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(54) Title: AN APPARATUS AND METHOD FOR DETERMINING THE POSTURE OF A USER

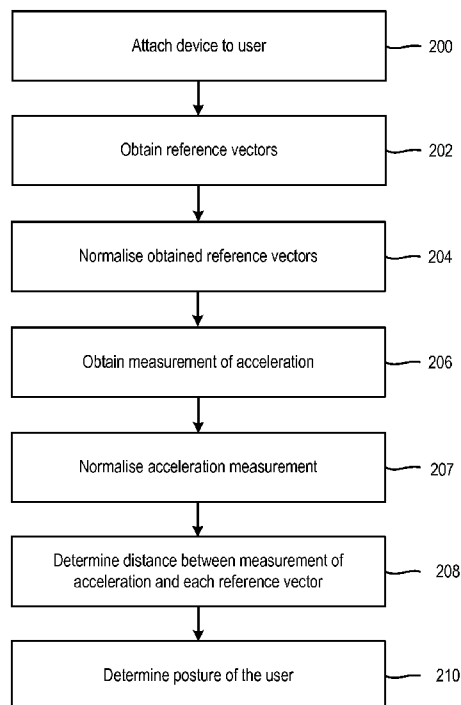


Figure 2

(57) Abstract: A device and method for determining the posture of a user is provided. A measurement of the acceleration acting on the user in three dimensions is obtained. The distance between the measurement of the acceleration acting on the user and each of a plurality of reference vectors is determined. Each reference vector corresponds to a respective posture of the user and represents the gravity acting on the user when the user is in that posture. The posture of the user is determined to be the posture represented by the reference vector having the minimum distance from the measurement of the acceleration.

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An apparatus and method for determining the posture of a user

FIELD OF THE INVENTION

The invention relates to an apparatus and method for determining the posture of a user.

5 BACKGROUND OF THE INVENTION

Many areas of technology now make use of accelerometric posture detection, i.e. the detection of the posture of a user through accelerometric measurements of the relative direction of the gravity acting on a device attached to the user. These areas include patient monitoring, fall detection, physical therapy relating to the behaviour of a person, computer
10 games, and various consumer and professional application areas that can benefit from context awareness to optimize user interaction.

Accelerometric posture detection requires an accelerometric device (i.e. a device containing an accelerometer) to be placed on, in, or attached to a user (for example, on the waist, trunk, thorax, back or sternum of the user) and an appropriate method to convert
15 the measured acceleration to an indication of the posture of the user (for example, upright, supine, prone, laying on left side, laying on right side, reclined, bent over, etc).

Typically, an acceleration measurement is mapped onto a set of pre-defined postures. Various approaches have been described to realize this mapping, all of which have particular disadvantages.

20 One example of an approach that uses mapping for converting acceleration measurements to an indication of a posture is described in US 2010/010384. US 2010/010384 describes a method in which a vector is measured while the user is in a particular posture to give a 'detected posture vector'. A 'tolerance' is defined around the detected posture vector in terms of an angle which identifies a maximum distance from the
25 detected posture vector that is to be classified to that posture. This 'tolerance' can be understood as a cone around the detected posture vector. If a subsequent measurement of the acceleration falls within the defined cone, the associated posture is output as the current posture of the user.

However, this method suffers from a number of disadvantages. For example, there will be gaps between the cones defined for various different postures, meaning that some (or even most) acceleration measurements may not fall within any of the defined cones, and the user cannot be classified to a particular posture. Also, there may be an overlap
5 between neighbouring cones for different postures, which means that an acceleration measurement cannot be classified to just one posture. In fact, In US 2010/010384, it is not possible to discriminate between different postures but rather it is only possible to determine whether or not one particular posture is present based on a measured acceleration vector.

Also, the method described in US 2010/010384 offers little flexibility in
10 configuring the system for the detection of a particular set of postures as it requires complicated processing steps to define posture zones and complicated techniques to interpret the results. Furthermore, the relatively inefficient computation method leads to unnecessarily high power consumption and system requirements, and the method can induce high sensitivity to small inaccuracies in the attachment of the device to the body of a user.

15 These disadvantages are typical of other conventional posture classification techniques.

SUMMARY OF THE INVENTION

The invention seeks to provide a device and method for determining the
20 posture of a user that enables an improved and more reliable classification of the postures of a user. The invention further seeks to overcome the other disadvantages described above.

This is achieved, according to an aspect of the invention, by a method of determining the posture of a user, the method comprising obtaining a measurement of the acceleration acting on the user in three dimensions; determining the distance between the
25 measurement of the acceleration acting on the user and each of a plurality of reference vectors, each reference vector corresponding to a respective posture of the user and representing the gravity acting on the user when the user is in that posture; and determining the posture of the user to be the posture represented by the reference vector having the minimum distance from the measurement of the acceleration.

