the transmission/reception means of the sensing means, said transmission/reception means being physically remote from the wearable sensor.

It may be preferable that the sensing means comprise said data processing means. The data processing means may be located in a wearable enclosure together with said wearable sensor and said transmission/reception means.

Preferably, the sensing means may be comprised in a mobile handheld computing device, such as a smartphone.

The wearable sensor device may preferably comprise a tri-axial accelerometer.

Preferably, the wearable sensor device may further comprise a tri-axial gyroscope and/or a tri-axial magnetometer, for measuring the position of the subject, said measurement data being processed by said processing means into physiological or activity related data. The sensing means may preferably comprise a plurality of different wearable sensors, for example a heart rate monitor.

Preferably, the sensing means may be configured to obtain said measurement data at a frequency of 50Hz.

The measurement data or the physiological or activity related data may preferably be transmitted to the collecting device continuously while measurements are being made.

Alternatively, the measurement data or the physiological or activity related data may be transmitted to the collecting device once said termination condition has been met.

Preferably, the physiological or activity related data may comprise muscle strength or balance of a subject, or a footstep count of a subject.

The start signal may preferably be transmitted synchronously to the sensing means of each subject.

Preferably, the termination condition may comprise the lapse of a predetermined time interval as measured from the reception of the start signal at the sensing means.

The start signal may preferably comprise data defining the type of exercise to be performed, the termination condition for the exercise or any other data useful for the configuration or calibration of the sensing means.

According to yet another aspect of the invention, a system for obtaining physiological or activity related data of at least one subject is provided. The system comprises at least one sensing means and a common data collecting device, which is remote from said sensing means. Each subject is associated with one sensing means. The sensing means each comprise a wearable sensor for sensing acceleration along three axes, and data transmission/reception means for communicating with the common remote data collecting device. The wearable sensor is configured to measure a sequence of acceleration data. The system comprises data processing means configured to process all or part of said acceleration data into physiological or activity related data, indicative of a property of the subject wearing the wearable sensor. The remote data collecting device is configured to collect and store said physiological or activity related data in a memory element. Each wearable sensor of the system is configured to start measuring acceleration data upon reception of a start signal transmitted from the remote data collecting device, and each wearable sensor is configured to stop measuring if a predetermined termination condition is met.

Preferably, the system may comprise a common data communication backend device, through which all data being transmitted/received from the sensing means to/from the remote data collecting device transits. A communication session between a sensing means and the collecting device may preferably comprise setting up a first data communication channel from the sensing means to the backend device, and a second data communication channel from the backend device

to the data collecting device, wherein the data collecting device is configured for relaying and/or processing data transiting from the sensing means to the data collecting device, or vice-versa.

According to a further aspect of the invention, a sensing device is provided. The sensing device comprises a wearable sensor for sensing acceleration along three axes, and data transmission/reception means for communicating with the common remote data collecting device. The wearable sensor is configured to measure a sequence of acceleration data. The wearable sensor is configured to start measuring acceleration data upon reception of a start signal transmitted from a remote data collecting device, and to stop measuring if a predetermined termination condition is met.

In accordance with another aspect of the invention, a remote data collecting device is provided, the remote data collecting device comprises at least one data processor, data transmission and reception means such as a networking interface, and a memory element. The data processor is configured to

- transmit, using said data transmission means, a start signal to at least one sensing means associated with a subject;
- to collect, using said data reception means, physiological or activity related data received from at least one sensing means associated with a subject, and to store said data in said memory element.

In accordance with yet another aspect of the invention, a computer program comprising computer readable code means is provided, which when run on a computer, causes the computer to carry out the method steps according to aspects of the invention.

In accordance with a final aspect of the invention, a computer program product comprising a computer-readable medium on which the computer program according to an aspect of the invention is stored.

