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(54)

MONITORING SYSTEM

(57)

A method for monitoring a first user at a site (7), the method comprising receiving (101), via a communication network, input signals from at least one sensor (2, 3) arranged at the site (7), wherein the input signal carries detection values. The method further comprises generating activity data from the received detection values, comparing the generated activity data with base line activity data and generating an alert if generated activity data deviates from the baseline activity data to a pre-determined degree.

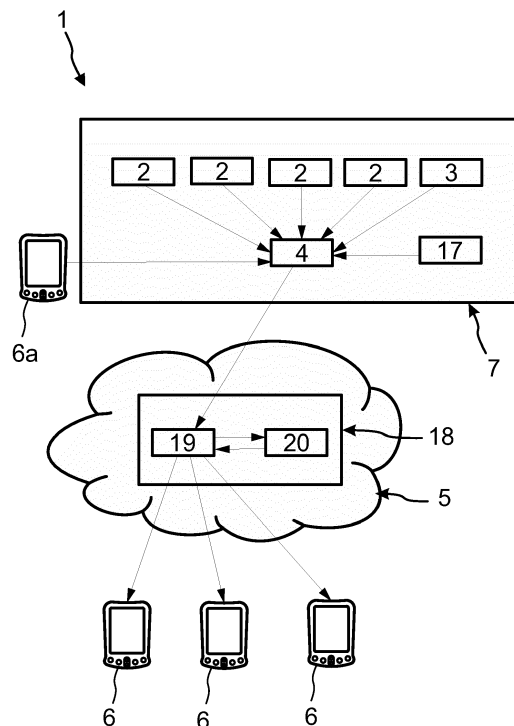


Fig. 1

Description

TECHNICAL FIELD

[0001] The present invention relates to a system and a method for monitoring movements of a first user, and a kit for installing such system.

BACKGROUND

[0002] Many elderly people live by themselves. It may be due to their own will, because they want to continue living in their own apartment or house, or it may be due to lack of retirement homes or service homes. It is common that their children do not live close by, and because of that cannot visit their elderly parents very often. Still, the children or other relatives are often concerned about the elder's ability to take care of themselves.

[0003] Correspondingly, an elderly person may be concerned about his/her own health and may feel anxious about living alone. Others want to live at home for as long as possible, but do not want their relatives to worry and be concerned about them.

[0004] Another issue occurs at service homes or retirement homes where the staff and caregivers worry about not being present when and where they are needed the most.

[0005] Safety alarms to be worn as a bracelet around the wrist exist in order to provide a resident with a sense of safety. However, many elderly residents are hesitant to use these alarms due to various reasons, one being that they do not want to disturb. Another reason to why the alarm bracelets do not function satisfactory is that the user takes it off and do not wear it when they e.g. fall over and therefore cannot press the alarm button.

[0006] Much of the valuable time spent with the elder is spent on practical matters such as "have you had food, do you sleep well, when do you go to bed" and so forth. There is a need for relatives to spend their time with the elder on love and care instead of practicalities.

[0007] From the above it is understood that there is room for improvements regarding the perceived safety for elders and their relatives.

SUMMARY

[0008] An object of the present invention is to provide a new type of information and safety monitoring system. More specifically, an object of the invention is to provide an information and safety monitoring system that provides real time information, compares individual historic data, provides trends and trend analysis and thereby enhances the perceived security for elders and their relatives. These objects are achieved by the technique set forth in the appended independent claims with preferred embodiments defined in the dependent claims related thereto.

[0009] In a first aspect, there is provided a method for

monitoring a first user at a site. The method comprises receiving, via a communication network, input signals from at least one sensor arranged at the site, the input signals carrying detection values; generating activity data from the received detection values; comparing the generated activity data with base line activity data; and generating an alert if generated activity data deviates from the baseline activity data to a predetermined degree.

[0010] This method is advantageous in that the activity of the first user is monitored, and also compared with base line data, corresponding to usual behavior of the first user. The alarm feature is advantageous in that a relative or caretaker who is the recipient of the alarm is informed when something is deviating from the usual behavior of the first user. This provides both the first user and the relative or caretaker with a sense of safety.

[0011] In one embodiment, the at least one sensor is a motion sensor, and the detection value carried in the input signal indicates that the sensor has detected movement. This is advantageous in that motion is easy to detect. Further, moving is something everyone is doing every day. Thus, the method does not require special behavior from the first user. He/she may continue living as usual, and the method is configured to determine when he/she is not acting as usual.

[0012] In one embodiment, the input signals are received from a plurality of sensors and the generation of activity data includes generating an activity value by counting the number of times during a predetermined time period the detection value indicating movement is shifting from a detection field of one motion sensor to the detection field of another motion sensor. This corresponds e.g. to movements between rooms. Oftentimes, people follow certain movement patterns when doing certain things in their homes. The method is configured to detect these movements, e.g. between rooms, and the time between detections.

[0013] In one embodiment, the received detection value includes an identification value identifying the sensor sending the input signal and the generation of activity data includes identifying a chronological sequence of detection values including identification values corresponding to a predefined sequence of identification values and generating an activity value by counting the number of times during a specific time period that the predefined sequence of identification values is identified. An advantage of this is that longer movement patterns are recognizable by means of the method and thus a more detailed analysis of the behavior of the first user is obtained.

[0014] The base line activity data may be a baseline activity value and the alert may be generated when the activity value is deviating from the baseline activity value to a degree corresponding to a predetermined deviation value. This is advantageous in that the alarm is triggered by deviation from an individual baseline activity value, and is thus more consistent with the first user's individual habits and behaviour.

[0015] In one embodiment, the step of generating an

alert comprises transmission of the activity value or transmission of a notification. The recipient of the alert is informed of the circumstances of the first user, either by the deviating activity value or by a notification. The notification may be informative, or it may be of alarm character indicating that the first user may need assistance.

[0016] In a second aspect, a system for monitoring movements of a first user at a site is provided. The system comprises at least one sensor arranged at the site, a monitoring service comprising a communication unit and a processing device. The sensor(s) are configured to register detection values at the site and transmitting said detection values as input signals to the monitoring service. The processing device is configured to generate activity data from the detection values, comparing the generated activity data with baseline activity data representing historic activities of the first user, and generating an alert if the generated activity data deviates from the baseline activity data to a predetermined degree. This system is advantageous in that it provides safety to both the first user and to a recipient of the alert.

[0017] In one embodiment, the at least one sensor is a motion sensor, and the detection value carried in the input signal indicates that the sensor has detected movement. Since movement is easy and reliable to register, the system is configured to be able to detect where the first user is moving, or is located. Further, since motion detectors are cheap, the system may comprise several sensors and still be cost efficient.

[0018] In one embodiment, the system further comprises an interface application installable in at least one user device. The alert may thus be received in the interface application. This is advantageous for a second user, i.e. the recipient of the alert. The second user may get the alert as a message or notification in e.g. a mobile device such as a smart phone. This is convenient for the second user as no additional device is required in order to connect with the system.

[0019] The processing device may be configured to put the system in a first deviation mode if the activity data is deviating from the baseline activity value to a degree corresponding to a first predetermined deviation value, and to transmit a signal to the interface application such that the activity data is available in the interface application. The second user, i.e. the holder of the interface application and the recipient of the alert, is thus informed that something is deviating from the usual activity of the first user, and may thus take appropriate action. In one embodiment, the system is configured to provide the deviation information in the interface application for the second user to look up.

[0020] The processing device may further be configured to put the system in a second deviation mode if the activity data is deviating from the baseline activity value to a degree corresponding to a second predetermined deviation value, and to transmit a signal to the interface application such that a notification is sent by the interface application, preferably by means of a push notice, a text

message or an email. The second user, i.e. the holder of the interface application and the recipient of the alert, is thus informed that something is deviating from the usual activity of the first user. In one embodiment, the second deviation mode represents a more serious situation compared to the first deviation mode. The system may thus be configured to transmit the information in a more direct manner to the second user, e.g. by a push notice or a text message such that the second user may handle and take action immediately.

[0021] The system may further comprise at least one door sensor arranged in connection with an outer door of the site and being configured to register an opening of the door. This is advantageous since the system may be configured to register when the first user has left the site. This may be accomplished by combining a detection of the outer door being opened, and an absence of detected motion within the site.

[0022] The system may further comprise a position sensor. The system may be configured to monitor the first user when the first user is out of range of the sensors, and the system may be configured to perform a handover from the sensors to the position sensor. This is advantageous since the system is configured to not only monitor the first user at the site, but also when the first user has left the site, which provides additional safety.

[0023] In one embodiment, the handover is performed in response to the door sensor being activated.

[0024] In one embodiment, the position sensor is incorporated in a mobile user device, preferably such as a mobile phone, a smart watch, or a bracelet. This is advantageous since these items are easy for the first user to carry along. The first user does not need an additional device to feel safe when he/she has left the site, but may carry the items normally carried.

[0025] In one embodiment, the system is configured to be put in the first deviation mode if no movement is registered by the position sensor in a predefined amount of time, the predefined amount of time preferably being based on the generated activity data.

[0026] In a third aspect, a kit for installing such system at a site is provided. The kit comprises a number of motion sensors, at least one door sensor, a gateway and an interface application installable on a user device. This kit is advantageous since it is easy to install at the site. It is easy to adapt the kit for different kinds of sites by incorporating different numbers of motion sensors. The interface application may be configured to comprise a manual for installation and setup of the system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] Embodiments of the invention will be described in the following; references being made to the appended diagrammatical drawings which illustrate non-limiting examples of how the inventive concept can be reduced into practice.