30 The method may further comprise the step of
normalising the measurement of the acceleration acting on the user prior to determining the distance between the measurement of the acceleration acting on the user and each of the plurality of reference vectors.

Each of the reference vectors may be normalised.

The method may further comprise the step of attaching or otherwise locating a device comprising an accelerometer on the user so that the accelerometer is in a fixed orientation relative to the user.

5 The method may further comprise the step of determining the plurality of reference vectors corresponding to the respective plurality of postures of the user.

The step of determining may comprise orienting the accelerometer in a plurality of orientations, each orientation corresponding to the orientation of the accelerometer when the accelerometer is being worn by a user and the user is in a respective posture; and measuring the gravity acting on the accelerometer to give the reference vector.

10 The step of determining the distance may comprise determining the 3-dimensional Euclidean distance between the measurement of the acceleration acting on the user and each of the plurality of reference vectors.

At least one of the plurality of postures may have a plurality of reference vectors associated therewith.

15 The method may further comprise determining an indication of the likelihood or reliability associated with a determined posture based on a comparison of the minimum distance and the distance between the measurement of the acceleration and one or more of the reference vectors associated with the other posture or postures in the plurality of postures.

20 The method may further comprise providing an output indicating the determined posture; and providing an output indicating the posture having a reference vector that is the next smallest distance from the measurement of the acceleration.

25 According to another aspect of the invention, there is provided a computer program product comprising program code for causing a computer or processor to carry out the method of determining the posture of a user described above when executed by said computer or processor.

30 According to another aspect of the invention, there is provided an apparatus for determining the posture of a user, the apparatus comprising a processor configured to obtain a measurement of the acceleration acting on the user in three dimensions; determine the distance between the measurement of the acceleration acting on the user and each of a plurality of reference vectors, each reference vector corresponding to a respective posture of the user and representing the gravity acting on the user when the user is in that posture; and determine the posture of the user to be the posture represented by the reference vector having the minimum distance from the measurement of the acceleration.

The processor can be further configured to normalise the measurement of the acceleration acting on the user prior to determining the distance between the measurement of the acceleration acting on the user and each of the plurality of reference vectors.

The processor can be further configured to normalise each of the reference
5 vectors.

The apparatus can further comprise means for attaching or otherwise locating the apparatus on the user so that an accelerometer comprised therein is in a fixed orientation relative to the user.

The processor can be further configured to determine the plurality of reference
10 vectors corresponding to the respective plurality of postures of the user. In some embodiments, the processor can be configured to determine the plurality of reference vectors by orienting an accelerometer in a plurality of orientations, each orientation corresponding to the orientation of the accelerometer when the accelerometer is being worn by a user and the user is in a respective posture; and measuring the gravity acting on the accelerometer to give
15 the reference vector.

The processor can be further configured to determine the distance by determining the 3-dimensional Euclidean distance between the measurement of the acceleration acting on the user and each of the plurality of reference vectors.

The processor can be further configured to determine an indication of the
20 likelihood or reliability associated with a determined posture based on a comparison of the minimum distance and the distance between the measurement of the acceleration and one or more of the reference vectors associated with the other posture or postures in the plurality of postures.

The processor can be further configured to provide an output indicating the
25 determined posture; and provide an output indicating the posture having a reference vector that is the next smallest distance from the measurement of the acceleration.

According to another aspect of the invention, there is provided a user device that is configured to be worn by or attached to a user, the user device comprising an accelerometer that measures the acceleration acting on the user and an apparatus as described
30 above.

According to another aspect of the invention, there is provided a system comprising a user device that is configured to be worn by or attached to a user, the user device comprising an accelerometer that measures the acceleration acting on the user; and a base unit or other electronic device that is remote from the user device and that is configured

to communicate with the user device to receive measurements of the acceleration at the device, the base unit or other electronic device comprising an apparatus as described above.

BRIEF DESCRIPTION OF THE DRAWINGS

5 For a better understanding of the invention, and to show more clearly how it may be carried into effect, reference will now be made, by way of example only, to the accompanying drawings in which:

Fig. 1 is a block diagram of a device for determining the posture of a user according to the invention;

10 Fig. 2 is a flow chart illustrating a method of determining the posture of a user according to the invention; and

Fig. 3 is a diagram illustrating an example unit sphere surface defining a plurality of posture zones according to the invention.

15 DETAILED DESCRIPTION OF THE EMBODIMENTS

An embodiment of a device 100 for determining the posture of a user in accordance with the invention is shown in Fig. 1. The device 100 is adapted to be attached to a part of the body of a user, and will comprise a suitable arrangement for attaching the device 100 to that part of the body (for example a belt, strap or adhesive) so that the device 100 is
20 held in a fixed orientation relative to the user. A suitable part of the body to which the device is to be attached may be, for example, the waist, trunk, thorax, back or sternum of the user. Alternatively, the device 100 could be integrated into an item of clothing or it can be in the form of a device that is to be implanted inside the body of a user (for example the device could be a pace maker).

