(19) LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

(11) N° de publication : **93360**

(12) **BREVET D'INVENTION** **B1**

(21) N° de dépôt: 93360

(51) Int. Cl.:
G06F 19/00

(22) Date de dépôt: 14/12/2016

(30) Priorité:

(43) Date de mise à disposition du public: 21/06/2018

(47) Date de délivrance: 21/06/2018

(73) Titulaire(s):
LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY (LIST) –
4362 ESCH/ALZETTE (Luxembourg)

(72) Inventeur(s):
MACK NICO – 3774 TETANGE (Luxembourg)

(74) Mandataire(s):
CORAX IP S.À.R.L. – 2732 LUXEMBOURG (Luxembourg)

(54) **METHOD AND SYSTEM FOR OBTAINING RELIABLE PHYSIOLOGICAL OR ACTIVITY RELATED DATA OF SUBJECTS.**

(57) 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.

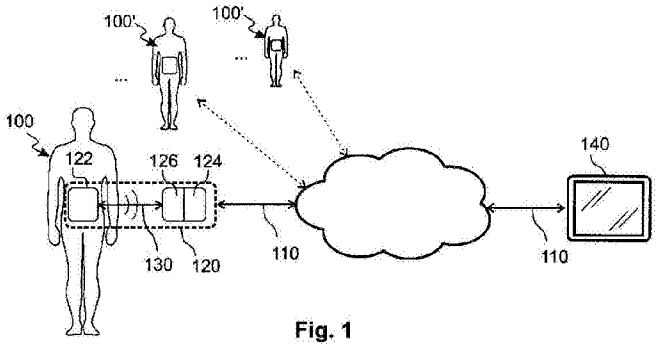

Fig. 1

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.

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 advantages 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. 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

The invention provides a method for obtaining physiological or activity related data of at least one subject using sensing means, each subject being 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 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 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 data collecting device, and each wearable sensor stops measuring if a predetermined termination condition is met.

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 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.

It is a further object of the invention to provide a system for obtaining physiological or activity related data of at least one. The system comprises at least one sensing means and a common data collecting device. 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 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

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 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 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.

In accordance with the invention, the measurements relating to a particular exercise and taken by worn sensors 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 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 preferred embodiments of the invention, the activity of multiple participants may be monitored by a single 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 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 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 exemplary 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 exemplary 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 configure 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.

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.

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 pre-defined 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.

It is noted that in all embodiments of the invention, the data communication channel linking the sensing means of a participant to the common 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 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.

Revendications

1. Procédé d'obtention de données physiologiques ou liées à l'activité (110, 210, 310, 410) d'au moins un sujet (100, 200, 300, 400) utilisant des moyens de détection (120, 220, 320, 420), chaque sujet étant associé avec un moyen de détection, dans lequel lesdits moyens de détection comprennent chacun un capteur portable (122, 222, 322, 422) pour détecter l'accélération selon trois axes, et des moyens d'émission/réception de données (124, 224, 324, 424) pour communiquer avec un dispositif de collecte de données commun (140, 240, 340, 440), le procédé comprenant les étapes suivantes:
   - au capteur portable, mesurer une séquence de données d'accélération (130, 230, 330, 430);
   - en utilisant des moyens de traitement de données (126, 226, 326, 426), traiter la totalité ou une partie desdites données d'accélération en données physiologiques ou liées à l'activité (110, 210, 310, 410) indicatives d'une propriété du sujet portant le capteur portable 122, 222, 324, 424);
   - au dispositif de collecte de données, en utilisant des moyens de réception de données de celui-ci, collecter et stocker lesdites données physiologiques ou liées à l'activité dans un élément de mémoire,

   dans lequel chaque capteur portable (122, 222, 324, 424) commence à mesurer des données d'accélération sur réception d'un signal de démarrage transmis par ledit dispositif de collecte de données (140, 240, 340, 440), et
   chaque capteur portable s'arrête de mesurer si une condition de terminaison prédéterminée est satisfaite.