Fig. 1 is a schematic view of a general structure of a system according to one embodiment of the teachings of this application;

Fig. 2 is a schematic view of an apartment provided with a system according to one embodiment;

Fig. 3a is a table of time stamps registered by sensors of the system according to one embodiment;

Fig. 3b is a schematic view of a movement pattern corresponding to the time stamps of Fig. 3a;

Fig. 4 is a table of time stamps registered by sensors of the system according to one embodiment;

Fig. 5 is a schematic view of a movement pattern subject to linear time shifting;

Fig. 6 is a schematic view of a movement pattern subject to irregular time shifting;

Fig. 7 is a schematic view of a movement pattern subject to exponential time shifting;

Fig. 8 is a schematic view of a general structure of a system according to one embodiment of the teachings of this application;

Fig. 9 is a user interface for a second user according to one embodiment of the system according to Fig. 8;

Fig. 10 is a schematic view of a method according to one embodiment.

DETAILED DESCRIPTION

[0028] Hereinafter, certain embodiments will be described more fully with reference to the accompanying drawings. The invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the invention, such as it is defined in the appended claims, to those skilled in the art. If nothing else is stated, different embodiments may be combined with each other.

[0029] Fig. 1 shows a monitoring system 1 for monitoring the movements of a first user, e.g. a resident of an apartment 7. The monitoring system 1 comprises a number of motion sensors 2, or motion detectors. In the depicted embodiment, there are four motion sensors in the monitoring system 1, e.g. IR sensors, IR cameras, cameras, ToF sensors, radar devices, lidar devices, etc., and a gateway 4. Depending on the network configuration in which the monitoring system is operating the gateway 4 may be substituted for a router, a switch, or a hub. In some embodiments the monitoring system 1 further comprises at least one door sensor 3, e.g. a magnetic sensor. The monitoring system 1 may further comprise an additional, possibly wearable, sensor 6a, e.g. a mobile device configured to transmit a position signal, e.g. a GPS signal. This will be further described below.

[0030] The monitoring system 1 further comprises a monitoring service 18 comprising a communication module 19 and a processing device 20. The sensors 2, 3 are connected for communication with the monitoring service

18 through gateway 4. The monitoring service 18 is in the depicted embodiment implemented as a service in the cloud 5, but may alternatively be implemented on a dedicated server (not shown) at a remote site or at a location nearby the monitored apartment. The processing device 20 may be implemented by one or more processors, e.g. central processing units, multi-core processors, microprocessors, etc., which is connected to or comprises a data storage (not shown) and is running program code making the one or more processors operate as described later in this description. The data storage may be implemented using any commonly known technology for computer-readable data storages such as network attached storages (NAS), data servers, databases, hard drives, solid state drives, or any other data storage solution provided in the system. The data storage is configured to store a motion data for movements detected by the sensors 2, 3. The communication between the sensors 2, 3 and the gateway 4 may be implemented using any one of various wireless communication systems, e.g. 3GPP based such as 2G, 3G, 4G and 5G, a shared wireless infrastructure such as LoRa, 433 MHz UHF band technologies, Z-Wave, Zigbee, Bluetooth, WiFi, etc. In some embodiments the gateway 4 may be shared by other systems, other users, and/or different technologies. In embodiments having a shared gateway 4, the gateway 4 may be accessed via a communication service provide. Alternatively, the gateway may be under the control of a system provider or the users.

[0031] The communication between the gateway 4 and the communication unit 19 of the monitoring service 18 may be implemented using a wide range of technologies. In embodiments of the monitoring service 18 being implemented in the cloud the communication may be performed over Internet using TCP-IP, UDP-IP, or other common protocols. Even if the monitoring service is not a cloud-based service but a dedicated private server, the Internet and common Internet protocols may be used for the communication. In case of an on-premise solution for the monitoring service 18 the communication may be performed over a LAN implementing any protocol of a wide variety of protocols well known to the skilled person. The infrastructure may be wired, wireless, or include both types of infrastructure.

[0032] The communication unit 19 is configured to receive the data values from the sensors 3 and sensors 2. The communication unit 19 is further configured to transmit the data signal as input values to the processing device 20. The monitoring functionality and functionality for detection of behavior and notification of detected deviations from expected movements (to be further described below) are implemented in the processing device 20.

[0033] The monitoring system 1 further comprises an application installed on at least one user device 6. The user device may be a mobile device, e.g. a mobile phone, a smart phone, a smart watch, a tablet, a laptop, etc., or a stationary device, e.g. a desktop computer, a worksta-

tion, a smart tv, a monitor in a monitoring center. The data collected by the sensors 2, 3 and stored in the service is processed in the processing device 18 for possible transmission to and presentation in the application on one or more user devices 6.

[0034] The user device(s) 6 associated with the monitoring system 1 is accessed by one or more second users of the monitoring system 1, e.g. one or more of a relative, a family member, a co-resident, a caregiver of the first user, i.e. the resident or any other person having interest in the care of the first user. The resident may him/herself be both the first user and the second user by carrying a mobile device 6a connected to the monitoring system 1.

[0035] In Fig. 2 a plan view of a site 7, in this case an apartment, is shown, in which the monitoring system 1 is installed. The apartment 7 according to this embodiment comprises a kitchen 8, a hallway 9, a bathroom or WC 10, a bedroom 11, a living room 12 and a balcony or terrace or patio 13. The apartment 7 comprises two outer doors 14, one front door and one balcony door. Both these doors 14 are provided with door sensors 3. The doors sensors 3 are configured to detect when the door 14 on which it is arranged is opened. Every one of the above mentioned rooms 8-12 are provided with motion sensors 2. The motion sensors 2 are provided such that all or some movements in the room 8-12 is detectable by it. The motion sensors 2 are preferably attached to a wall or ceiling surface by means of adhesive such as double-sided adhesive tape, or by screws, or by any other suitable fastening means. In the depicted embodiment, the gateway 4 of the monitoring system 1 is arranged in the hallway 9 of the apartment 7.

[0036] The monitoring system 1 is configured to be delivered to a user in the form of a kit comprising a number of motion sensors 2, preferably 5-10 sensors 2, but may in other embodiments be as many sensors 2 as necessary for covering the site 7, one or more door sensors 3, a gateway 4, and instructions for downloading the associated mobile application. Possibly, the kit also comprises pieces of double-sided adhesive tape or screws, or any other suitable fastening means for attaching the sensors 2 to an indoor surface. Thereafter, the monitoring system 1 is intended to be installed by the second user by following instructions provided in the mobile application. Optionally, the monitoring system 1, and therefore also the kit, may also comprise a camera (not shown).

[0037] The function of the monitoring system 1 will now be described in connection with Figs 3a, 3b, 4 and 10. The intention of the monitoring system 1 is, as described in the Background section, to provide information on pattern changes (short and long term) and a sense of safety to persons in need of monitoring (referred to as the resident or the first user) and their family and relatives (referred to as second users). The monitoring system 1 is thus configured to detect movements in the apartment 7 where the person in need of monitoring lives. The motion sensors 2 are configured to frequently send data of detected and/or not detected motion, for example every fifth

second. The door sensor 3 is configured to detect if an outer door 14 is opened. In this case, combined with no detection of motion inside the apartment 7, it may be assumed that the resident has left the apartment 7.

[0038] The processing device 20 of the monitoring system 1 is configured to calculate how many times during a predetermined time a first user moves so that detection of movement is changed from one sensor to another, e.g. sensor responses by sensors arranged in different rooms. An activity is defined as a sensor change, i.e. the first user entering a "new" room. That is the sensor change represents the first user moving between two rooms. An activity level of the first user is defined as number of sensor changes per unit of time.

[0039] The activity level is used to analyze and monitor the state of health of the first user. A trend of activity level is obtained by comparing the activity level for a relatively short time period, e.g. the past couple of days, past week, past month, or past year with base line activity data including data representing the activity level of a longer time period, e.g. the past 1, 2, 3, 6 or 12 months, or past 1, 2, or 5 years, or longer. The activity level may increase, decrease or remain unchanged in this comparison. The base line activity data may be formed from activity levels registered during said longer time period and then summarized into a statistical distribution, e.g. a normal distribution. Alternatively, other statistical methods are applied to the activity levels registered for generation of baseline activity data. The baseline activity data may include a plurality of threshold values determining when to enter a deviation mode. There may be a specific threshold value representing a specific time period during a day, a week, or a month, e.g. there may be a specific value for every 10 min, 20 min, 30 min, 1 hour. The length of these time periods may vary during a day and/or a week, e.g. the time period may be 20 min during daytime and 1 hour during nighttime. The threshold value corresponds to a probability calculated in the generation of the baseline activity data, e.g. the threshold value may be set to a value that is reached at a lower likelihood, i.e. indicating that the first user is not acting as normal. In case of two threshold values the second threshold value may be set to a value that is even less likely to be reached. Accordingly, if the activity value reaches a level below the threshold value the monitoring system 1 is put in a deviation mode and configured to trigger a time-out (to be further described below).

