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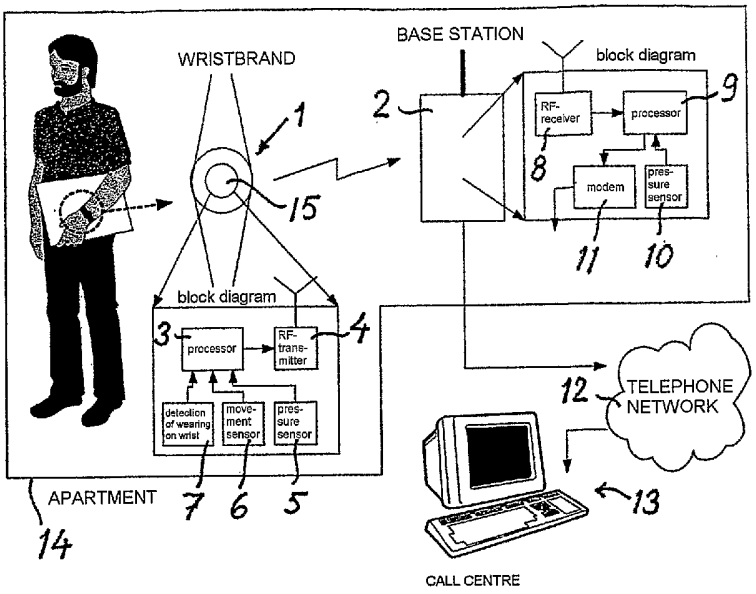
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(54) Title: A DEVICE FOR INDICATING A FALL



Safety wristband system with means required for fall indication.

(57) Abstract: The invention relates to a device for indicating a fall, the device (1, 2) comprising a portable device (1) attached to the wrist or elsewhere on the body. The portable device (1) comprises a sensor (5) for measuring differences in height, and falling is indicated by a change in the relative height measured by the device, which is caused by a sudden reduction in the height of the portable device (1).

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A device for indicating a fall

The invention relates to a device for indicating a fall, the device comprising a portable device attached to the wrist or elsewhere on the body.

Falling accidents are common among the elderly. Following a fall, an elderly person is often unable to stand up again by himself and thus requires help. By means of conventional safety alarm devices, an elderly person is himself able to summon help by pressing the alarm button he carries on his person. The problem with this method is, however, that the elderly person may be so badly injured as a result of the fall that he will not be able to summon help, for example, due to unconsciousness. An automatic fall detector system could generate an alarm automatically, should the elderly person himself be unable to stand up or activate the alarm.

The automatic safety alarm devices currently in use, which are able to activate an alarm even if the user is unable to do so, apply two methods based on different principles to such falling situations.

The IST Vivago wrist-care measures movements from the user's wrist. Should no movements be detected, or if the number of movements is low for a longer period of time, the device will send an automatic alarm. The idea is that this state is not normal. The device is unable to detect falls directly, but it can detect an immobility state possibly following a fall and thus trigger an alarm. The problem with the method is that an alarm of this type is not very specific and to avoid false alarms, the alarm delay must be relatively long (30 min. to 3 h).

The fall detectors described, for example, in the patent applications GB 2323196, EP 0 877 346 A and EP 1 128 349 A1 are based on measuring the acceleration, speed and posture of the body and by means of them, on

indicating the falling incident through various algorithms. Studies have shown that one such device is relatively reliable and has a short delay, but the problem with this and all other corresponding methods is the usability of the device. In the method, the state of moving is measured by means of a device that must be carried attached to the trunk, for example on a belt. If attached to the extremities, for example the wrist, the device will not function. The use of a separate device that has to be carried on a belt will in practice often be neglected, which means that help will not be available when needed. In practice, the most suitable locations for the device in long-term use are in a wristband and a pendant.

An optimal fall detector should be easy to carry, reliable and have as short an alarm delay as possible.

The aim of the invention is to provide a device by means of which the problems relating to the above-mentioned methods and devices can be avoided.

This aim is achieved in accordance with the invention, by means of the characteristics described in claim 1. Preferred embodiments and applications of the invention are disclosed in the dependent claims.

A preferred embodiment of the invention is based on the fact that by means of a sensitive barometer (air pressure sensor) fitted to a safety wristband, or corresponding portable alarm device, can be detected differences in air pressure that correspond to a vertical displacement of some 0.5 m . The required measurement resolution is achieved, for example, by means of sport wrist computers that comprise an altimeter, or height meter based on the measurement of air pressure. At its simplest, the indication of a fall is based on a rapid change in measured air pressure.

If measurement of movement is combined with the measurement air pressure from the wrist, the reliability of the fall alarm can be increased. By measuring movement, both the big movement caused by the fall, and a motionless state following the fall, which may be due to, for example, unconsciousness, may be detected.