In accordance with the invention, the measurements relating to a particular exercise or activity, which are taken by worn sensors, for example during an APA session, are initiated remotely, and terminated either automatically or remotely. Compared to known methods and systems, several potential sources of errors in the data acquisition chain are thereby removed. For example, the session participant or user of the sensing device does not have to manually select a type of measurement or exercise on the device he/she is wearing, nor does he/she have to indicate when the exercise, or taking of measurements is finished. Manipulating the sensing device may dislocate it, rendering the following measurements prone to be erroneous or useless. Furthermore, manipulations of the sensing device may put the participant in an awkward physical position,

depending on his/her disabilities or impairments. As no screen or input interface apart from a power-up or initialisation switch is required to be featured on the wearable sensor, its use is greatly simplified, especially considering the target user group of elderly people, in accordance with some embodiments of the invention. In accordance with preferred embodiments of the invention, the activity of multiple participants may be monitored by a single remote data collecting entity, and feedback on the execution of a physical exercise may be provided to each one of them in real-time, while the exercise or activity is still being executed. This improves the efficiency of the delivery of remote APA sessions and alleviates the overall burden on both the trainer and the participants. Compared to the known delivery of APA sessions using only audio/video data feeds, the features of the invention allow for the monitoring and for the provision of feedback with greater precision, thanks to the use of sensing means that provide accurate and objective data for the assessment of a participant's performance.

Brief description of the drawings

Several embodiments of the present invention are illustrated by way of figures, which do not limit the scope of the invention, wherein:

- figure 1 provides an illustration of a system for implementing a method in accordance with a preferred embodiment of the invention;
- figure 2 shows an algorithm for evaluating muscle strength based on acceleration data, in accordance with a preferred embodiment of the invention;
- figure 3 provides an illustration of a system for implementing a method in accordance with a preferred embodiment of the invention;
- figure 4 provides an illustration of a system for implementing a method in accordance with a preferred embodiment of the invention;
- figure 5 provides an illustration of a system for implementing a method in accordance with a preferred embodiment of the invention.

Detailed description of the invention

This section describes features of the invention in further detail based on preferred embodiments and on the figures, without limiting the invention to the described embodiments. Unless otherwise stated, features of one described embodiment may be combined with additional features of another described embodiment. Similar features of the invention are referenced with similar reference numbers, wherein a reference number for a given feature is incremented by one hundred when switching from one embodiment of the invention to the next. For example, reference numbers 120,

220, 320 and 420 each describe sensing means as used in four different embodiments of the invention.

Figure 1 shows subjects 100, 100' participating in an Adapted Physical Activity, APA, session. While the invention is not limited to the framework of APA sessions, this framework is used to illustrate how the invention works by way of example only. While three participants are shown, several further participants may be present. By way of example, the method and system in accordance with a first embodiment of the invention will be described with regards to subject 100. Subject 100 wears a sensor 122 for sensing acceleration along three axes, preferably close to his/her body's center of mass. The sensor 122 is part of sensing means 120 which are associated with the subject 100. Apart from the sensor 122, the sensing means 120 comprise data processing means 126 as well as data transmission and reception means 124, which are not worn by the subject. For the sake of clarity, the dimensions of the drawings are not at scale. The sensor 122 preferably has a footprint of only several square centimeters.

Without limiting the invention to a specific implementation, an implementation of the sensor 122 is in the form of the Texas Instruments™ SensorTag open Internet of Things, IoT, platform. The device features a small footprint of about 5x6,7x1,4 cm and incorporates a wide array of sensors, including a 9-axes Inertial Measurement Unit, IMU, at moderate cost. Apart from a tri-axial accelerometer, the device further comprises a tri-axial gyroscope and a tri-axial magnetometer. IMUs are Micro Electronic Mechanical Systems, MEMS, integrating the three types of measurement in a single chip with a footprint of several square millimetres. Using the tri-axial accelerometer, the device is capable of measuring its acceleration, and the acceleration of a subject wearing or carrying the device. It is further configured to output raw acceleration data 130 using a data transmitter. The sensor has limited data processing capabilities and does not participate in processing the acceleration data 130 measured by the sensor chip, in order to save power. The output data is transmitted, preferably wirelessly, to the data processing means 126, which are external to the worn sensor's 122 enclosure. The data processing means 126 are preferably implemented by the Central Processing Unit, CPU, of a computing device such as a personal computer or a dedicated set-top box. The wireless communication between the wearable sensor 122 and the data processing means 126 is preferably established by way of a Bluetooth™ wireless link, for example a Bluetooth 4 LE™ wireless connection. Bluetooth 4 LE uses limited energy, which enables to maximise the longevity of the wearable sensor's power source, which generally comprises a battery having limited capacity.

Once the raw acceleration data 130 reaches the processing means 126, they are processed into physiological data or activity related data indicative of a property of the subject wearing the wearable sensor 122.