[0040] In an alternative method, that may be used by itself or in combination with any of the other methods described herein, e.g. a week is divided into smaller time periods (Tp), e.g. 10 min, 20 min, 30 min, 1 hour. For each time period there are thresholds Th1, Th2 for two different deviation modes which each is expressed in a measurement of time. In this specific method the time between activities is measured. After every activity, a timer starts. The timer starts at T1, and the duration Tx-T1 is frequently compared to Th1 and Th2 belonging to the Tp in which the timer is running. Th1 and Th2 is generated

from historical data over a certain time such as 4 weeks (the baseline data), which is being summarized into a statistical distribution such as a normal distribution. Th1 and Th2 corresponds to two different probabilities P1 and P2 respectively. P1 and P2 are defining the probability (given the statistical distribution based on historical data) of the Th1 and Th2 to be a natural part of the historical data, or in other words based on the same activity behavior as seen during corresponding Tp during the time that the information for the baseline activity data was collected.

[0041] When the first user has entered a room, the sensor 2 arranged in that room will continue to provide readings for as long as the user stays in that room and is performing any movement. However, in order to count as an activity according to the above, only the first registered movement is taken into account.

[0042] The sensors 2 may be arranged such that two or more of them register movement at the same time. That is, the area monitored by one sensor 2 overlap the area monitored by another of the sensors 2. In this case, motion data registered by one of the sensors 2 is removed determined on previously and/or succeeding registered data. For example, if the first user is detected to be in a first room, but the sensor in the bedroom across the hallway outside that room also provides a reading. Thereafter, the sensor in the living room gives a reading. Thus, it is recognized that the first user actually entered the living room, and not the bedroom. The data registered by the bedroom detector is thus disregarded.

[0043] In one embodiment, all activities as defined above registered during a predetermined time period, e.g. a day and night, are stored in the data storage of the monitoring system and is put in a list. The list is analyzed by the processing unit 20 in order to find repeated sequences of activities. This is referred to as patterns. By studying the activities registered during several days, or even longer periods of time, individual habits of the first user are determined. Thus, a detailed scheme over the movements occurring inside, and into/out of the apartment 7 is obtained.

[0044] The processing unit 20 of the monitoring system 1 is configured to predict how often a certain pattern should be detected. By using standard deviation or any other suitable statistical method, the deviation (if any) of the current day compared to the pattern is obtained. If the deviation is too large (this may be individually determined, or it may be a predetermined percentage of the normally occurring number of the pattern during a day) the system is put in a deviation mode and configured to trigger a time-out

[0045] For example, as shown in Fig. 3, a morning pattern has been detected. It is referred to as morning pattern, since it represents actions commonly performed in the morning, but the actions could be performed at any time of the day and still be detected as the morning pattern.

[0046] In this case, movement is detected in the bed-

room 11 at 07:02 in the morning. This may be interpreted as the time of wake up of the resident, if no prior movement has been detected for some time before. Thereafter, movement is detected at 07:03 in the hallway 9 and in the bathroom 10. The bathroom 10 sensor 2 is activated also at 07:05, and thereafter the hallway 9 sensor 2 at 07:06. The morning pattern continues with the resident entering the kitchen at 8 at 07:06 and stays there for a couple of minutes before returning to the hallway 9 at 07:09, into the bedroom 11 at 07:11 and into the living room 12 via the hallway 9 at 07:15. Fig. 3b shows a visual image of the morning pattern.

[0047] A corresponding evening pattern (not necessarily taking place in the actual evening), shown in Fig. 4, is also detected where the resident leaves the living room 12, passes the hallway 9 for entering the bathroom 10. Thereafter, the resident enters the kitchen 8 and the living room 12 via the hallway 9 (perhaps for turning off the lights) before entering the bedroom 11.

[0048] For example, after approximately two weeks the monitoring system 1 has collected enough data in order to recognize regular habits of the resident. The period of two weeks should only be seen as an example, the period may be shorter, e.g. one week, longer, e.g. a month or two. Thus, it is possible to detect anomalies of the resident's behavior by analyzing the data from the sensors 2, 3. The monitoring system 1 is configured to analyze the motion pattern of the resident on three levels:

1) real time data, by comparing 102 real time sensor data with expected activity, if the expected activity is not detected within a predetermined time period an alert is set 104;

2) real time data and individual data analytics in which the system is configured to compare 102 a detected event with the resident's individual expected movement pattern, and

3) real time data combined with individual data analytics and macro data analytics in which a detected event is also compared 102 with general historic data of many users. In this case, the data used for comparison 102 may be filtered to correspond to the resident's abilities and conditions, such that the individual data is compared 102 with relevant macro data.

[0049] In some embodiments, patterns are identified and registered for a time period, e.g. a week, two weeks, a month, or any other reasonable time period. The method may include finding matching sequences of at least a predetermined number of activities in length. In some cases, the shortest sequence may be set to three activities in sequence. Reoccurring patterns are counted and the information regarding how many times during a shorter time period each identified sequence would occur is registered. Such a shorter time period may be two hours, a day, or any other suitable time period. The length of such time period may be varying during different times of a day and/or over a week. The identified and registered

sequences may then be used in calculating a baseline activity data specifying how often during a specific time period at least one of the patterns is likely to be repeated. The baseline may be in the form of a statistical model of the number of occurrences for one or a plurality of patterns. Then, when the system is active, patterns are identified, counted, and compared with the statistical model and making the system enter the deviation mode when the number of occurrences of a pattern deviates to a pre-determined degree from a number estimated by the statistical model.

[0050] For instance, a pattern including movement from a sensor A to a sensor B to a sensor C is identified and is found, by the system, to occur 20 times during a day. Then, when the system is up and running and the occurrences of the pattern A, B, C only occurs 15 times during a day a warning may be initiated. The baseline activity data may include a plurality of different sequences, sequences may also be connected to specific time periods during a day or a week.

[0051] The monitoring method 100 is now described in connection with Fig. 10. When a motion sensor 2 detects a movement, the sensor 2, 3 is configured to transmit, via the gateway 4, a signal to the monitoring service 18. The signal is received 101 by the communication module 19 and further transmitted to the processing unit 20.

[0052] The processing unit 20 is configured to compare 102 the signal with the first user's expected activity according to one or more of the alternatives 1)-3) above.

[0053] If the signal is found to deviate 103 from the expected activity or movement pattern according to a first criteria, the processing unit 20 is configured to put the monitoring system 1 in a first deviation mode 104. The first deviation mode 104 comprises and transmitting 105 a signal to the one or more mobile device 6 associated with the monitoring system 1 such that deviation information is available in the mobile application installed on the mobile device 6.

[0054] If the signal is found to deviate 106 from the expected activity or movement pattern according to a second criteria, the processing unit 20 is configured to put the monitoring system 1 in a second deviation mode 107. The second deviation mode 107 comprises transmitting a signal to the one or more mobile device 6 associated with the monitoring system 1 such that a notification is issued by the mobile application installed on the mobile device 6. The notification is for example a push notice, a text message or an email.

[0055] If an anomaly or deviation 103, 106 from the normal and expected pattern is detected, the monitoring system 1 is configured to trigger a time-out, i.e. putting the monitoring system in a deviation mode 104, 107. The monitoring system 1 has two levels of time-out, i.e. deviation modes: a) yellow level, warning, and b) red level, alarm. The warning time-out is in this embodiment $\frac{1}{2}$ of the time when the monitoring system 1 expects a motion being detected in the apartment 7 according to the de-

termined activity pattern.

[0056] For example, the morning activity pattern of a resident includes a bathroom 10 visit of 10 minutes. If no motion has been detected in the hallway 9 outside the bathroom 10 in 15 minutes from the last detected motion event in the hallway 9, the monitoring system 1 is set to the yellow level, i.e. the first deviation mode 104. The deviation data is sent 105 to the user devices 6 associated with the monitoring system 1, which allows second users, e.g. relatives of the resident, to become aware that something may be wrong with the resident of the apartment 7. If further time passes and no movement value from the hallway 9 sensor 2 is received 101 by the processor 20, the monitoring system 1 is configured to raise the level to red, i.e. the second deviation mode 106, after the double amount of time has passed, i.e. 10 minutes after the end of the expected 10 minute bathroom 10 visit, i.e. in total twenty minutes from the last detection event of the hallway 9 sensor 2. In this case, the monitoring system 1 is configured to transmit a notification 108. The notification is in the form of a push notice sent to one or more of the associated user devices 6. It could also be in the form of an email or a text message. In the case if no deviation is detected 109, the processing unit 20 of the monitoring system 1 is configured to transmit status updates 110 e.g. via a text message or email, saying that everything seems to be ok with the resident, based on that the normal detected pattern is followed. The time interval for transmission of the status updates may be any suitable interval, and may be determined by each second user from a time to another, e.g. once a day, several times a day, once every other day etc.

[0057] In one embodiment, the monitoring system 1 comprises one or more cameras 17. The at least one camera 17 is configured to be activated only when a deviation 106 occurs such that the monitoring system 1 is set to the red alarm level. Then, the camera 17 starts transmitting motion pictures or still images via the gateway 4 to the user device(s) 6. In this way a relative gets visible real time information of the resident's wellbeing, such as if the resident has fallen, or just taken a longer than usual coffee break in the kitchen.