25 The device 100 comprises a sensor 102 for measuring the proper accelerations (i.e. physical accelerations measurable by an accelerometer) experienced by the device 100, which, assuming that the device 100 is being correctly worn by the user, correspond to the proper accelerations experienced by the user. Any reference to acceleration or measurements of acceleration in this application should be understood as referring to the proper acceleration
30 (i.e. physical accelerations measurable by an accelerometer, including effects of gravity), not just the rate of change of velocity of the device 100. This sensor 102, for example an accelerometer, outputs the acceleration measurements (signals) to a processor 104 in the device 100. In some embodiments, the accelerometer 102 is a micro-electromechanical system (MEMS) accelerometer.

The accelerometer signals obtained from the accelerometer 102 of the device 100 are analysed or processed in the processor 104. The measurements obtained from the accelerometer can be used to determine the posture of the user (for example, whether the user is upright, supine, prone, laying on left side, laying on right side, reclined, bent over, etc).

5 The device 100 optionally comprises a user interface 105, which can include, for example, one or more buttons or controls for allowing the user to operate the device 100 (including instructing the device 100 to enter into a calibration mode), and/or a display or other visual indicators that provide instructions to the user of the device 100, and/or feedback or information such as the currently detected posture of the user.

10 The device 100 further comprises a memory module 106 that is connected to the processor 104 and that can store the measurements from the accelerometer 102 prior to processing and/or the results of the processing performed by the processor 104. In addition, the memory module 106 may store computer code or program instructions relating to the processing steps to be performed by the processor 104, which can be retrieved and executed
15 by the processor 104 as required.

In this embodiment, the device 100 further comprises transmitter (TX) or transceiver (TRX) circuitry 108 and an associated antenna 110 that can be used for transmitting the accelerometer measurements or the results of the processing wirelessly to a base unit 112.

20 The base unit 112 comprises respective receiver (RX) or transceiver (TRX) circuitry 114 and an antenna 116 for receiving transmissions (such as the accelerometer measurements and/or processing results) from the device 100 and a processor 118 for controlling the operation of the base unit 112.

In an alternative implementation, the device 100 and the base unit 112 may
25 communicate via a wired connection (such as a detachable USB cable), and antennas 110 and 116 can be omitted, and the circuitry 108 and 114 adapted accordingly.

The base unit 112 optionally comprises a user interface 119, which can include, for example, one or more buttons or controls for allowing the user to operate the device 100 (including instructing the device 100 to enter into a calibration mode) remotely,
30 and/or a display or other visual indicators that provide instructions to the user of the device 100, and/or feedback or information such as the currently detected posture of the user.

The base unit 112 also optionally comprises a memory module 120 that is used for storing the information received from the device 100 along with computer code or

program instructions relating to the processing steps to be performed by the processor 118 in order to control the operation of the base unit 112.

Although in the embodiment of the invention described herein the processor 104 in the device 100 performs the processing of the accelerometer measurements, it will be appreciated that in an alternative embodiment of the invention, processor 104 in the device 100 can simply transmit the accelerometer measurements to the base unit 112 via the transceiver circuitry 108 and the processing of the accelerometer measurements can be performed by the processor 118 in the base unit 112.

In a further alternative, the processor 104 in the device 100 may perform some initial processing steps on the accelerometer measurements before transmitting the results to the base unit 112 which, for example, completes the processing.

In these embodiments, the base unit 112 can be a general purpose computer running appropriate software for processing and/or analysing the accelerometer measurements, or alternatively it can be a unit that is specifically associated with or dedicated to the user-worn device 112.

In another alternative, the device 100 may perform the processing steps on the accelerometer measurements and may store the results of the processing locally in the memory module 106 for retrieval at a later time, for example after the device 100 has been detached from the user. In this case, the device 100 can be a stand-alone device (i.e. there is no associated base unit 112). This alternative would be useful in cases of non-acute or long term monitoring, and for research purposes.

In accordance with the invention, a respective reference vector is obtained for each of a plurality of postures of a user (the reference vector indicating the direction of gravity acting on the device/user while the user is in that posture). A subsequent measurement of acceleration by the accelerometer 102 is mapped to one of the plurality of postures by evaluating the distance between the measurement of acceleration and each of the reference vectors, and determining the posture of the user to be the posture represented by the reference vector having the least distance from the measurement of the acceleration. In this way, any measurement of acceleration can be mapped to a single posture in the plurality of postures.

Fig. 2 is a flow chart illustrating some exemplary steps in a method according to an embodiment of the invention.