2. Procédé selon la revendication 1, dans lequel ledit capteur portable (122, 222) communique lesdites données de mesure (130, 230) en utilisant un canal de transmission de données câblé ou sans fil aux moyens d'émission/réception (124, 224) des moyens de détection (120, 220), lesdits moyens d'émission / réception étant physiquement éloignés du capteur portable.

3. Procédé selon l'une quelconque des revendications 1 ou 2, dans lequel lesdits moyens de détection (120) comprennent lesdits moyens de traitement de données (126), et dans lequel lesdits moyens d'émission/réception de données (124) transmettent les données physiologiques (110) audit dispositif de collecte de données commun (140).

4. Procédé selon l'une quelconque des revendications 1 ou 2, dans lequel lesdits moyens d'émission/réception de données (224) transmettent les données d'accélération mesurées

(210) audit dispositif de collecte de données commun (240), qui comprend lesdits moyens de traitement de données (226).

5. Procédé selon la revendication 1, dans lequel les moyens de détection (320) comprennent lesdits moyens de traitement de données (326), dans lequel lesdits moyens de traitement de données sont situés dans une enceinte portable avec ledit capteur portable (322), et dans lequel ledit capteur portable (322) communique lesdites données physiologiques ou liées à l'activité (310) aux moyens d'émission/réception (324) des moyens de détection (320), lesdits moyens d'émission/réception étant physiquement éloignés du capteur portable.

6. Procédé selon la revendication 1, dans lequel les moyens de détection (420) comprennent lesdits moyens de traitement de données (426), dans lequel lesdits moyens de traitement de données sont situés dans une enceinte portable avec ledit capteur portable (422) et ledit moyen d'émission/réception (424).

7. Procédé selon la revendication 6, caractérisé en ce que les moyens de détection sont compris dans un dispositif ordinateur mobile portatif, tel qu'un smartphone.

8. Procédé selon l'une quelconque des revendications 1 à 7, dans lequel ledit capteur portable comprend un accéléromètre triaxial.

9. Procédé selon la revendication 8, dans lequel ledit capteur portable comprend en outre un gyroscope triaxial et/ou un magnétomètre triaxial, pour mesurer la position du sujet, lesdites données de mesure étant traitées par ledit moyen de traitement en données physiologiques ou liées à l'activité.

10. Procédé selon l'une quelconque des revendications 1 à 9, dans lequel lesdites données de mesure ou lesdites données physiologiques ou liées à l'activité sont transmises au dispositif de collecte en continu pendant la prise des mesures.

11. Procédé selon l'une quelconque des revendications 1 à 9, dans lequel lesdites données de mesure ou lesdites données physiologiques ou liées à l'activité sont transmises au dispositif de collecte une fois que ladite condition de terminaison a été remplie.

12. Procédé selon l'une quelconque des revendications 1 à 11, dans lequel lesdites données physiologiques ou liées à l'activité comprennent la force musculaire ou l'équilibre d'un sujet, ou le nombre de pas d'un sujet.

13. Procédé selon l'une quelconque des revendications 1 à 12, dans lequel ledit signal de départ est transmis de manière synchrone aux moyens de détection de chaque sujet (100, 100 ').

14. Procédé selon l'une quelconque des revendications 1 à 13, dans lequel ladite condition de terminaison comprend l'écoulement d'un intervalle de temps prédéterminé mesuré à partir de la réception du signal de démarrage au niveau des moyens de détection.

15. Système pour l'obtention de données physiologiques ou liées à l'activité (110, 210, 310, 410) d'au moins un sujet (100, 200, 300, 400), le système comprenant au moins un moyen de détection et un dispositif de collecte de données commun, chaque sujet étant associé à un moyen de détection, dans lequel lesdits moyens de détection comprennent chacun un capteur portable (122, 222, 322, 422) pour détecter l'accélération le long de trois axes, et des moyens d'émission/réception de données (124, 224, 324, 424) pour communiquer avec le dispositif de collecte de données commun (140, 240, 340, 440), dans lequel