[0058] A visible indication may be activated on the camera in order to inform the resident that one of the second users has activated the camera. The indication is deactivated when the camera is deactivated. The activation events of the camera may be recorded and displayed in the mobile application such that at least the superuser of the monitoring system 1 is able to see who has activated the camera and when. The camera may be activated automatically when a second deviation 106 occurs, or it may be activatable only on command of a second user when a second deviation 106 occurs.

[0059] The monitoring system 1 is also configured to enter the first or second deviation modes 104, 107 time shifting is detected in the motion pattern. Fig. 5 discloses a shift in the morning pattern of Figs 3a-b. At November 11, the morning pattern began 07:00 in the morning. At

December 16, the same morning pattern starts around 07:50. There is thus a linear shifting of the time at which the morning pattern begins. The pattern itself is unchanged, which means that the resident has not changed his/her behavior, he/she is only doing it at another point in time. The monitoring system 1 is configured to recognize this type of deviations and transmit a yellow level information 104 or a red level notification 108, depending on how large the time shift is, to the associated user devices 6.

[0060] Other types of deviations from the normal pattern are shown in Figs 6 and 7. Fig. 6 shows a morning pattern which is irregular, but still shifting towards a postponement of the starting time for the morning pattern. Fig. 7 shows an exponential postponement of the start of the morning pattern. From November 11 when the morning pattern began at 07.00, the same pattern is postponed to begin at 07:50 on November 25.

[0061] This information is transmitted to the user device(s) 6 as an information 105 or as a notification 108. This provides the relative with useful information about the resident's state of health. For example, it is a common effect of vascular dementia to turn the clock around, and this may be seen as a postponement of the morning and/or evening pattern(s). If the resident has diagnosed dementia, the time shifting of detected patterns may be a sign that the condition is worsening.

[0062] The pattern itself may also be subject to change. For example, the evening pattern may suddenly change such that the resident, after having been in the bathroom is going directly to the bedroom, without entering any of the other rooms. This probably results in that the lights are not turned off in the apartment when the resident goes to sleep. If this deviation in the detected pattern occurs, a warning is sent to the mobile device(s) 6. Another example is a resident who is detected to make several visits to the bathroom during the night. A warning is thus transmitted 108 to the mobile device(s) 6 that a detected night pattern is broken. The new pattern may be a sign of incontinence of the resident.

[0063] In some embodiments the system may be arranged to take into account that some patterns, e.g. "bed time pattern", are unlikely to be detected at other time periods during a day. Then the system may generate an alert if there has been detected movement into the bedroom and no movement out of the bedroom within a specific time period.

[0064] The resident him/herself may not be aware of the above mentioned warning signs, and/or may forget to discuss the issues with his/her physician. A relative who has access to the statistics of the monitoring system 1 may remind the resident, and/or discuss it together with the responsible physician. The information provides relatives with a sense of safety regarding the state of health of the resident. The relative(s) need not ask the relative every day if he/she has eaten, slept, visited the bathroom, taken a walk, etc. Thereby, the conversations between the relative and the resident may be joyful instead of in-

formative only, and the resident (maybe a parent) may feel like a grown up person capable of taking care of him/herself and not a child and not being trusted by his/her own children.

[0065] In summary, the monitoring system 1 is configured to detect for example one or more of the following patterns and deviations from patterns: change/reduction in activity level (sleep/wake/rest) over day/night, average and total time spent in a room and deviation (e.g. staying in the bathroom for longer than expected), verify at home, number of outdoor visits, average bed time deviation, average first bathroom entry deviation, average first kitchen entry deviation, change in movement pattern (which rooms visited in which order at which time), number of movements (between rooms), change in frequency of visiting "important" rooms (e.g. kitchen and bathroom), outside the detected area (between rooms), out of habit (not in kitchen at lunch time).

[0066] The monitoring system 1 is further configured to perform long term behavior change analysis, such as one or more of: long term change (reduction/time slip) in activity level (e.g. weekly average), change in time spent in each room, using historical data from other first users for conclusions (e.g. people with similar change in behaviour), how "fast" the first user moves in the apartment, between the rooms.

[0067] In one embodiment, second users of the different user devices 6 associated with the monitoring system 1 are able to connect with each other through the user device application. If for example one second user takes the resident for a full day trip, he/she can write a status report in the application that the resident will not be home for the whole day. Thus, other second users connected to the resident can see this and knows not to worry even if the system would send out an alarm due to the resident leaving the apartment 7 and not returning for a longer time period than expected, according to the individual movement pattern.

[0068] Optionally, in the case where the first user has access to the application him/herself, he/she is able to communicate with the second users of the associated user devices 6 via the application in a corresponding manner as described above.

[0069] Different second users of the mobile devices 6 may be given access to different parts of the monitoring system 1. One second user is the superuser of the monitoring system 1 and handles the access given to the other second users. For example, the super user may give a neighbor or other second user access to the monitoring system 1 for a week, when additional monitoring is required. Other second users may be notified when a red level alarm is transmitted, but not to the real time data of the resident.

[0070] Further, it is possible to monitor the battery status and/or the on/off status of the motion sensors 2 via the mobile application.

[0071] Another embodiment, which may be combined with the embodiment previously described in connection

with Fig. 2, is disclosed in Fig. 8. In this figure, several of the previously described systems 1, each one arranged in a separate apartment 7a, 7b, 7c, 7d, are interconnected as subsystems to a common monitoring service 15. Each sub-monitoring system 1 comprises a number of sensors/detectors 2, 3 and a gateway 4, arranged in the associated apartment 7a-d. Each gateway 4 communicates and transmits data from the sensors 2, 3 to the cloud 5 in the same manner as described above. However, when a deviation from a recognized pattern occurs 103, 106, information is transmitted 105, 108 to a monitoring center 16. By means of the monitoring center 16, all apartments 7a-d are monitored simultaneously.

[0072] This kind of monitoring service 15 is beneficial for e.g. by home care services, nursing homes or assisted livings. Depending on the settings of the monitoring system 15, notifications such as information, notifications, warnings and alarms may still be transmitted to one or more mobile user device(s) 6 such that relatives of the resident can get the same information as a care giver.

[0073] Fig. 9 shows an example of a display view of a monitoring center 16. For each apartment 7 the display view shows, e.g. by a symbol (for instance a bed for the bedroom, a sofa for the living room, a table with chairs for the kitchen, a rubber duck for the bath room) where (i.e. in which room) in the apartment a movement was last detected, i.e. in which room the resident is currently present, and for how long the resident has been in that room, i.e. movements have not been detected in any other room.

[0074] One second user of the monitoring center 16 may monitor all apartments 7 associated with the monitoring service 15. This provides for an improved staffing schedule and optimize the resources for the caretaker service, as the staff can be where they are needed the most.

[0075] Again referring to Fig. 1, in one embodiment, the monitoring system 1 also comprises an additional sensor in the form of a movement tracker provided in a mobile device 6a, e.g. a cell phone or smart phone or such as a bracelet or smart watch of the resident. The mobile device 6a comprises a position detection system such as GPS. Thus, the monitoring system 1 is configured to keep track of the position signal from the mobile device 6a of the resident connected to the monitoring system 1. As long as the resident is in the apartment 7, the monitoring system 1 functions as described above. However, if the resident leaves the apartment 7, the monitoring system 1 detects that an outer door 14 is opened, and since no movement is detected inside the apartment 7 the resident is assumed to have left the apartment 7. In this embodiment, provided that the resident carries the mobile device 6a, the monitoring system 1 hands over to the mobile device 6a. Instead of being configured to detect motion in the apartment 7, the monitoring system 1 is now configured to detect and monitor the GPS signal from the mobile device 6a. Thus, the movement of the resident may be mapped in real time. The movement

may also be communicated to the second users of the monitoring system 1.

[0076] A motion pattern may be established also for outdoor movement. E.g. a resident may take a 15 minute walk around the block every morning after breakfast or going to the supermarket every Monday and Tuesday afternoon.

[0077] The same warning and alarm functions is present also in this embodiment. Thus, as long as the resident makes his/her usual morning walk around the block, everything is deemed to be ok, and no second user is alerted. However, if the 15 minute morning walk suddenly is extended to over 22 minutes (based on the warning level being $\frac{1}{2}$ of the time when the monitoring system 1 expects a motion being detected, i.e. in this case the event of the resident being back from the walk) a warning is sent to the connected mobile device(s) 6 of the second user(s) of the monitoring system 1. This allows the second user(s) to call the resident to check if everything is ok.

[0078] If the resident is not back in the apartment 7 30 minutes after the expected 15 minute walk begin, the monitoring system 1 is set to red level and configured to transmit an alarm to the mobile device 6.

[0079] If the resident, taking his/her usual 15 minute morning walk suddenly has a change of plan, e.g. taking an extra long walk in the park, he/she may enter this as a status message in the mobile application, and possibly also an expected return time. Thus, the second users of the monitoring system 1 are aware of that the expected 15 minute walk is extended. If the resident enters an expected end time, the system may be configured to recalculate the time limits for warning and alarm notifications.

[0080] Other advantages of the monitoring system 1 according to this embodiment is that it may detect if the resident is not moving for too long when outside the apartment 7. This may indicate that the resident has fallen and cannot get up again.

[0081] The monitoring system 1 may also be configured to use geofencing and send a warning notification if the resident is outside of a predetermined geographical area. This may for example indicate that resident has gone astray or taken the wrong bus.