In step 200, the device 100 is attached to the body of a user. The attachment of the device to the user is achieved using a suitable arrangement for attaching the device 100

to that part of the body (for example, a belt, strap, or adhesive), or by the user putting on the item of clothing into which the device 100 is integrated. A suitable part of the body to which the device is to be attached may be, for example, the waist, trunk, thorax, back or sternum of the user. It may be necessary for the device 100 to be in a particular orientation relative to the user's body (for example if one or more reference vectors for various postures have already been determined or defined), in which case the device 100 may contain visual markings indicating the desired orientation, and/or the attachment means or clothing can be such that it is only possible to place the device 100 on the user in one orientation.

In step 202, the processor 104 obtains a plurality of reference vectors corresponding to a respective plurality of postures of the user. Each reference vector represents the gravity acting on the user when the user is in that posture (where gravity is represented as observed through accelerometry, i.e. as an acceleration directed away from the Earth's surface). These reference vectors can be obtained in a calibration process in which the user adopts various postures, and a measurement of the acceleration (gravity) is taken while the user is in that posture. In some embodiments, the posture associated with each measured vector can be identified for the device 100 by the user or other device operator selecting the posture from a list presented on the user interface 105 of the device 100 or at the base unit 112, or by the user or operator manually inputting in the name or a description of the current posture of the user. The reference vectors are typically in the form of a vector $\mathbf{a}_{\text{ref}} = [a_{\text{refx}}, a_{\text{refy}}, a_{\text{refz}}]$, which relates to a point in 3D Euclidean space where x, y, and z correspond to the three axes of the accelerometer 102. The reference vectors are stored in the memory module 106, along with an indication (e.g. the name) of the associated posture. The processor 104 can obtain or retrieve the reference vectors from the memory module 106 when a posture is to be determined.

Optionally, in step 204, the reference vectors are normalised so that the reference vectors are of unit length:

$$\hat{\mathbf{a}}_{\text{ref}} = \frac{\mathbf{a}_{\text{ref}}}{\sqrt{(a_{\text{refx}}^2 + a_{\text{refy}}^2 + a_{\text{refz}}^2)}} \quad (1)$$

Once normalised, the reference vectors can be thought of as defining a reference point corresponding to the respective posture on the surface of a unit sphere. This is illustrated in Fig. 3, where there are reference vectors for a number of different postures including left side, reclined, upright, forward, supine and upside down. It can be seen that,

for example, the posture 'upright' on the unit sphere has a reference vector [0,1,0], and the posture 'supine' on the unit sphere has a reference vector [0,0,1].

When the device 100 is to be used to determine the posture of the user, a measurement of the acceleration acting on the user in three dimensions is obtained from the accelerometer 102 (step 206). Preferably, the user of the device 100 is not undergoing any substantial acceleration (other than the effect of gravity) when the measurement is obtained (as otherwise this acceleration will affect the measurement of gravity by the accelerometer 102). A pre-processing step may be applied to ensure that gravity is reliably represented in the measurement before further processing is performed. The measurement of the acceleration obtained from the accelerometer 102 is provided to the processor 104, which performs posture detection.

Prior to posture detection, however, the measurement of acceleration can be (optionally) normalised according to equation (1) above (step 207).

In step 208, the processor 104 determines the distance between the measurement of the acceleration acting on the user obtained in step 206 and each of the plurality of reference vectors obtained in step 202. If the measurement of acceleration and the reference vectors are normalised, the processor 104 may calculate the 3-dimensional Euclidean distances between the normalised measurement of acceleration and each of the obtained normalised reference vectors. This is calculated using:

$$\text{distance} = \sqrt{(\hat{a}_{mx} - \hat{a}_{refx})^2 + (\hat{a}_{my} - \hat{a}_{refy})^2 + (\hat{a}_{mz} - \hat{a}_{refz})^2} \quad (2)$$

where $\hat{a}_m = [\hat{a}_{mx}, \hat{a}_{my}, \hat{a}_{mz}]$ is the normalised measurement of acceleration.

Alternative to the processor 104 calculating 3-dimensional Euclidean distances (which are the lengths of the chords linking the acceleration vector and each of the reference vectors), the processor 104 may calculate angular distances between the reference vectors (i.e. the distance traversed along the surface of the unit sphere between the measured acceleration vector and the reference vectors), or the processor 104 may use the magnitude of the cross product (vector product) of the measurement of acceleration and the reference vector as a distance measure. Those skilled in the art will appreciate how to implement such distance calculations. In addition, it will be appreciated that in alternative embodiments, rather than determine an explicit measure of the distance between the measurement of acceleration and each of the reference vectors, the distance can be determined in terms of the angle between the measured acceleration vector and each of the reference vectors (the

angle being directly related to the distance therebetween). References to determining the 'distance' between a measurement of acceleration and a reference vector in this application should be interpreted accordingly.