Changes in ambient air pressure resulting from opening doors or air conditioning in the apartment may be compensated for by means of another reference sensor fixedly installed in the apartment. The safety alarm devices transmit the alarms and any measurement data to a fixed base station in the apartment wirelessly by means of a short-range radio transmitter. In the base station can advantageously be located a second pressure sensor for measuring the air pressure in the apartment. When the portable alarm device sends the air pressure data to the base station it is able to compare the changed data with the signal of its own pressure sensor. If the same change is detected by both sensors at the same time, this refers to a change in the ambient pressure and is not related to falling.

The reliability of fall detection can also be increased if the wristband or portable alarm device identifies automatically that it is properly carried by the user. In the case of a wristband, this may advantageously be done, for example, by impedance measurement of the skin on the wrist. If the device does not identify being attached to the arm, pressure changes will not indicate a fall. In this way, false alarms resulting, for example, from dropping the device can be eliminated.

The invention is illustrated in the following by means of an example, with reference to the accompanying drawing, in which

Figure 1 shows the device according to the invention when comprised in a safety wristband as a block diagram, and

Figure 2 shows the behaviour of the measurement signals measured by the device according to the invention in a falling incident.

Figure 1 shows a safety wristband 1 carried by the user which is in wireless data communication with the base station 2 located on the same premises or in the same apartment 14 as the user.

The safety wristband 1 comprises a sensitive pressure sensor 5 for measuring changes in air pressure, a movement sensor 6 for measuring changes (accelerations) in the state of movement, and a sensor 7 for identifying the wearing on the wrist. The functioning of the sensor 7 may be based, for example, on impedance measurement of the skin. The measurement data from the sensors 5, 6, 7 are entered in a processor 3, which formulates an indication of the fall from the measurement results, or sends the data on the measurement results to the base station 2 by means of a transmitter 4, in which case the base station uses the measurement data from the sensors 5, 6, 7 for analysing and indicating the falling incident. Alternatively, analysis and indication may be done already on the processor of the portable device 1.

The base station 2 includes a receiver 8 which relays the measurement data from the device 1 to the processor 9. The base station 2 has a second, stationary pressure sensor 10, which functions as a reference sensor of pressure changes and which is connected to the processor 9. An alarm on a possible falling incident can be sent through a modem 11 and the telephone network 12 to the call centre 13 or other recipient.

One possible fall detection algorithm could be, for example, the following:

1. The wristband 1 identifies that it is on the wrist and detects a rapid reduction in height (>0.5 m) by measuring a change in the air pressure.

The change corresponds to moving from an upright posture to a supine posture on the floor.

2. It is checked whether the change in air pressure is associated with a rapid movement of high amplitude.

3. The wristband 1 sends the measurement data to the base station 2. The base station 2 checks whether the ambient air pressure has changed at the same time. If it has, no alarm is sent.

4. The base station 2 waits until it can be confirmed on the basis of the measurement of movement by the wristband 1 that the user's movements have stopped for a sufficiently long time (possible unconsciousness) following the change.

5. The base station sends an alarm on a possible fall.

The algorithm can be optimised by using real measurement data from real sensors. Figure 2 illustrates graphically the behaviour of the measuring signals in a falling incident.

The basic idea is that the rapid change in the height of the wristband resulting from the fall is detected by the sensor 5 measuring the differences in height, which is an air pressure sensor in the embodiment disclosed. Changes in air pressure may, however, occur often due to various reasons: moving in stairs, changes in the air pressure of the room, etc. Changes in the environment may advantageously be compensated for by a second, stationary reference sensor 10. Other normal changes in height due to the user moving can be distinguished by combining a specific change in air pressure with a rapid change in the state of movement and a possible discontinuation of movement following it. Measurement of changes in

posture may also be used for the same purpose. In such a case, the wristband 1 comprises a posture measurement sensor in addition to or instead of the movement sensor 6. Pressure changes due to the moving of the device alone can be compensated for automatically by identifying whether the device is on the wrist or otherwise properly carried.

By means of the device, detection of falls is improved and expedited considerably in comparison with known fall alarm devices.

A special application of the device according to the invention is a fall alarm connected to a safety telephone or other safety service of special groups, particularly the elderly.

The advantages of the device according to the invention are the following:

- The technical implementation required is easily accomplished in an existing safety telephone system which comprises a portable wristband and a base station installed in the apartment.

- The sensors can be fitted in the wristband, which is not possible with a fall alarm based solely on the indication of body posture. The method does not, therefore, require wearing a separate accessory on the waist, or attached to the trunk.