[0082] In other embodiments, the site may, instead of being an apartment, be a house, a hospital room, a room of a retirement home or a service home, or anything similar. In alternative embodiments, only the front door, and not any balcony/terrace, patio door(s), is provided with a door sensor 2. The mobile device 6 may in other embodiments be a tablet, a laptop, a handheld computer, a smart watch or any other suitable mobile device with connection to the internet. The elderly person in the exemplary embodiments may also be any person with additional needs or requirements for security, but who still wants to or has to live in a home by him-/herself.

[0083] In one embodiment, the time-out time settings of the monitoring system 1 may differ from the above

described ½ of the time when the system expects a motion being detected in the apartment 7. The trigger time for the timeout may be longer or shorter or may be individually adapted to the first user's habits.

[0084] In one embodiment, if the resident does not leave a room for a specific, individually determined, time period, and the monitoring system 1 is set to level red and transmits a alarm, this alarm may also be transmitted as a direct SOS alarm call. Preferably, the SOS transmission includes the address of the site 7, and optionally basic information about the resident such as name. Further optionally, the transmission may include age, state of health, diagnosed conditions etc. of the resident.

Claims

1. Method for monitoring a first user at a site (7), the method comprising:

receiving (101), via a communication network, input signals from at least one sensor (2, 3) arranged at the site (7), the input signals carrying detection values;
generating activity data from the received detection values,
comparing (102) the generated activity data with base line activity data;
generating (105, 108) an alert if generated activity data deviates (103, 106) from the baseline activity data to a predetermined degree.

2. The method according to claim 1, wherein the at least one sensor is a motion sensor (2), and the detection value carried in the input signal indicates that the sensor (2) has detected movement.

3. The method according to claim 2, wherein input signals are received from a plurality of sensors (2) and wherein the generation of activity data includes generating an activity value by counting the number of times during a predetermined time period the detection value indicating movement is shifting from a detection field of one motion sensor (2) to the detection field of another motion sensor (2).

4. The method according to any one of claims 1-3, wherein the received detection value includes an identification value identifying the sensor sending the input signal and wherein the generation of activity data includes identifying a chronological sequence of detection values including identification values corresponding to a predefined sequence of identification values and generating an activity value by counting the number of times during a specific time period that the predefined sequence of identification values is identified.

5. The method according to any one of claims 3-4, wherein the base line activity data is a baseline activity value and wherein the alert is generated (105, 108) when the activity value is deviating from the baseline activity value to a degree corresponding to a predetermined deviation value.

6. The method according to claim 5, wherein the step of generating (105, 108) an alert comprises transmission (105) of the activity value or transmission of a notification (108).

7. System for monitoring movements of a first user at a site (7), the system (1) comprising:

at least one sensor (2, 3) arranged at the site (7), a monitoring service (18) comprising a communication unit (19) and processing device (20), wherein the sensor(s) (2) are configured to register detection values at the site (7) and transmitting said detection values as input signals to the monitoring service (18), wherein the processing device (20) is configured to

generate activity data from the detection values,
comparing (102) the generated activity data with baseline activity data representing historic activities of the first user; and
generating (105, 108) an alert if the generated activity data deviates (103, 106) from the baseline activity data to a predetermined degree.

8. The system according to claim 7, wherein the at least one sensor is a motion sensor (2), and the detection value carried in the input signal indicates that the sensor (2) has detected movement.

9. The system according to claim 7 or 8, further comprising an interface application installable in at least one user device (6, 6a).

10. The system according to claim 9, wherein the processing device (20) is configured to put the system (1) in a first deviation mode (103) if the activity data is deviating from the baseline activity value to a degree corresponding to a first predetermined deviation value, and to transmit a signal to the interface application such that the activity data is available in the interface application.

11. The system according to claim 10, wherein the processing device (20) is configured to put the system (1) in a second deviation mode (107) if the activity data is deviating from the baseline activity value to a degree corresponding to a second predetermined

mined deviation value, and to transmit a signal to the interface application such that a notification is sent by the interface application, preferably by means of a push notice, a text message or an email.

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12. The system according to any one of the claims 7-11, further comprising at least one door sensor (3) arranged in connection with an outer door (14) of the site (7) and being configured to register an opening of said door (14). 10
13. The system according to any one of the claims 7-12, further comprising a position sensor (6a), wherein the system (1) is configured to monitor the first user when the first user is out of range of the sensors (2), and wherein the system (1) is configured to perform a handover from the sensors (2) to the position sensor (6a). 15
14. The system according to claim 12 and 13, wherein the handover is performed in response to the door sensor (3) being activated. 20
15. The system according to claims 13-14, wherein the position sensor (6a) is incorporated in a mobile user device, preferably such as a mobile phone, a smart watch, or a bracelet. 25
16. The system according to the preceding claim, wherein the system (1) is configured to be put in the first deviation mode if no movement is registered by the position sensor (6a) in a predefined amount of time, the predefined amount of time preferably being based on the defined movement pattern. 30
- 35
17. Kit for installing a system (1) according to any one of the claims 7-16 at a site (7), the kit comprising a number of motion sensors (2), at least one door sensor (3), a gateway (4) and a mobile application installable on a user device. 40

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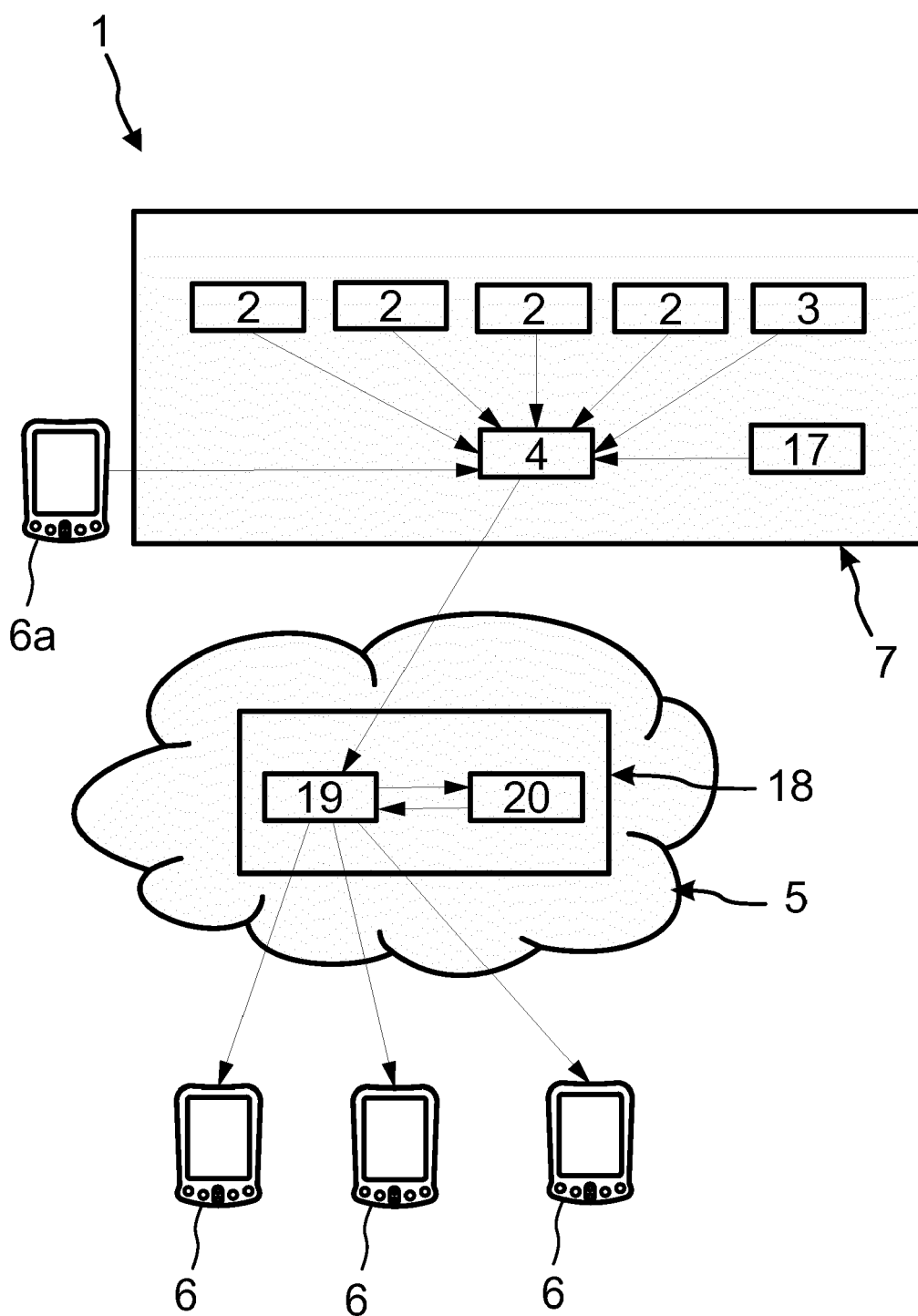