- le capteur portable est configuré pour mesurer une séquence de données d'accélération (130, 230, 330, 430);
- le système comprend des moyens de traitement de données (126, 226, 326, 426) configurés pour traiter la totalité ou une partie desdites données d'accélération en données physiologiques ou liées à l'activité (110, 210, 310, 410) indicatives d'une propriété du sujet portant le capteur portable (122, 222, 324, 424);
- le dispositif de collecte de données est configuré pour collecter et stocker lesdites données physiologiques ou liées à l'activité dans un élément de mémoire,

dans lequel chaque capteur portable du système (122, 222, 324, 424) est configuré pour commencer à mesurer des données d'accélération sur réception d'un signal de démarrage transmis par le dispositif de collecte de données (140, 240, 340, 440), et
chaque capteur portable est configuré pour arrêter la mesure si une condition de terminaison prédéterminée est satisfaite.

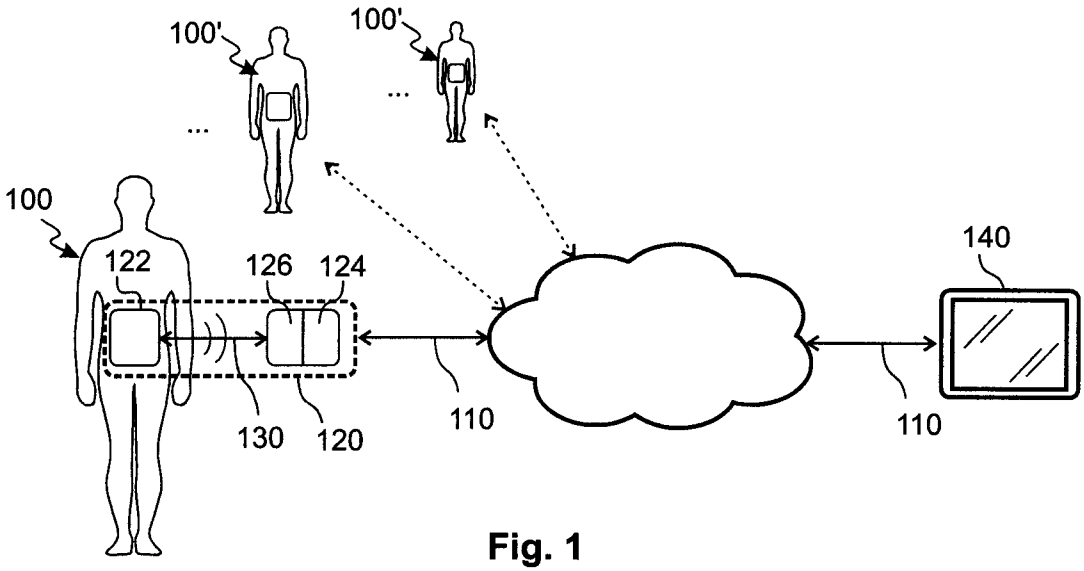

Fig. 1

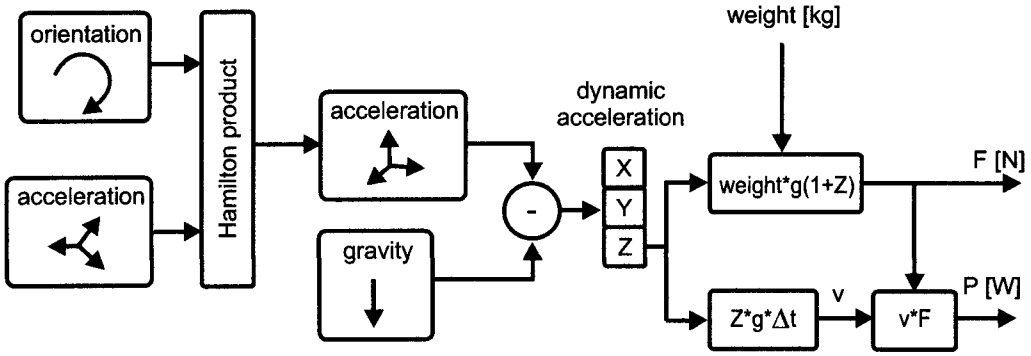

Fig. 2

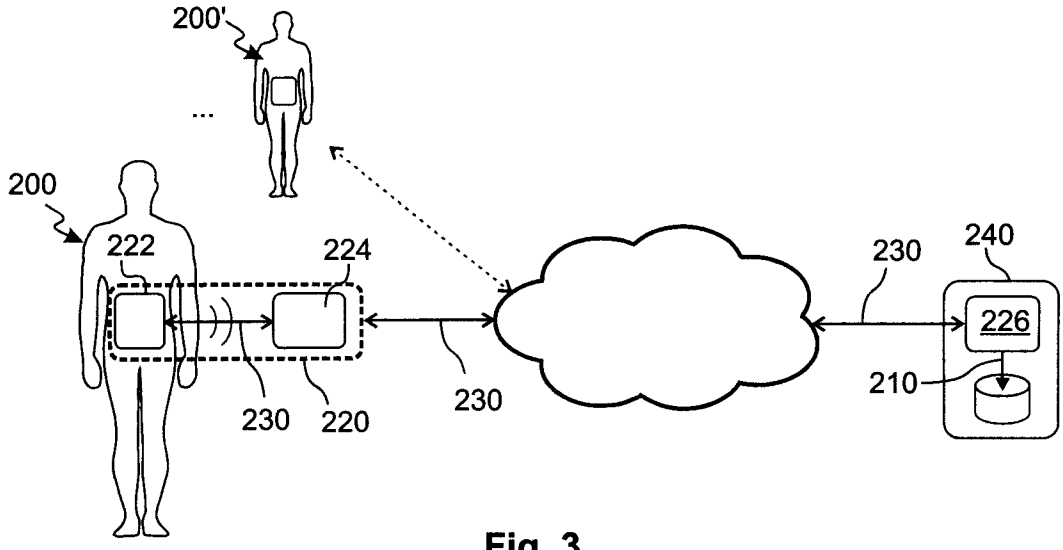

Fig. 3

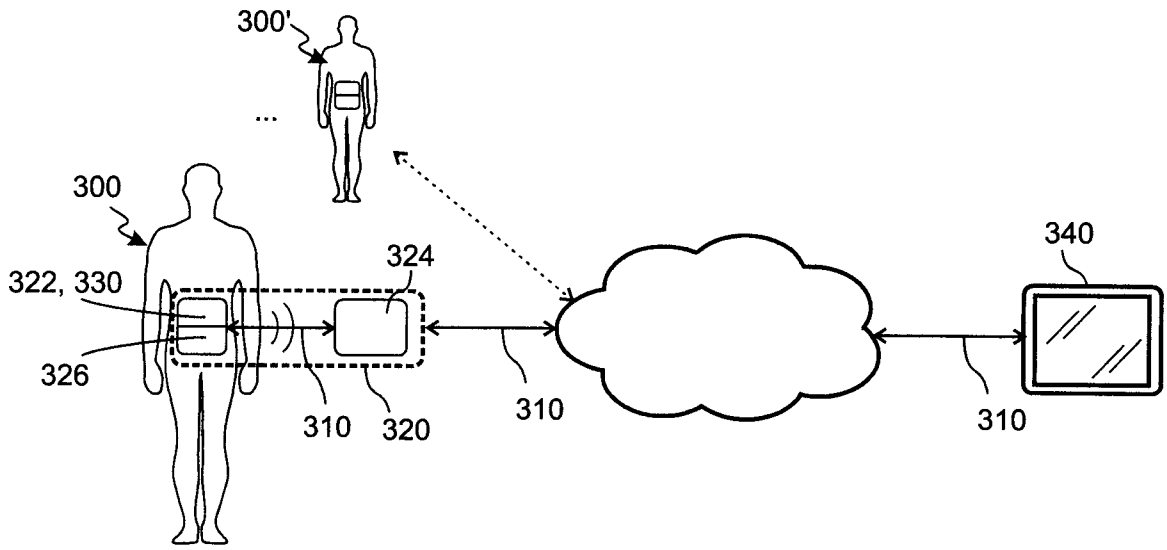
300'
...
300
322, 330
326
324
310
320
310
340
310