The physiological data comprises for example muscle strength. Muscle strength, specifically muscle strength of the lower limbs, is measured by performing an exercise called the "explosive squat". An explosive squat is an exercise during which the participant has to lower his/her body to a squatting position and then rise as quickly as possible without actually jumping. The exercise may be replaced by a less demanding sit-to-stand routine for older seniors. A sit-to-stand exercise requires the participant to sit on a chair first, then having him or her move from a seated position to a standing position. In both cases, muscle strength is deduced from the vertical acceleration imparted on the body by the rising motion. The acceleration data 130 measured by the sensor 122 worn by the participant 100 during the performance of the exercise allows to extract the participant's muscle strength using the processing means 126 by way of the method illustrated in figure 2. Measured sensor orientation and acceleration in three dimensions are transmitted at fixed time intervals Δt. The sampling period Δt is typically of about 50Hz and may be configured at the wearable sensor. By performing the Hamilton product of the orientation and acceleration vectors, an acceleration vector aligned with ground normal, i.e., gravity pointing towards ground, is obtained. The constant gravity vector is subtracted from the ground normal acceleration vector in order to obtain the dynamic acceleration vector, representative of the acceleration imparted by body motion. Only the vertical component Z of the dynamic acceleration is of interest, as the muscle force required to impart the acceleration is given by the formula $F=m \cdot g(1+a_Z)$. m denotes the body mass, i.e., the weight of the person provided to the processing means before starting the exercise, g is the gravitational constant 9.81 m/s^2, and a_Z is the vertical component of the measured dynamic acceleration. In order to determine the amount of developed power, the velocity of the participant's body is determined by $v= a_Z \cdot g \cdot \Delta t$. Instantaneous power is then determined by multiplying instantaneous velocity with the previously computed force: $P=v \cdot F$. The processing means 126 are configured to implement this and other processing algorithms by appropriate programming or by specific analogue circuitry, as it is known in the art.

The activity related data comprises for example the subject's 100 standing balance. Standing balance is typically measured by observing body sway in both body planes, i.e., the medial-lateral plane (sideward) and the anterior-posterior plane (forward-backward). Body sways is determined by projecting the body's center of mass to the floor and by measuring its displacement in both planes. For a person standing perfectly still, the projection would remain in one single spot and the displacement would be zero in both planes. However, a human body maintain its naturally instable balance by performing numerous micro-adjustments in order to maintain its center of mass within

the base of support. Hence, the center of mass wanders and its projection describes a path. The analysis of this path is at the center of standing balance evaluation. An algorithm for determining the displacement of the center of mass projection is described for example in *"Standing balance evaluation using a triaxial accelerometer"*, Mayagoitia R. E. et al, Gait and Posture 16 (2002) 55-59. A number of metrics can be extracted from the recorded path time series, including the sway area, the overall path length, the maximum displacement or the center of mass's average velocity. The data 110 may further comprise an indication of the participant's breathing rate, which may all be readily derived from the acquired acceleration data. When the sensor is worn at a different body location of the subject, different movements such as acceleration or movement of arms, or walked steps may be derived from the acquired acceleration data.

Once the acceleration data 130 has been processed into physiological or activity related data 110 by the processing means 126, the processed data 110 is transmitted using the data transmission/reception means of the sensing means 120 to a data collecting device 140. The data collecting device 140 is common to all participants 100, 100' and to their respective sensing means. The data collecting device 140 is typically implemented by a computing device operated or supervised by the APA session's coach. At the device 140, the collected data of all participants is stored in a memory element such as a non-volatile storage element known in the art, and/or displayed on a display. Alternatively, the device 140 may be implemented by a collection of network nodes providing the data collecting service collectively.

The data collecting device 140 is remote to the sensing means and to the subject wearing them, preferably it is located at a different site. A data connection between the sensing means of any subject and the data collecting device 140 is established by way of a data communication channel. Preferably, the data communication channel comprises a wireless data communication link.