Fig. 1

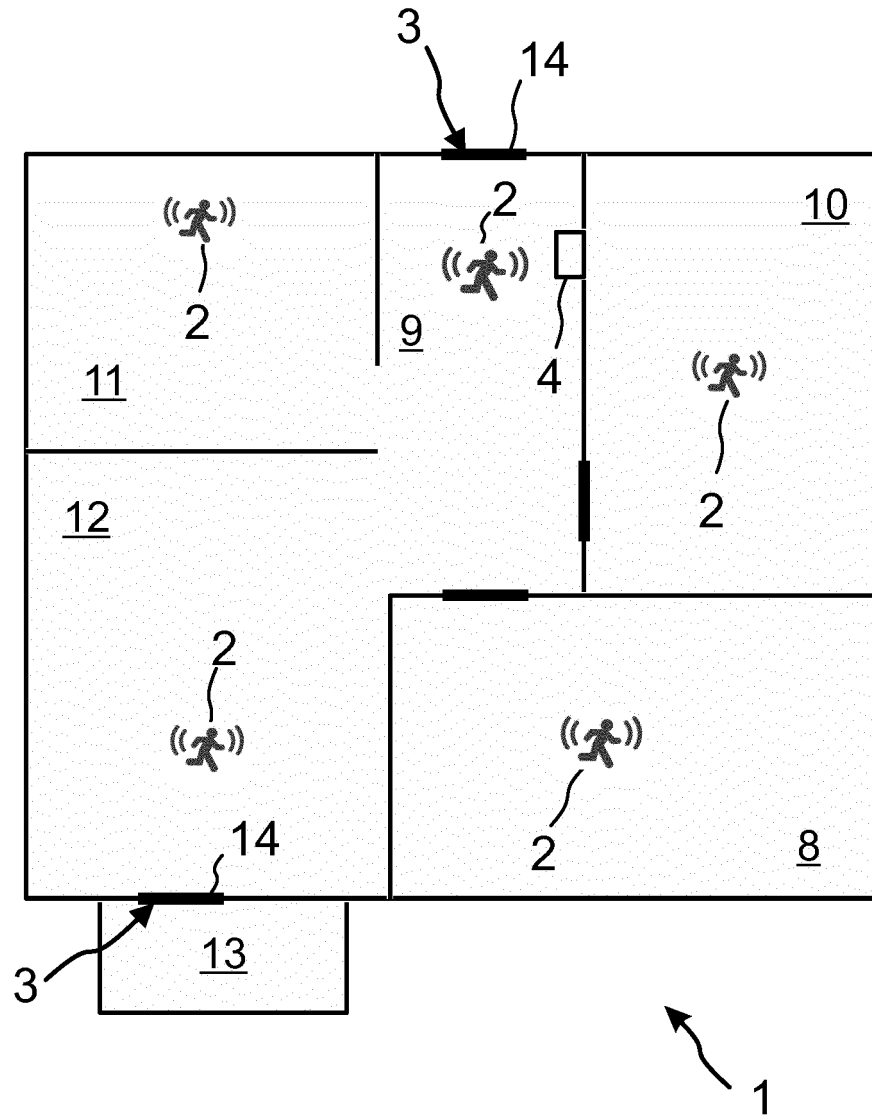


Fig. 2

Location	Time →											
Bed room (13)	07:02							07:11				
Hallway (11)		07:03			07:06		07:09		07:15			
WC (12)			07:03	07:05								
Kitchen (10)						07:06				07:15	07:16	07:17
Living room (14)												

Fig. 3a

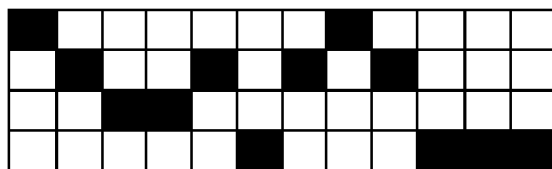


Fig. 3b

Location	Time →											
Bed room (13)									22:41	22:42	22:43	22:44
Hallway (11)		22:31		22:40		22:40		22:40				
WC (12)			22:31									
Kitchen (10)					22:40							
Living room (14)	22:30						22:40					