In step 210, the processor 104 determines the posture of the user to be the posture represented by (or corresponding to) the reference vector having the minimum/smallest distance from the measurement of the acceleration. In this way, any measurement of acceleration can be classified to a particular posture, the posture being that which has a reference vector closest to the measurement of acceleration. The processor 104 can control the user interface 105 to display the determined posture, store the determined posture in the memory module 106 for later retrieval and/or to output the determined posture via the antenna 110 to the base unit 112.

It will be appreciated that by determining the posture of the user to be that which has a reference vector closest to the current measurement of acceleration, the entire surface of the unit sphere shown in Fig. 3 is effectively divided into respective zones for each of the postures. Thus, any measurement of acceleration lying in a particular zone on the surface of the unit sphere will be classified to the posture associated with that zone. For example, zone 302 is the zone associated with the supine posture, and any measurement of acceleration lying within zone 302 will be classified as representing the user being in the supine posture. Likewise zones 304 and 306 correspond to the user being on their left side or upright respectively. The borders between posture zones are effectively located on so called great circular arcs (i.e. particular line segments on a sphere surface) that are exactly halfway between reference points/vectors, and thus the configuration of the borders/zones will depend on the number of postures being monitored for and their respective reference vectors.

Thus the above method for determining the posture of a user provides a number of advantages. For example, the method provides flexibility in the set of postures to be detected. This is achieved since adding or removing postures from the set is as simple as adding or removing the corresponding reference vectors (which, when visualising the classification performed by the invention in terms of a unit sphere as in Fig. 3, results in the posture zones and their borders being automatically adapted). Moreover, by evaluating the distance measurement, every possible measurement of acceleration will be classified to a single posture (i.e. there are no gaps between posture zones – the total set of posture zones exactly covers the sphere surface). The preferred embodiments of the device and method illustrated above further provide efficient computation compared to the prior art because the need to calculate angles is eliminated in view of the implicitly defined borders, and a 3D

Euclidean distance only has to be calculated per defined reference vector. Furthermore, the device and method provides accurate posture detection, with tolerance to variations in the way that the user attaches the device 100 to themselves, or in the way different users use the device 100 (for example due to anatomical variability).

5 It will be noted that the method illustrated in Fig. 2 includes initial calibration steps (steps 202 and 204) as well as the steps performed during normal use of the device 100. It will be appreciated that the calibration steps can be performed during the design, manufacture or testing of the device 100 and need not require the device 100 to be attached to an end user. For example, where the device 100 is to be used in a predetermined orientation
10 on the user, the reference vectors can be estimated without having to manually orientate the device 100 into each of the posture positions and take an appropriate measurement of gravity.

Furthermore, it will be appreciated that even after an initial calibration stage in which reference vectors are determined for a plurality of postures, calibration so that the device 100 can monitor for additional postures can be performed by repeating step 202 while
15 the user is in the additional posture(s). As the posture of the user is determined based on simply evaluating the distance between the current measurement of acceleration and the previously-determined reference vectors, adding or removing postures from the analysis is easy to do and does not affect the complexity of the calculations to be performed by the device 100. It will be appreciated from Fig. 3 that removing the reference vector
20 corresponding to, say, the supine posture, will result in zone 302 being removed and the borders of the zones surrounding zone 302 will be 'redrawn' to classify any measurement vector in zone 302 to one of the remaining postures.

In the embodiment described above, each posture is associated with one reference vector. However, it will be appreciated that, in an alternative embodiment,
25 multiple reference vectors may be associated to a single posture (for one or more postures). This has the additional advantage of enabling further control over the implicit definition of the borders between posture zones, which may be desirable for some applications. If multiple reference vectors are associated to a single posture, it is preferably ensured that no other reference vectors are located in/on the area/line(s) between those multiple reference
30 vectors.

In an extended embodiment, in addition to a detected posture, the system may provide more elaborate indications of how the acceleration measurement relates to the posture reference vectors. For instance, the system may provide an indication if the measured acceleration vector is very close to a border between two or more reference

vectors. Such an indication may be presented and/or interpreted as a measure of ambiguity, likelihood or reliability: i.e. when the measured acceleration vector is close to a border (i.e. the minimum distance is not much smaller than the next smallest distance - which is the distance to the other reference vector defining the border), ambiguity is high, and therefore

5 the posture detection result may need to be treated differently than when the measured vector is far from borders and ambiguity is therefore low. For example, if the distance between the measured vector and the nearest border (which can be derived from the distances of the measured vector to the first and second nearest reference vectors) is less than 10% of the distance between the measured vector and the first nearest reference vector, it may be said
10 that ambiguity is 'high'; if it is more than 50% it may be said that ambiguity is 'low'; otherwise it may be said that ambiguity is 'intermediate'. In another example, absolute rather than relative distances to borders may be used (e.g. a distance of less than 0.15 [based on unit sphere dimensions] between measured vector and border may be judged as high ambiguity).