In order for the data 110 to reliably represent the physiological or activity related properties of the subject 100, the measurement data 130 must firstly have been accurately acquired and the sensor 122 must have been set up and worn correctly. In known systems, the subject or participant 100 has to set up a worn sensor manually. In accordance with the invention, the participants only has to switch his/her sensing means on. A start signal is transmitted from the common data collecting device 140 to the sensing means 120 of each participant 100, 100', via the data communication channel linking these to one another. The start signal may for example comprise structured metadata for configuring the sensing means 120 and/or the wearable sensor 122. Typically, the start signal is provided in the form of a data packet. The structured metadata indicates for example the type of exercise or sequence of exercises in the session, the type of measurement, a measurement duration, or an indication of which sensor data is to be acquired. On reception of the start signal,

the sensor 122 is instructed to start measuring the acceleration data, and/or any other data necessary for evaluating the physiological or activity related properties of the participant wearing the sensor 122 – without requiring further intervention of the participant. If the start signal comprises the described structured metadata, the sensing means 120 are configured to automatically set up the sensor 122 accordingly, prior to starting to take measurements. If a predetermined termination condition is satisfied, the sensing means 120 automatically stop measuring the sensed data without requiring the intervention of the participant. The predetermined condition may be a predetermined number of recorded measurement samples, a predetermined time interval for taking measurements (which may be specified in the metadata comprised in the start signal), or the reception of a predefined stop signal received remotely from the common data collecting device 140. Another termination condition may be the detection at the data collecting device of a typical acceleration profile. For instance, the explosive squat or sit to stand transition follow a typical acceleration profile which may be detected automatically and thus trigger the transmission of stop signal identified at the sensing means as a termination condition, see for example "*Detecting short time-duration physical activity through statistical modelling of accelerometry data*", M. Tadeusiak et al., Institute of Digital Healthcare - WMG, University of Warwick, Coventry, UK. Other termination conditions may be implemented depending on the specific application, without departing from the scope of the present invention. In accordance with an embodiment of the invention, the start signal is only emitted from the collecting device 140 once all sensing means 120 report a "ready" signal via the data communication link. Such a "ready" signal may for example be generated at the sensing means only if the sensor 122 has been powered up and bootstrapped correctly. Alternatively, the APA session may comprise an additional video/audio data communication channel between each of the subject's sensing means 120 and the common collecting device 140. In that case, the start signal may only be generated by the common collecting device once the detection of a correctly worn sensor 122 is positive for the specific participant 100.

By comparing the received data 110 for a given participant 100 performing a predetermined physical exercise to an expect data pattern or to the same participant's data recorded during an earlier APA session, the collecting device 140 is configured to detect the mid- to long-term trend of the participant's execution of the physical exercise. Alternatively, the APA session coach supervising the collecting device 140 may inspect the received data 110 to conclude on the participant's performance. In both cases, appropriate feedback is generated and transmitted to the participant. The feedback is more accurate and may be delivered faster as compared to known systems, as the chain of measurement acquisition is less prone to errors stemming from the manipulation of the worn sensors.

Figures 3-5 show further embodiments of systems for implementing the method in accordance with the invention. The embodiment shown in figure 3 is similar to the one shown in figure 1. However, the sensing means 220 do not comprise the described processing means 226. Rather, the processing means 226 for processing the raw sensed data 230 are implemented at the common data collecting device 240. The processing means 226 of each of the sensing means 220 associated with any of the session participants 200, 200' are centralized and implemented at the common data collecting device 240, or at a central entity connected thereto via a data communication channel. Therefore, the sensing means 220 comprise the wearable sensor 222 as described earlier, and the data transmission/reception means 224, which are configured to relay the sensed but unprocessed data 230 to the data collecting device 240 via the data communication channel connecting the two entities.

The embodiment shown in figure 4 differs from the embodiment in figure 1 in that the data processing means 326 of the sensing means 320 of subject 300 are physically collocated in a common wearable enclosure together with the sensor 322. Alternatively, the data processing means and the sensor may both be separate wearable devices communicating in a personal area network, such as a Bluetooth™ network for example. The sensor 322 measures acceleration data 330, which is locally processed into physiological or activity related data 310 as described here above. Further, the data 310 may comprise an evaluation of the participant's number of walked footsteps. The data transmission/reception means 324 of the sensing means 320 are configured to relay the processed data to the data collecting device 340 via the data communication channel connecting the two entities.

In the embodiment shown in figure 5, the data processing means 426 and the data transmission/reception means 424 of the sensing means 420 of subject 400 are both physically collocated in a common wearable enclosure or housing together with the sensor 422. The sensing means 426, processing means 426 and data transmission/reception means are functionally connected to one another. The sensor 422 measures acceleration data 430, which is locally processed into physiological or activity related data 410 as described here above. The data transmission/reception means 424 of the sensing means 420 are configured to relay the processed data to the data collecting device 440 via the data communication channel connecting the two entities. This embodiment corresponds for example to an implementation wherein the sensor 422 is a tri-axial accelerometer of a smartphone or any other handheld computing device, wherein the data processing means 426 are implemented by the CPU of the same computing device, which is programmed appropriately by known means, and wherein the data transmission/reception means 424 are implemented by a WiFi™ or LTE communications module of the same computing device.