Fig. 4

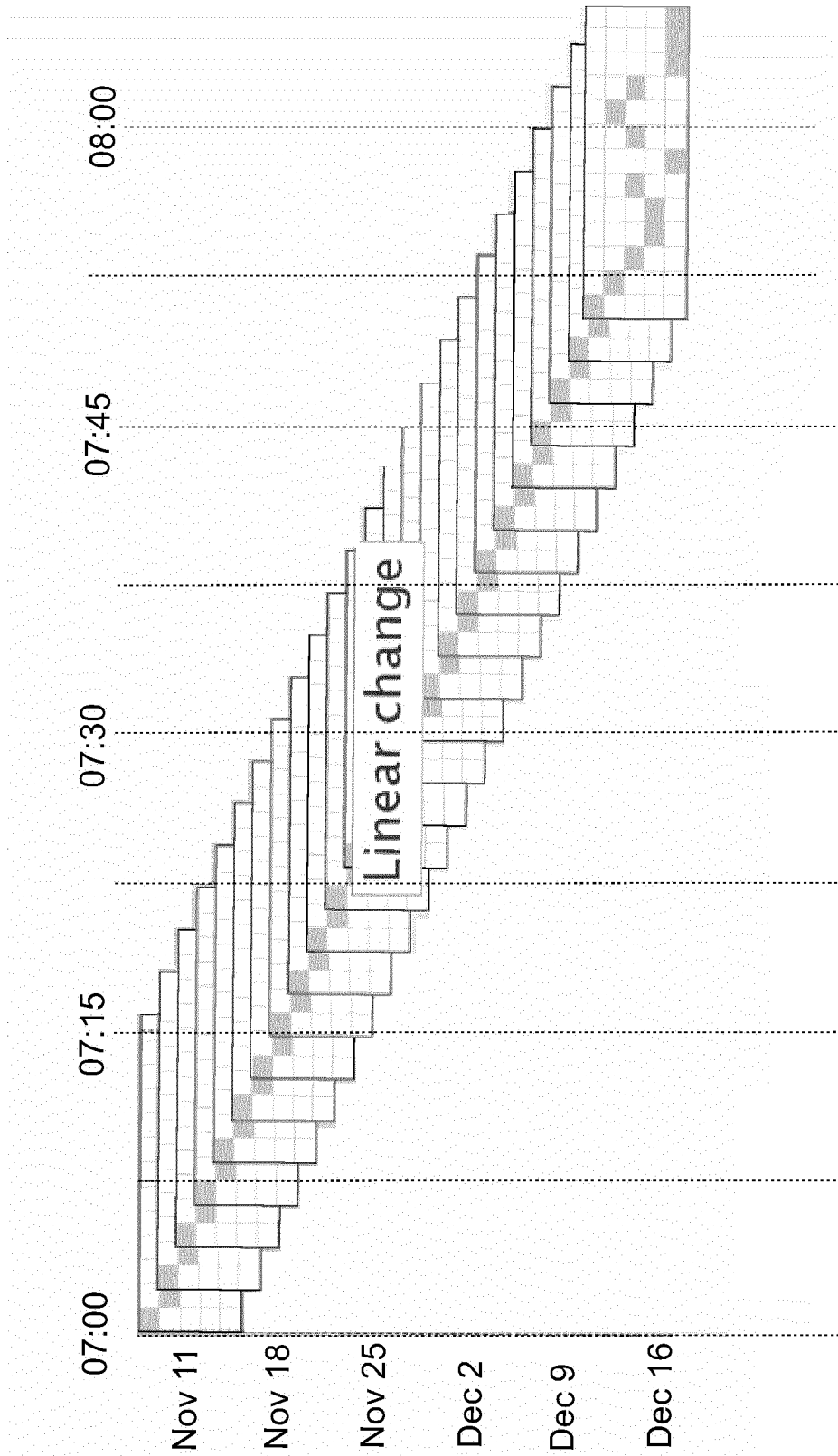


Fig. 5

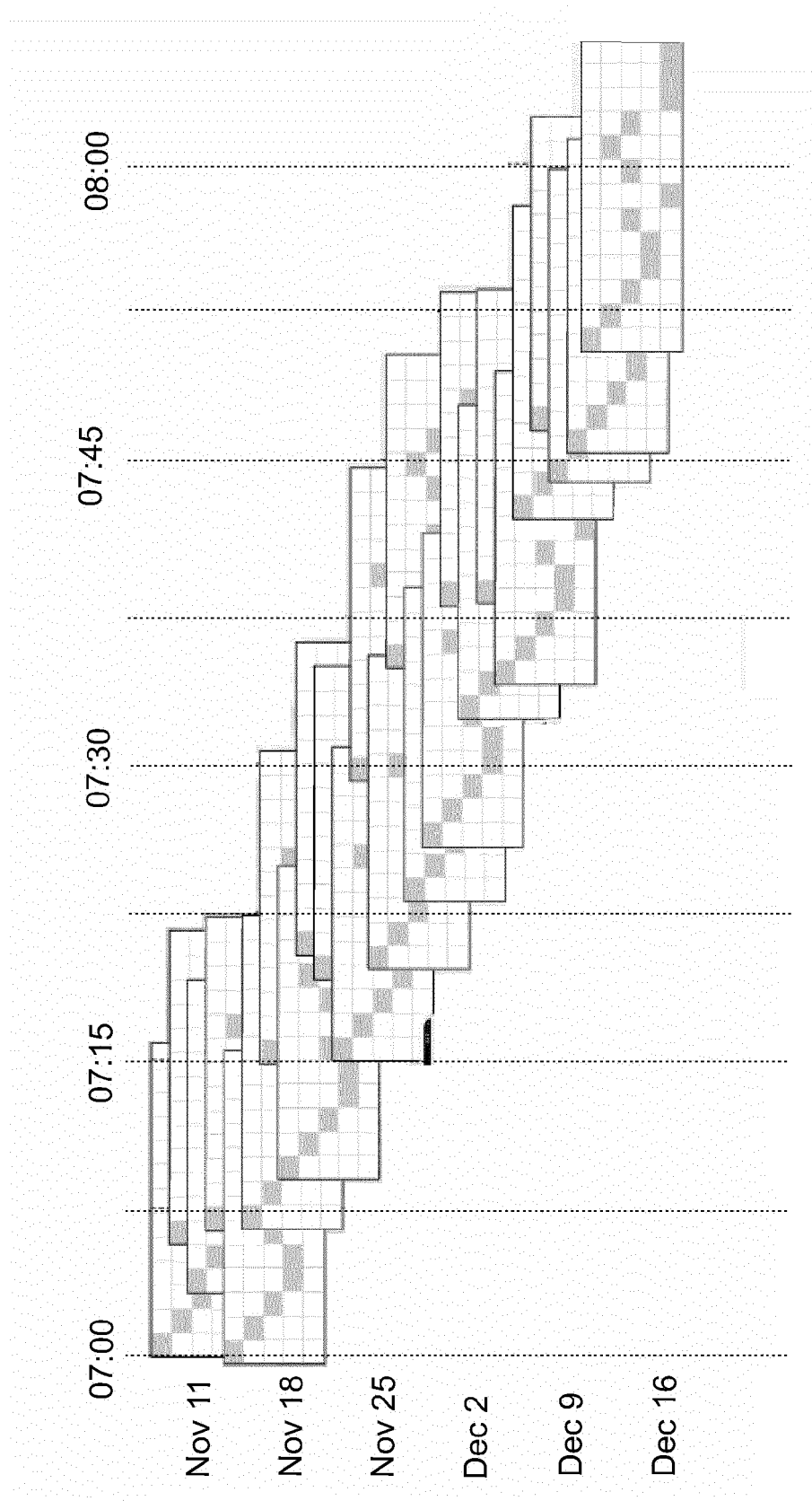


Fig. 6

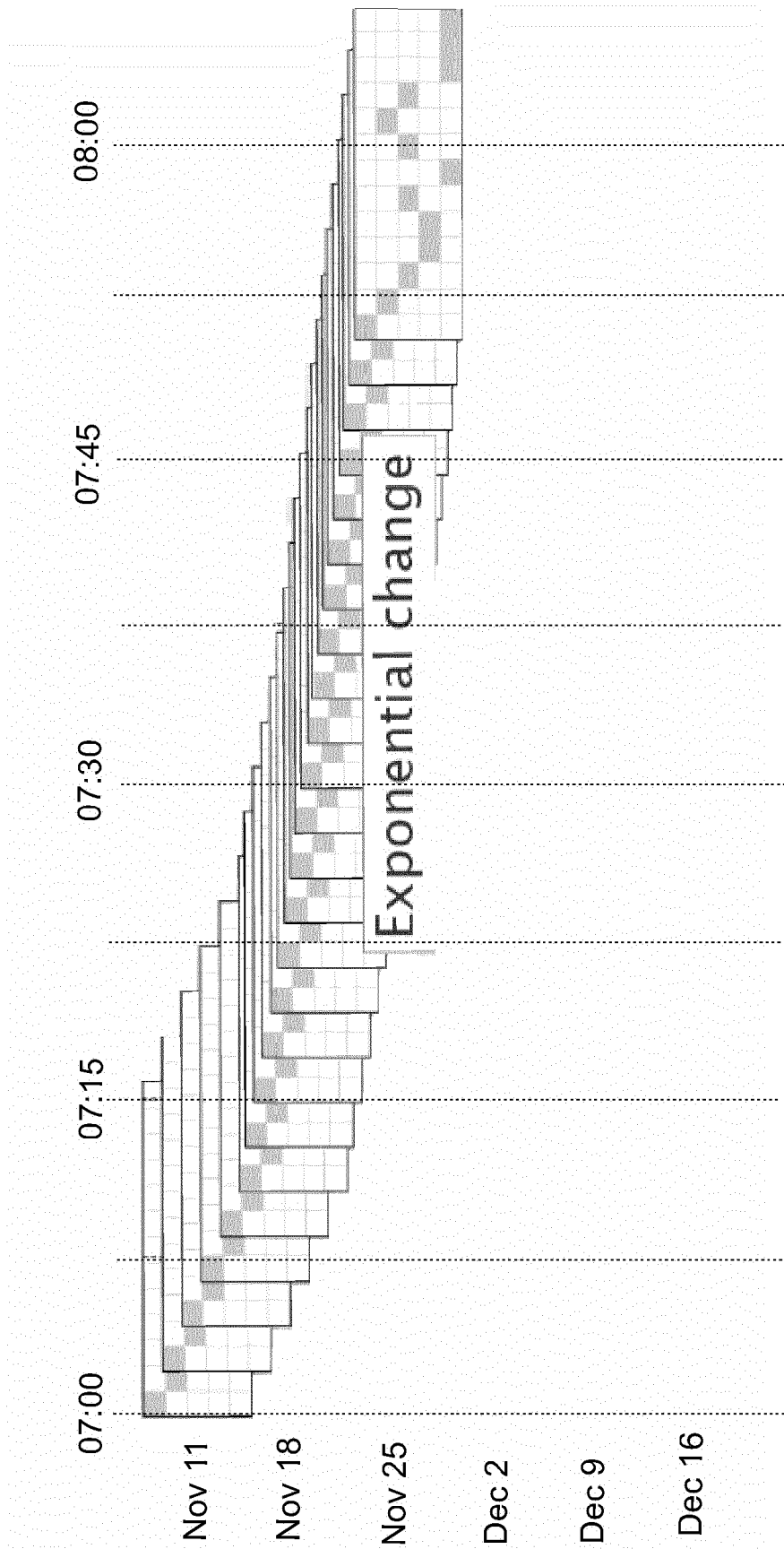


Fig. 7

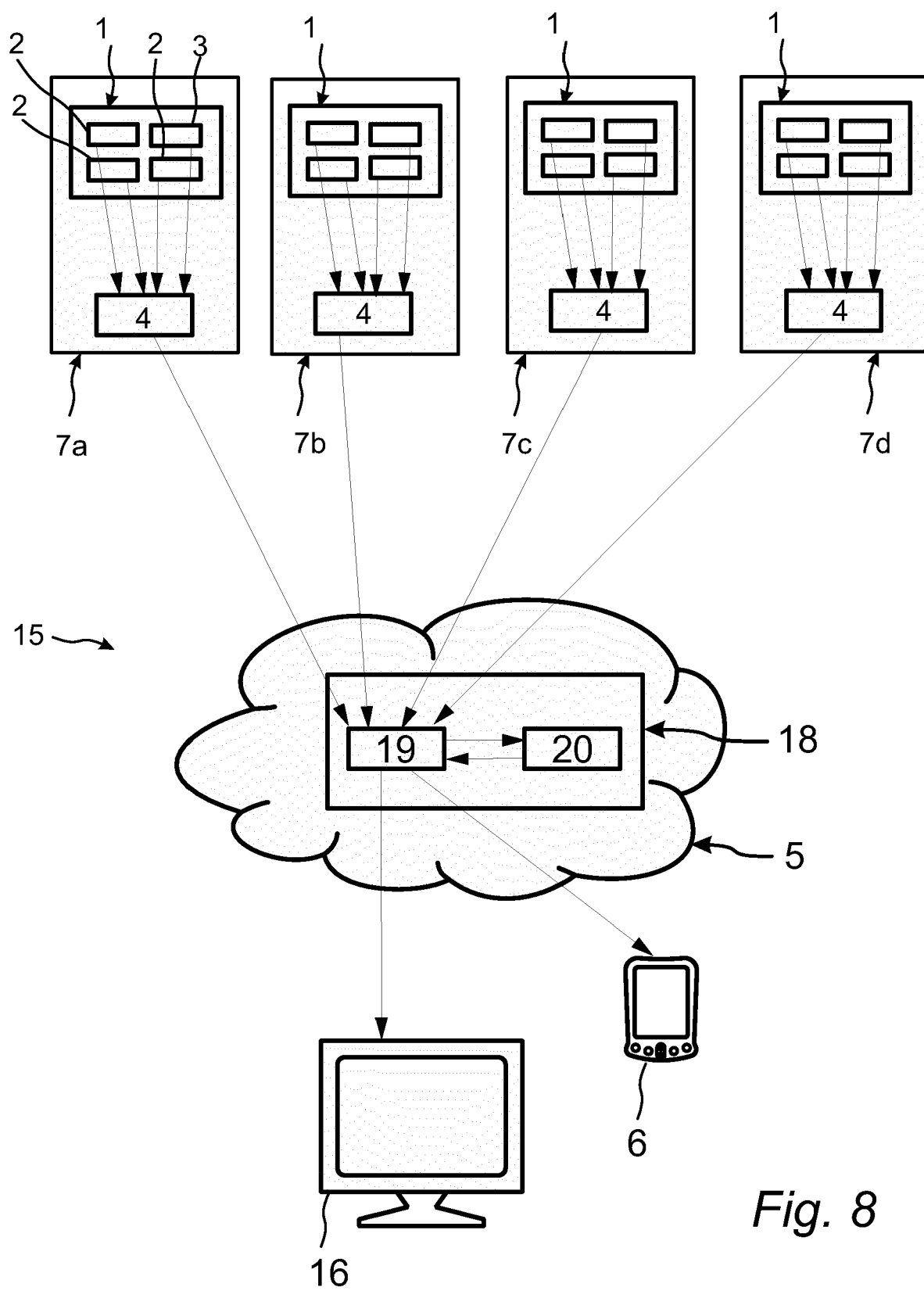


Fig. 8

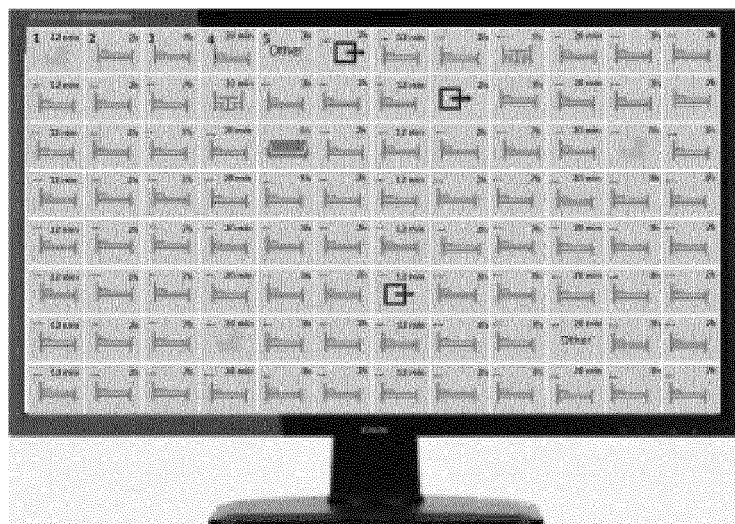


Fig. 9

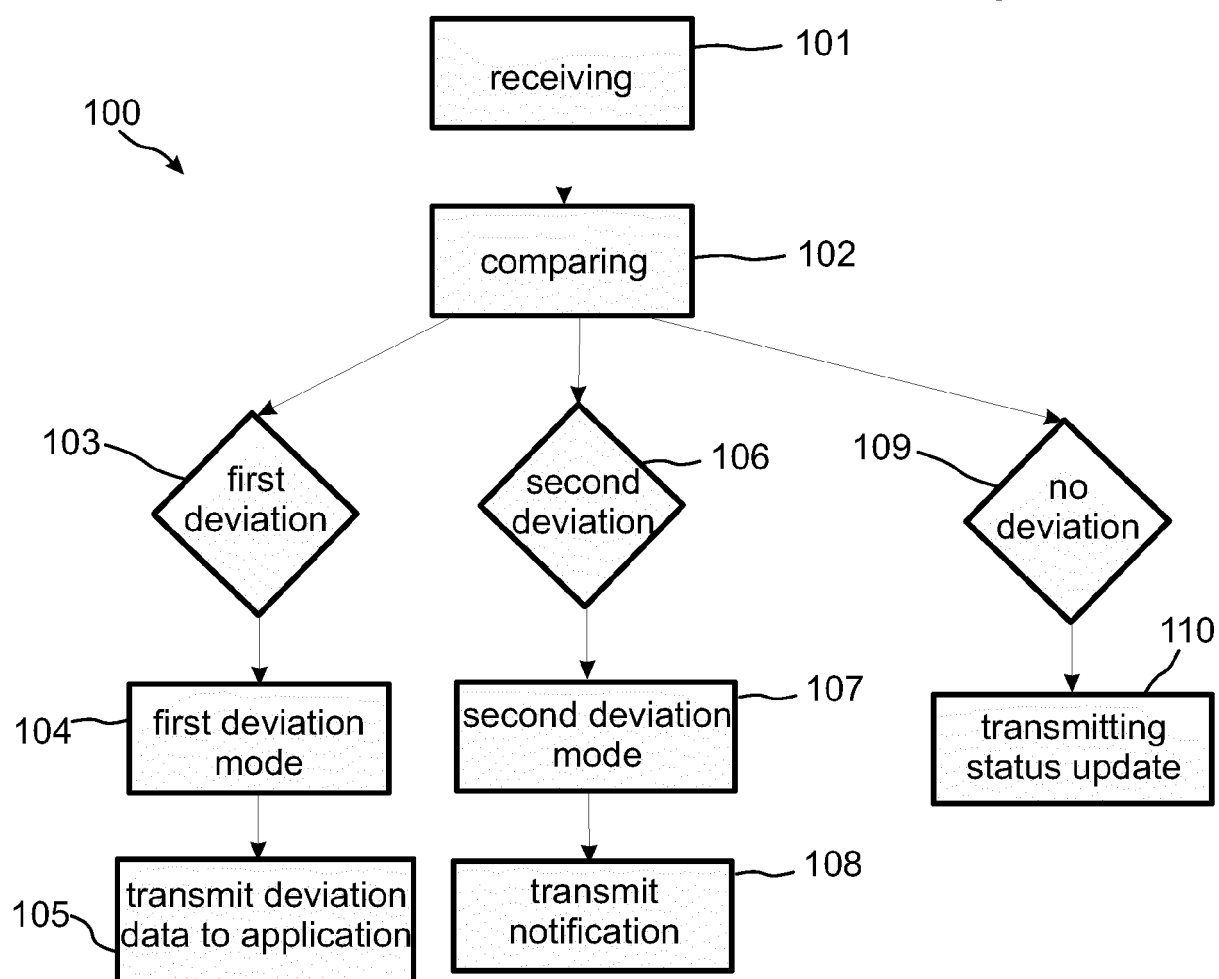


Fig. 10



EUROPEAN SEARCH REPORT

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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	EP 2 472 487 A2 (LANO GROUP OY [FI]) 4 July 2012 (2012-07-04)	1,2, 4-12,16, 17 3	INV. G08B21/04
Y	* paragraph [0001] * * paragraph [0010] * * paragraphs [0022], [0023] * * paragraph [0027] * * paragraph [0029] * * paragraph [0033] * * paragraph [0037] * * paragraphs [0039] - [0043] * * paragraph [0045] * * paragraphs [0048] - [0050] * * paragraphs [0057], [0058] * * paragraph [0064] * * paragraphs [0070] - [0073] * * paragraph [0075] * * paragraphs [0077] - [0088] * * paragraphs [0108], [0109] * * paragraphs [0116], [0117] * * paragraph [0125] * * paragraph [0128] * * paragraph [0131] * * claims 2,4 * * figures 2,3 * ----- -/--		TECHNICAL FIELDS SEARCHED (IPC) G08B
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		28 May 2020	Meister, Mark
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			

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 EPO FORM 1503 03.82 (P04C01)



EUROPEAN SEARCH REPORT

Application Number
EP 19 21 4134

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 2016/161119 A1 (SMARTCARE CONSULTANTS LLC [US]) 6 October 2016 (2016-10-06)	1,2, 4-12,16, 17, 3	
Y	* paragraph [0022] * * paragraph [0025] * * paragraph [0035] * * paragraphs [0037] - [0039] * * paragraph [0044] * * paragraphs [0046] - [0049] * * paragraphs [0051] - [0054] * * paragraphs [0059], [0060] * * paragraph [0066] * * figures 1a,1b,2,4,5a,5b * -----	3	
Y	US 2005/125403 A1 (WAKABAYASHI NOBORU [JP]) 9 June 2005 (2005-06-09) * paragraph [0019] * * paragraphs [0022], [0023] * * paragraph [0037] * * paragraph [0039] * * figures 1-3,7 * -----		TECHNICAL FIELDS SEARCHED (IPC)
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 May 2020	Examiner Meister, Mark
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 (P04C01)



Application Number

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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-12, 16(completely); 17(partially)

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



LACK OF UNITY OF INVENTION