Fig. 4

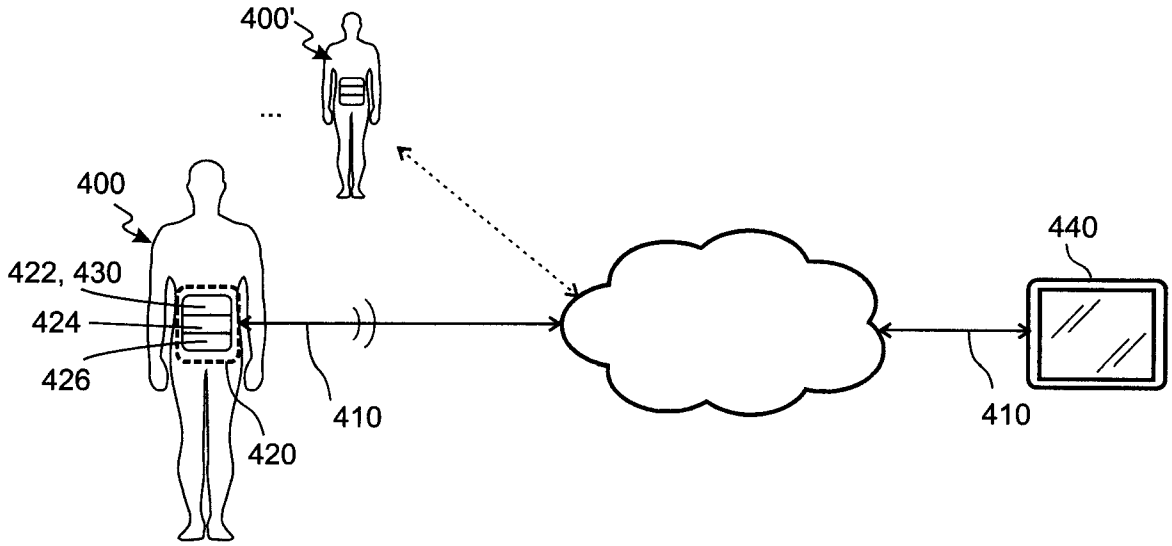
400'
...
400
422, 430
424
426
410
420
440
410

Fig. 5

Abstract

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

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.

(Fig. 1)

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

National Application Number

LO 1540
LU 93360

SEARCH REPORT

in accordance with Article 35.1 a)
of the Luxembourg law on patents
dated 20 July 1992

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2014/144258 A2 (NIKE INC [US]; NIKE INTERNATIONAL LTD [US]) 18 September 2014 (2014-09-18) * paragraphs [0004], [0006], [0124], [0148], [0150] * * paragraphs [0363], [0364] *	1-15	INV. G06F19/00
X	US 2013/184613 A1 (HOMSI KRISTOPHER L [US] ET AL) 18 July 2013 (2013-07-18) * paragraphs [0040], [0044]; figure 1a *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

G06F

The present search report has been drawn up for all claims

Date of completion of the search	Examiner
14 August 2017	Samulowitz, Michael

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C59)

ANNEX TO THE SEARCH REPORT ON LUXEMBOURG PATENT APPLICATION NO.

LO 1540
LU 93360

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

14-08-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2014144258 A2	18-09-2014	CN 105229650 A	06-01-2016
		EP 2973101 A2	20-01-2016
		JP 6158417 B2	05-07-2017
		JP 2016517329 A	16-06-2016
		KR 20150128970 A	18-11-2015
		US 2014288680 A1	25-09-2014
		US 2015306457 A1	29-10-2015
		US 2016317868 A1	03-11-2016
		WO 2014144258 A2	18-09-2014
US 2013184613 A1	18-07-2013	CA 2862214 A1	25-07-2013
		CA 2868009 A1	25-07-2013
		CN 104169922 A	26-11-2014
		CN 104169923 A	26-11-2014
		EP 2805271 A1	26-11-2014
		EP 2805272 A1	26-11-2014
		JP 5951046 B2	13-07-2016
		JP 5964456 B2	03-08-2016
		JP 2015509755 A	02-04-2015
		JP 2015511133 A	16-04-2015
		JP 2016195788 A	24-11-2016
		KR 20140117545 A	07-10-2014
		KR 20140117548 A	07-10-2014
		KR 20160127142 A	02-11-2016
		US 2013184613 A1	18-07-2013
		US 2013185016 A1	18-07-2013
		WO 2013109776 A1	25-07-2013
		WO 2013109777 A1	25-07-2013