In another embodiment that may be structurally implemented in accordance with any one of the previous embodiments, the common remote data collecting device is configured for collecting information about the usage adoption of the worn sensors incorporated in the sensing means, which are worn by subjects. In order to obtain meaningful results, the remote data collecting device remotely initiates the start of taking measurements by sending said start signal to the sensing means, so that the subjects do not have to take action. Similarly, the remote data collecting device remotely terminates the taking of measurement at the sensing by sending a termination signal to the sensing, means once all necessary data have been collected, without requiring action by the subjects. The remote data collecting device is configured to automatically detect when the data has been successfully collected and at which time the termination signal is transmitted. Conditions for successful collection comprise, but are not limited to the detection of a number of collected samples, or the detection of a specific activity profile/exercise in the collected data.
It is noted that in all embodiments of the invention, the data communication channel linking the sensing means of a participant to the common remote data collecting device only requires to be operable for transmitting the start signal and for collecting the sensed and/or processed measurement data. Therefore, an exercise may be performed and measurements may be made while the sensing means are offline, and the measured/processed data may be transmitted to the data collecting device once the sensing means are online and connected to the collecting device at a later time. However, depending on the frequency of required feedback and depending on the physical exercise or sequence of exercises to be performed during an APA session, it may be advantageous to continuously transmit the measurement data to the data collecting device in real time, while the measurements are being made.

All communication between the sensing means of each participant and the common remote data collecting device may preferably be made using secure communication channels, as they are known in the art. Preferably, all communication may be routed through a common network node or application back-end, which may further store a log of transiting data packets.

It should be understood that the detailed description of specific preferred embodiments is given by way of illustration only, since various changes and modifications within the scope of the invention will be apparent to the skilled person. The scope of protection is defined by the following set of claims.

Claims

1. Method for obtaining physiological or activity related data (110, 210, 310, 410) of at least one subject (100, 200, 300, 400) using sensing means (120, 220, 320, 420), each subject being associated with one sensing means, wherein said sensing means each comprise a wearable sensor (122, 222, 322, 422) for sensing acceleration along three axes, and data transmission/reception means (124, 224, 324, 424) for communicating with a common remote data collecting device(140, 240, 340, 440), the method comprising the following steps:
   - at the wearable sensor, measuring a sequence of acceleration data (130, 230, 330, 430);
   - using data processing means (126, 226, 326, 426), processing all or part of said acceleration data into physiological or activity related data (110, 210, 310, 410) indicative of a property of the subject wearing the wearable sensor (122, 222, 324, 424);
   - at the remote data collecting device, using data reception means thereof, collecting and storing said physiological or activity related data in a memory element,

   wherein each wearable sensor (122, 222, 324, 424) starts measuring acceleration data upon reception of a start signal transmitted from said remote data collecting device (140, 240, 340, 440), and
   each wearable sensor stops measuring if a predetermined termination condition is met.

2. Method according to claim 1, wherein physiological or activity related data of a plurality of subjects is obtained using sensing means, wherein each subject is associated with one sensing means, and wherein each sensing means communicates with said common remote data collecting device.

3. Method according to any of claims 1 or 2, wherein said wearable sensor (122, 222) communicates said measurement data (130, 230) using a wired or wireless data transmission channel to the transmission/reception means (124, 224) of the sensing means (120, 220), said transmission/reception means being physically remote from the wearable sensor.

4. Method according to any of claims 1 to 3, wherein said sensing means (120) comprise said data processing means (126), and wherein said data transmission/reception means (124) transmit the physiological data (110) to said common data collecting device (140).

5. Method according to any of claims 1 to 3, wherein said data transmission/reception means (224) transmit the measured acceleration data (210) to said common data collecting device (240), which comprises said data processing means (226).

6. Method according to any of claims 1 or 2, wherein the sensing means (320) comprise said data processing means (326), wherein said data processing means are located in a wearable enclosure together with said wearable sensor (322), and wherein said wearable sensor (322) communicates said physiological or activity related data (310) to the transmission/reception means (324) of the sensing means (320), said transmission/reception means being physically remote from the wearable sensor.