- By applying the method to a wristband, it is easy and economical to carry out automatic identification as to whether the device is on the wrist or not. This may be carried out, for example, by the widely known impedance measurement of the skin of the wrist. By means of this identification, false indications can be avoided when the device is not in fact in use.

- The method improves the reliability of alarms based merely on movement or body posture, and makes possible a shorter alarm delay.

- Implementation does not require any additional devices in the living environment, such as fall indication based on indoor positioning does.

- The technical implementation is based on the utilisation of existing sensors and on combining the information obtained from them.

- The implementation is extremely economical, because the pressure sensor required and its measuring electronics are low-priced and simple to connect to the electronics of a portable alarm device and a processor. This also concerns the sensor in the base station which is needed for compensating ambient pressure changes.

The sensor 5 for measuring height difference may also be other than a sensor measuring changes in air pressure. It may be based on, for example, 3-dimensional indoor positioning, or on indoor positioning applying radio technology and time modulation in general, by means of which changes in relative height can also be measured.

Claims

1. A device for indicating a fall, the device (1, 2) comprising a portable device (1) attached to the wrist or elsewhere on the body, **characterised** in that the portable device (1) comprises a sensor (5) for measuring differences in height, and a fall is indicated by a change in the relative height measured by the device.

2. A device as claimed in claim 1, **characterised** in that the sensor (5) measuring differences in height is a sensor (5) that measures air pressure and a fall is indicated by a change in the air pressure measured by the device, which is caused by a reduction in the height of the portable device (1).

3. A device as claimed in claim 1 or 2, **characterised** in that the portable device (1) further comprises a sensor (6) for measuring movement, and a fall is indicated, when the measured relative height changes and, at the same time, the movement sensor (6) detects a rapid movement of the hand or body due to the fall.

4. A device as claimed in claim 3, **characterised** in that the device (1, 2) comprises a data processing unit (3/9) which is arranged to indicate falling through measurements of relative height and movement, when a change in relative height is followed by a motionless state of the user which continues for a predetermined period.

5. A device as claimed in claim 1 or 2, **characterised** in that the portable device (1) further comprises a sensor for measuring the body posture, and a fall is indicated when the measured relative height changes and, at the same time, the body posture sensor detects a rapid change in the posture of the hand or body due to the fall.

6. A device as claimed in claim 5, **characterised** in that the device comprises a data processing unit (3/9), which is arranged to indicate falling through measurements of relative height and body posture, when a change in relative height is followed by a state continuing for a predetermined period during which the user's posture does not change.

7. A device as claimed in any of the claims 1 to 6, **characterised** in that the portable device (1) comprises a sensor (7) for identifying wearing on the wrist, by means of which the portable device (1) automatically identifies whether it is being carried by the user or not, and falling is only indicated when the portable device (1) identifies that it is being carried by the user.

8. A device as claimed in any of the claims 1 to 7, **characterised** in that in addition to the portable device (1), on the same premises (14) with the user is another, stationary device (2) comprising a reference sensor (10) and a fall is indicated by comparing the data from the reference sensor and the height difference sensor (5) of the portable device.

9. A device as claimed in claim 8, **characterised** in that the reference sensor (10) is a pressure sensor (10) for measuring changes in ambient air pressure, and a fall is indicated when the air pressure measure by the portable device (1) changes and at the same time the ambient air pressure measured by another, stationary device (2) does not change.

10. A device as claimed in claim 8 or 9, **characterised** in that the portable device (1) is in data communication with the other, stationary device (2) which indicates the fall on the basis of measurements.

11. A device as claimed in claim 8 or 9, **characterised** in that the portable device (1) is in data communication with the other, stationary device (2), and the portable device (1) indicates the fall on the basis of measurements.

12. A device as claimed in any of the claims 1 to 11, **characterised** in that on indication of a fall, the device (1, 2) sends an alarm which is transmitted via data communication (12) an the alarm control centre (13) or other alarm recipient.

13. A device as claimed in any of the claims 1 to 12, **characterised** in that the portable device (1) has an alarm button (15), by pressing which the user is himself able to trigger the alarm that is transmitted to the alarm control centre (13) or other recipient.