In order to determine whether the measured acceleration vector is close to a border, the
15 comparison of the minimum distance and the distance between the measurement of the acceleration and one or more of the reference vectors associated with the other posture or postures in the plurality of postures may include normalisation to one or more of the distances involved or may simply be based on the relative size of the distances involved.

In addition to such a measure of ambiguity, and especially in case of higher
20 ambiguity, the system may provide indications of second (and further) nearest postures, so as to enable a more detailed interpretation of the measurement (for example, the posture determination can output that the user is in an 'upright' posture, but indicate that they are leaning to their right if the next nearest posture is 'lying on right side').

Also, a system that assesses ambiguity in such a way may be configured to
25 change the posture detection output in particular situations: e.g. when ambiguity is high, the posture detection result may be changed to 'undefined' or 'near border between [first posture] and [second posture]'.

While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or
30 exemplary and not restrictive; the invention is not limited to the disclosed embodiments.

Variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A

single processor or other unit may fulfil the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. A computer program may be stored/distributed on a suitable medium, such as an optical storage medium or a solid-state medium supplied together with or as part of other hardware, but may also be distributed in other forms, such as via the Internet or other wired or wireless telecommunication systems. Any reference signs in the claims should not be construed as limiting the scope.

5

CLAIMS:

1. A method of determining the posture of a user, the method comprising:
obtaining a measurement of the acceleration acting on the user in three
dimensions;

determining the distance between the measurement of the acceleration acting
on the user and each of a plurality of reference vectors, each reference vector corresponding
to a respective posture of the user and representing the gravity acting on the user when the
user is in that posture; and

determining the posture of the user to be the posture represented by the
reference vector having the minimum distance from the measurement of the acceleration.

2. A method as claimed in claim 1, further comprising the step of:
normalising the measurement of the acceleration acting on the user prior to
determining the distance between the measurement of the acceleration acting on the user and
each of the plurality of reference vectors.

3. A method as claimed in claim 1 or 2, wherein each of the reference vectors is
normalised.

4. A method as claimed in claim 1, 2 or 3, the method further comprising the step
of:

attaching or otherwise locating a device comprising an accelerometer on the
user so that the accelerometer is in a fixed orientation relative to the user.

5. A method as claimed in any preceding claim, the method further comprising
the step of:

determining the plurality of reference vectors corresponding to the respective
plurality of postures of the user.

6. A method as claimed in claim 5, wherein the step of determining comprises:
orienting the accelerometer in a plurality of orientations, each orientation
corresponding to the orientation of the accelerometer when the accelerometer is being worn
by a user and the user is in a respective posture; and

5 measuring the gravity acting on the accelerometer to give the reference vector.

7. A method as claimed in any preceding claim, wherein the step of determining
the distance comprises determining the 3-dimensional Euclidean distance between the
measurement of the acceleration acting on the user and each of the plurality of reference
10 vectors.

8. A method as claimed in any preceding claim, wherein at least one of the
plurality of postures has a plurality of reference vectors associated therewith.

15 9. A method as claimed in any preceding claim, further comprising:
determining an indication of the likelihood or reliability associated with a determined posture
based on a comparison of the minimum distance and the distance between the measurement
of the acceleration and one or more of the reference vectors associated with the other posture
or postures in the plurality of postures.

20 10. A method as claimed in any preceding claim, further comprising:
providing an output indicating the determined posture; and
providing an output indicating the posture having a reference vector that is the
next smallest distance from the measurement of the acceleration.

25 11. A computer program product comprising program code for causing a
computer or processor to carry out the method according to any one of the preceding claims
when executed by said computer or processor.

30 12. An apparatus for determining the posture of a user, the apparatus comprising:
a processor configured to:
obtain a measurement of the acceleration acting on the user in three
dimensions;

determine the distance between the measurement of the acceleration acting on the user and each of a plurality of reference vectors, each reference vector corresponding to a respective posture of the user and representing the gravity acting on the user when the user is in that posture; and

- 5 determine the posture of the user to be the posture represented by the reference vector having the minimum distance from the measurement of the acceleration.

13. A user device that is configured to be worn by or attached to a user, the user device comprising:

- 10 an accelerometer that measures the acceleration acting on the user; and
 an apparatus as claimed in claim 12.

14. A system, comprising:

- a user device that is configured to be worn by or attached to a user, the user
15 device comprising an accelerometer that measures the acceleration acting on the user; and
 a base unit or other electronic device that is remote from the user device and
that is configured to communicate with the user device to receive measurements of the
acceleration at the device, the base unit or other electronic device comprising an apparatus as
claimed in claim 12.