7. Method according to any of claims 1 or 2, wherein the sensing means (420) comprise said data processing means (426), wherein said data processing means are located in a wearable enclosure together with said wearable sensor (422) and said transmission/reception means (424).

8. Method according to claim 7, wherein the sensing means are comprised in a mobile handheld computing device, such as a smartphone.

9. Method according to any of claims 1 to 8, wherein said wearable sensor device comprises a tri-axial accelerometer.

10. Method according to claim 9, wherein said wearable sensor device further comprises a tri-axial gyroscope and/or a tri-axial magnetometer, for measuring the position of the subject, said measurement data being processed by said processing means into physiological or activity related data.

11. Method according to any of claims 1 to 10, wherein said measurement data or said physiological or activity related data is transmitted to the collecting device continuously while measurements are being made.

12. Method according to any of claims 1 to 9, wherein said measurement data or said physiological or activity related data is transmitted to the collecting device once said termination condition has been met.

13. Method according to any of claims 1 to 12, wherein said physiological or activity related data comprises muscle strength or balance of a subject, or a footstep count of a subject.

14. Method according to any of claims 1 to 13, wherein said start signal is transmitted synchronously to the sensing means of each subject (100, 100').

15. Method according to any of claims 1 to 14, wherein said termination condition comprises the lapse of a predetermined time interval as measured from the reception of the start signal at the sensing means.

16. System for obtaining physiological or activity related data (110, 210, 310, 410) of at least one subject (100, 200, 300, 400), the system comprising at least sensing means and a common data collecting device, which is remote from said sensing means, each subject being associated with one sensing means, wherein said sensing means each comprise a wearable sensor (122, 222, 322, 422) for sensing acceleration along three axes, and data transmission/reception means (124, 224, 324, 424) for communicating with the common remote data collecting device(140, 240, 340, 440), wherein

- the wearable sensor is configured to measure a sequence of acceleration data (130, 230, 330, 430);
- the system comprises data processing means (126, 226, 326, 426) configured to process all or part of said acceleration data into physiological or activity related data (110, 210, 310, 410) indicative of a property of the subject wearing the wearable sensor (122, 222, 324, 424);
- the remote data collecting device is configured to collect and store said physiological or activity related data in a memory element,

wherein each wearable sensor of the system (122, 222, 324, 424) is configured to start measuring acceleration data upon reception of a start signal transmitted from the remote data collecting device (140, 240, 340, 440), and
each wearable sensor is configured to stop measuring if a predetermined termination condition is met.

17. A computer program comprising computer readable code means, which when run on a computer, causes the computer to carry out the method steps according to claim 1, which take place at the sensing means or at the common remote data collecting device.

18. The computer program according to claim 17, comprising further computer readable code means, which when run on a computer, causes the computer to carry out the method according to any one of steps 2 to 15.

19. A computer program product comprising a computer-readable medium on which the computer program according to any of claims 17 or 18 is stored.