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
LO1540	14.12.2016		LU93360

International Patent Classification (IPC)
INV. G06F19/00

Applicant
Luxbg Inst. of Science and Technology (LIST)

This report contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

Form LU237A (Cover Sheet) (January 2007)

Examiner
Samulowitz, Michael

Application No.
LU93360

WRITTEN OPINION

Box No. I Basis of the opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	1-15
	No:	Claims	
Inventive step	Yes:	Claims	
	No:	Claims	1-15
Industrial applicability	Yes:	Claims	1-15
	No:	Claims	

2. Citations and explanations

see separate sheet

1 Reference is made to the following documents:

D1 WO 2014/144258 A2 (NIKE INC [US]; NIKE INTERNATIONAL LTD [US]) 18 September 2014 (2014-09-18)

D2 US 2013/184613 A1 (HOMSI KRISTOPHER L [US] ET AL) 18 July 2013 (2013-07-18)

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

2 The present application does not meet the criteria of patentability, because the subject-matter of claim 1 does not involve an inventive step.

3 D1 is regarded as being the prior art closest to the subject-matter of claim 1, and discloses:

Method for obtaining physiological or activity related data of at least one subject using sensing means, each subject being associated with one sensing means, wherein said sensing means each comprise a wearable sensor for sensing acceleration along three axes, and data transmission/reception means for communicating with a common data collecting device, the method comprising the following steps **(Fig. 3; [0124],[0363])**:

- 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 **([0364])**

-at the data collecting device, using data reception means thereof, collecting and

storing said physiological or activity related data in a memory element **([0006])**,

wherein each wearable sensor starts measuring acceleration data upon reception of a start signal transmitted from said data collecting device **([0148])**

~~and~~

~~each wearable sensor stops measuring if a predetermined termination condition is met.~~

4 The subject-matter of claim 1 therefore differs from this known method in that it not explicitly notes that *each wearable sensor stops measuring if a predetermined termination condition is met.*

5 The *predetermined condition* is not further specified in claim 1, but as it appears from dependent claim 14 that the terminating condition may comprise *the lapse of a predetermined time interval as measured form the start signal* [...].

6 The problem to be solved by the present invention may therefore be regarded as how to avoid unnecessary measurements of a sensor (e.g. to save power).

7 If the duration of an athletic performance is known in advance it is considered straightforward to only activate the sensors for this duration (claim 14); in this context the person skilled in the art would straightforwardly solve the problem posed in the manner of claim 1. Hence, claim 1 does not involve an inventive step.

8 Further on, it is noted that claim 1 relates to a commonplace method for monitoring user activities. Considering the application as a whole the search examiner could not establish any technical problem which might potentially have required an inventive step to overcome. Consequently, it appears that the present application does not fulfill the requirements of inventive step. D2 merely provides an another example for demonstrating the commonplace features of the application.

9 Independent claim 15 corresponds to claim 1. Hence, the same reasoning as for claim 1, mutatis mutandis, applies for claims 15. In consequence, claim 15 does not involve an inventive step.

10 Dependent claims 2-14 do not contain any features which, in combination with the features of any claim to which they refer, are considered inventive, because said features are disclosed by D1, or considered straightforward:
claim 2-4: Fig. 3;
claim 5,6: [0364], [0364];
claim 7: [0004],[0146]
claim 8: [0363];
claim 9: magnetometers are commonly known;
claim 10: [0124];
claim 12: [0148];
claim 11, 13, 14: see above, reasoning for claim 1.