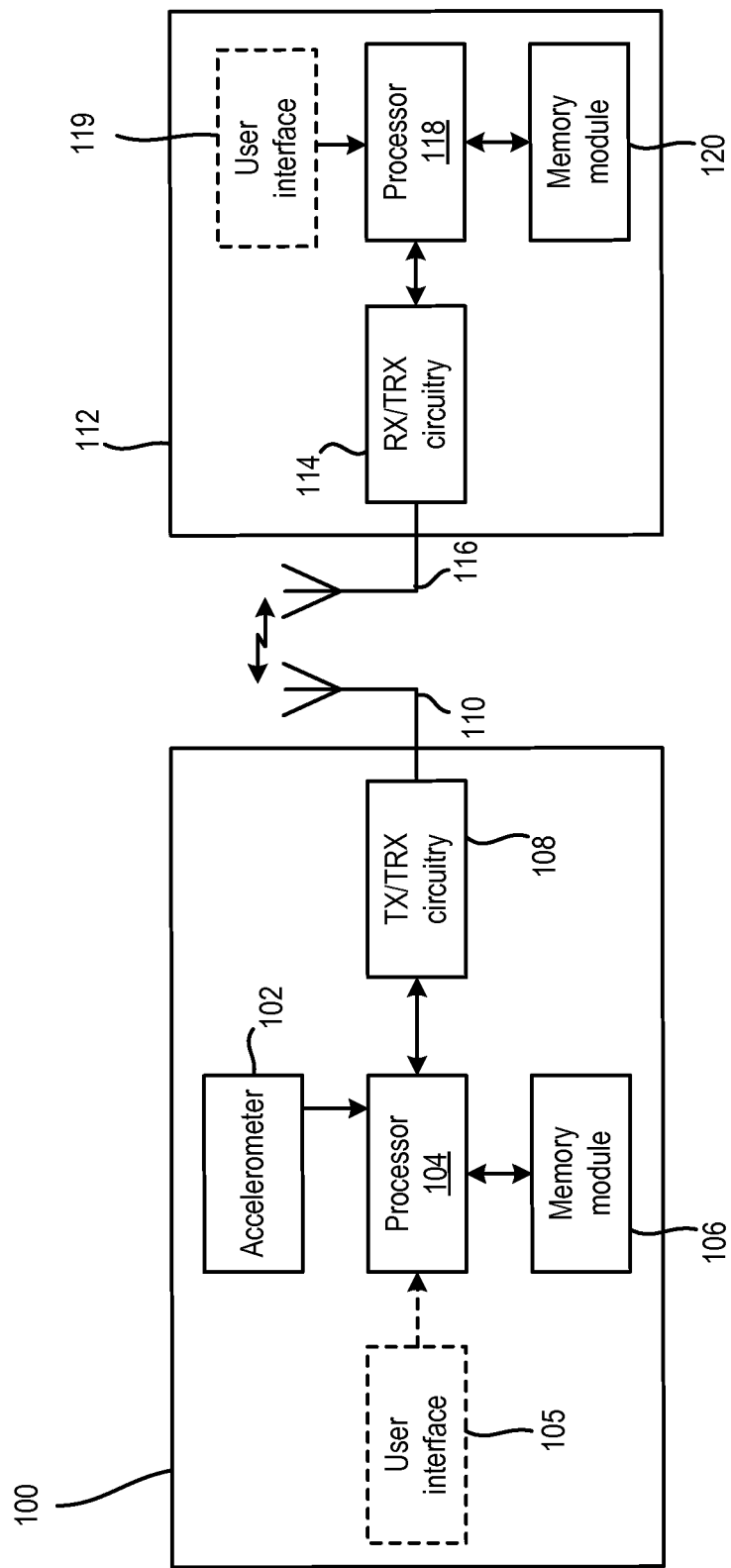


Figure 1

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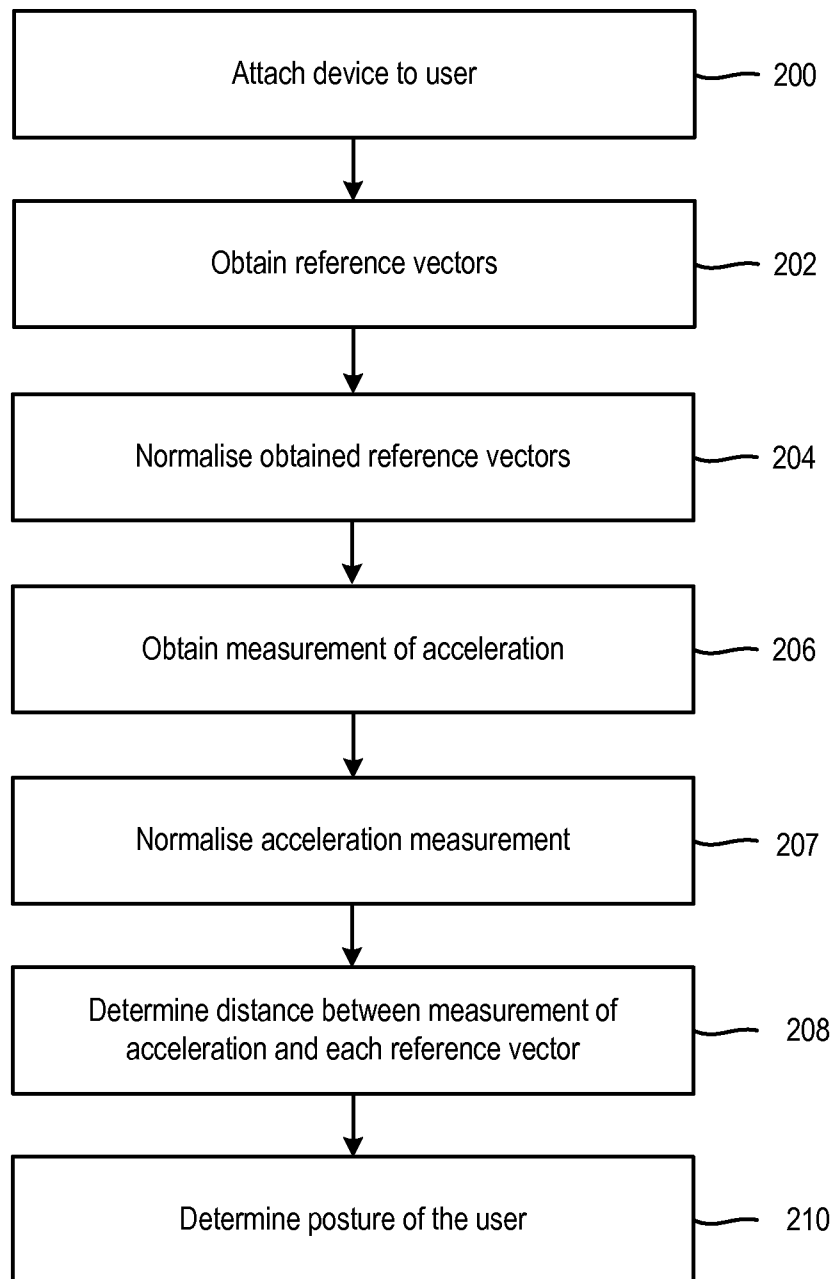


Figure 2

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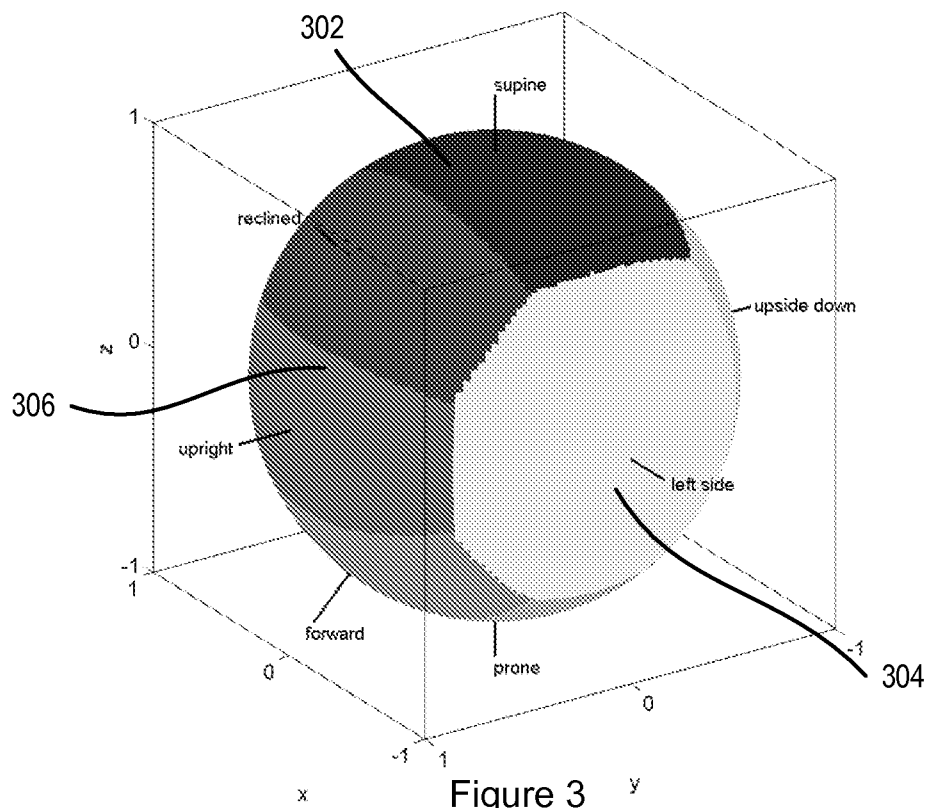


Figure 3

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2013/051949

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61B5/11

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)

A61B

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

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Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

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Date of the actual completion of the international search

10 July 2013

Date of mailing of the international search report

16/07/2013

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/051949

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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