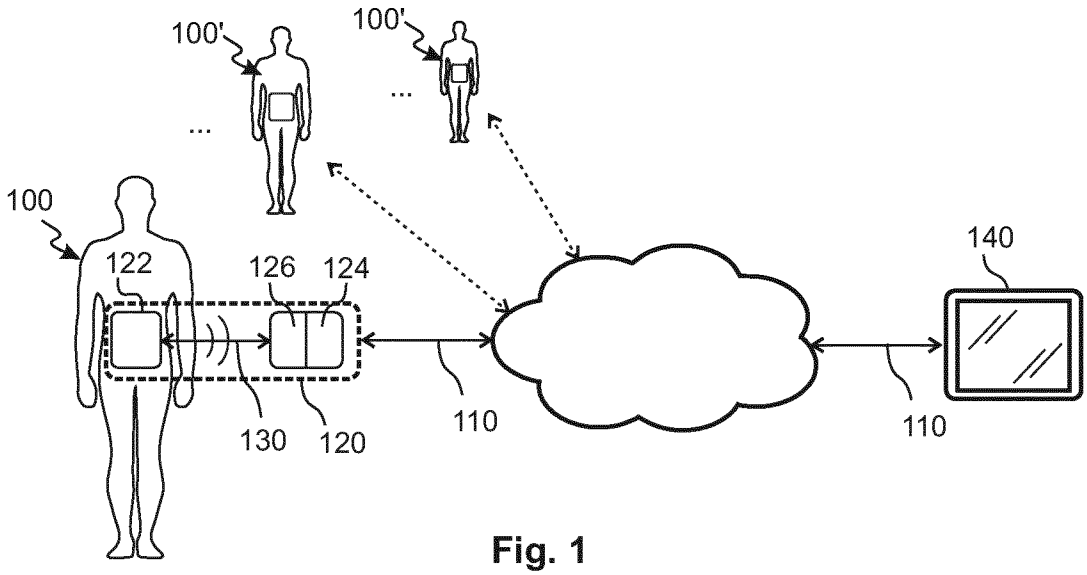

Fig. 1

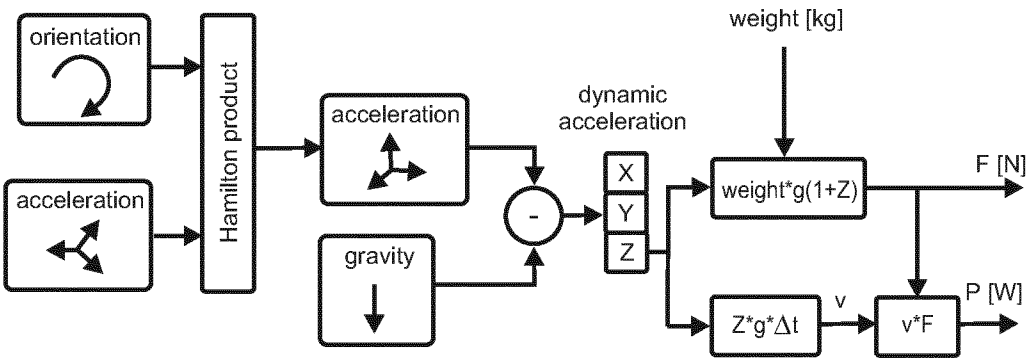

Fig. 2

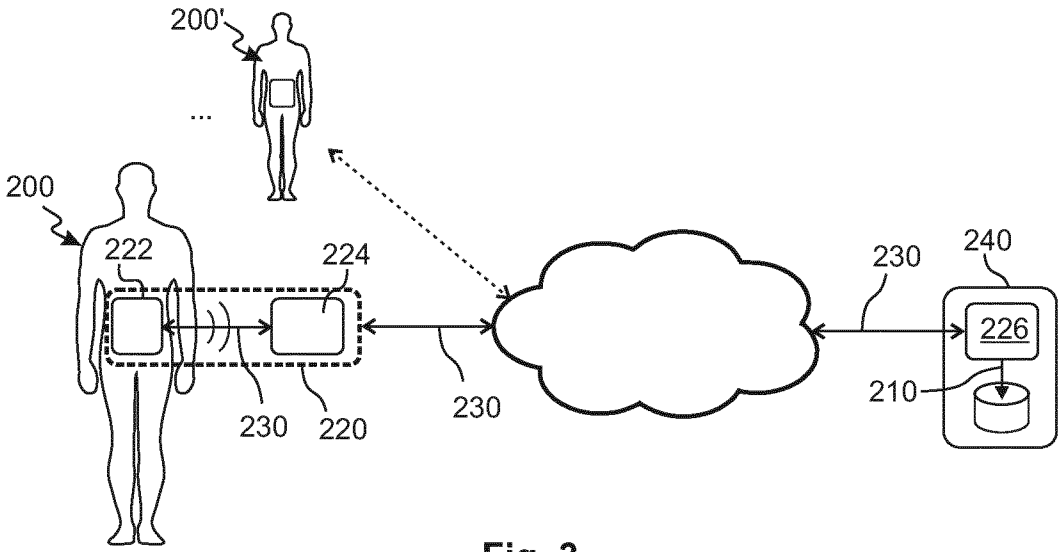

Fig. 3

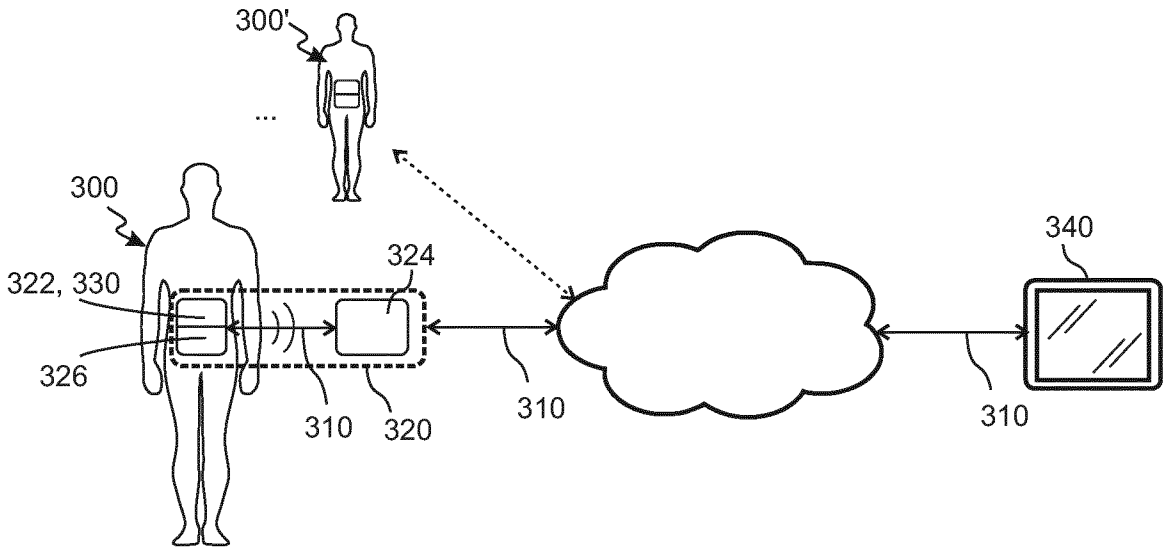
300'
...
300
322, 330
326
324
310
320
310
340
310

Fig. 4

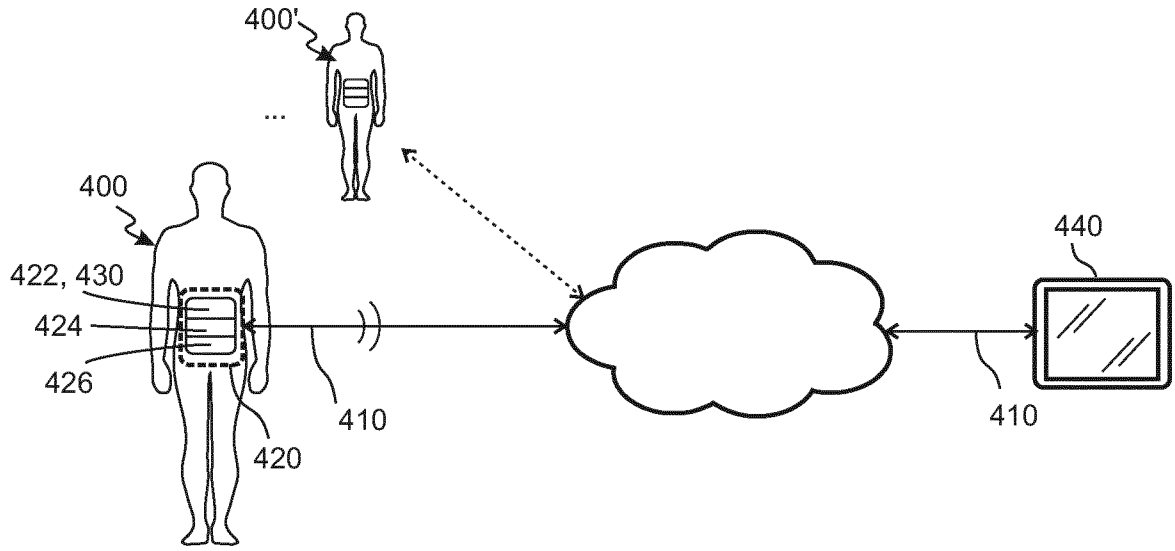
400'
...
400
422, 430
424
426
420
410
410
440

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/079210

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F19/00 G16H40/67 G16H20/30
ADD.

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)
G06F G16H

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 2011/112771 A1 (FRENCH BARRY [US]) 12 May 2011 (2011-05-12) paragraphs [0026], [0027], [0028], [0047], [0075], [0077]; figure 3 -----	1-19
X	US 2008/204225 A1 (KITCHEN DAVID [US]) 28 August 2008 (2008-08-28) paragraphs [0025], [0028], [0029], [0034], [0038], [0056], [0070], [0072], [0091]; claim 3; figure 11 -----	1-19
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 March 2018	09/03/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Samulowitz, Michael

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

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