SHEET B

Application Number

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The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-12, 16(completely); 17(partially)

A method for monitoring a first user at a site, the method comprising:
receiving, via a communication network, input signals from at least one sensor arranged at the site, the input signals carrying detection values;
generating activity data from the received detection values, comparing the generated activity data with base line activity data;
generating an alert if generated activity data deviates from the baseline activity data to a predetermined degree, wherein the at least one sensor is a motion sensor, and the detection value carried in the input signal indicates that the sensor has detected movement, wherein input signals are received from a plurality of sensors and wherein the generation of activity data includes generating an activity value by counting the number of times during a predetermined time period the detection value indicating movement is shifting from a detection field of one motion sensor to the detection field of another motion sensor.

2. claims: 13-15(completely); 17(partially)

A system for monitoring movements of a first user at a site, the system comprising:
at least one sensor arranged at the site,
a monitoring service comprising a communication unit and processing device,
wherein the sensor(s) are configured to register detection values at the site and transmitting said detection values as input signals to the monitoring service,
wherein the processing device is configured to generate activity data from the detection values, comparing the generated activity data with baseline activity data representing historic activities of the first user; and
generating an alert if the generated activity data deviates from the baseline activity data to a predetermined degree, wherein the system further comprises a position sensor, wherein the system is configured to monitor the first user when the first user is out of range of the sensors, and wherein the system is configured to perform a handover from the sensors to the position sensor.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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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
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28-05-2020

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82