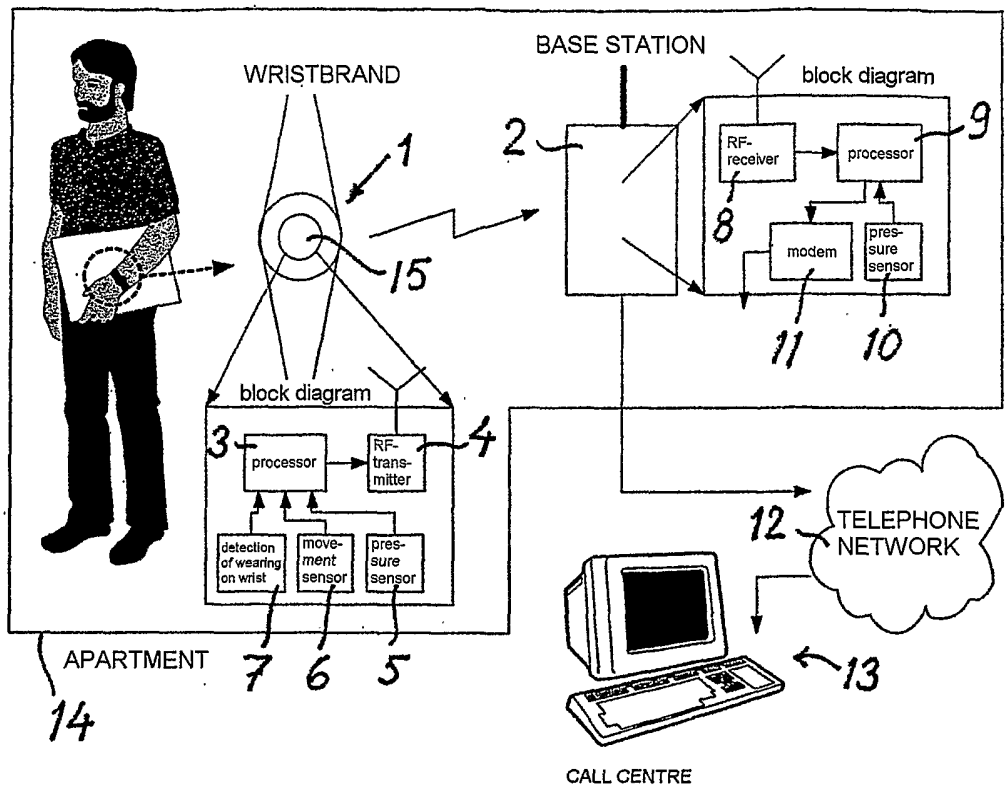


Figure 1. Safety wristband system with means required for fall indication.

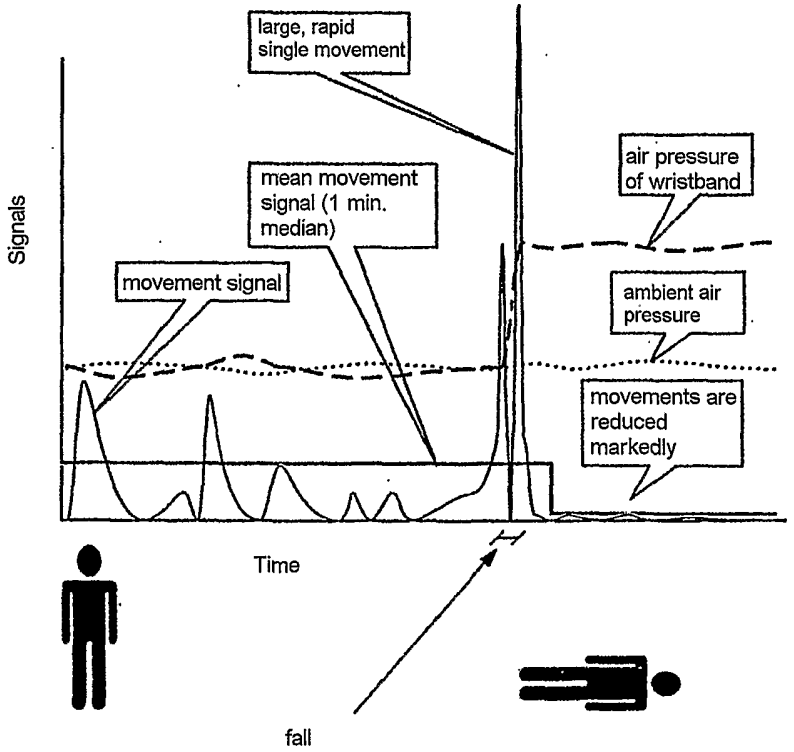


Figure 2. Behaviour of measurement signals in a falling incident.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 2004/050103

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G08B 21/02, G08B 21/04
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)

IPC7: G08B

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL,WPI,PAJ,INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DATABASE WPI week 200103 Derwent Publications Ltd.,London,GB; Class S05,AN 2001-019504 & JP 2000285223 A (MATW)MATSUSHITA ELECTRIC WORKS LTD) 13 October 2000(2000-10-13) abstract ---	1-13
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Y	EP 0877346 A1 (CSEM), 11 November 1998 (11.11.1998), claim 1, abstract ---	1-13

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

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Date of the actual completion of the international search	Date of mailing of the international search report
1 November 2004	03 -11- 2004
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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