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METHOD AND APPARATUS FOR DETECTING WAKING TIMES

(57) A method to determine a waking-up time of an individual includes acquiring motion sensor data indicating activity of an individual for a plurality of days, the motion sensor data having instances of triggering of motion sensors (112, 114, 116) located in a night zone living area and a day zone living area. The data is loaded into a state machine to detect a transition from a sleep state

to a wake state from sensor data in the day zone living area. Waking times are determined via the transition time from the sleep state to the wake state. A range of waking-up times for the individual is determined from the waking-up times for the individual over the plurality of days. A deviation out of the range of a new waking-up time is reported to caretaker equipment (130).

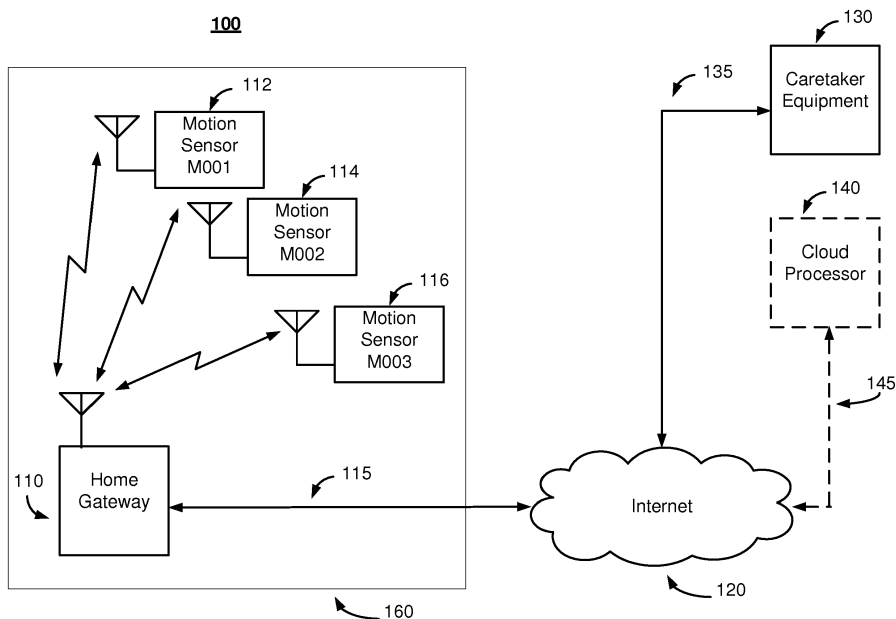


Fig. 1

Description**FIELD**

5 **[0001]** The present disclosure relates to data processing, specifically, to gathering and processing data to determine the waking time of elder individuals.

BACKGROUND

10 **[0002]** In the domain of the care of elderly people staying in their own home or in non-medicalized residences, one key area of interest is the sleeping habits of the individual. The care workers monitoring the elderly may fruitfully use a report on the sleep patterns of the person as a tool for diagnosis of behavioral or health problems. Anomalies may be detected for further investigation and alerts may be raised for immediate action; as in the case of an emergency.

15 **[0003]** With the development of the Internet of Things, wearable sensors are now available which are able to facilitate the detection of sleep periods. However, permanently wearing something around the neck or on the wrist is perceived as an unwelcome constraint by many and is not widely accepted by elderly people. A more acceptable approach is then to base waking detection on less-intrusive sensors in the home, such as motion sensors. If so used, the problem raised is how to detect waking times from motion sensor measurements.

20 **[0004]** Machine learning techniques may typically apply. Clustering, which consists in grouping measured points, may not systematically lead to the expected grouping. In particular, clustering of data may only poorly apply to waking detection. Physical motion sensor values which are measured may be far from human body physiology in determining waking times. This disadvantage may be compensated by using a classification technique rather than a clustering one. But a new problem arises: the obligation to have preliminary labelled data to train the system. Thus, a simpler approach is needed. This disclosure focuses on a solution to the specific problem of detecting the time at which the elderly person
25 gets up in the morning.

SUMMARY

30 **[0005]** This summary is provided to introduce a selection of concepts in a simplified form as a prelude to the more detailed description that is presented later. The summary is not intended to identify key or essential features of the invention, nor is it intended to delineate the scope of the claimed subject matter.

35 **[0006]** In one embodiment a method to determine a waking-up time of an individual, the method comprises acquiring motion sensor data indicating activity of an individual for a plurality of days, the motion sensor data comprising instances of triggering of at least one motion sensor located in at least one day zone living area; loading the acquired motion sensor data into a state machine, wherein a transition from a sleep state to a wake state is detected by multiple triggers of a sensor in the day zone living area; determining a waking-up time for the individual associated with the transition from the sleep state to the wake state, wherein the determination is performed by the state machine; recording the determined waking-up time; establishing a range of waking up time for the individual based on the determined waking-up times for the individual over the plurality of days; detecting when a new waking-up time deviates from the range; and
40 reporting the deviation of the new waking-up time.

45 **[0007]** In another feature, the aspect of loading the acquired motion sensor data into a state machine further comprises loading motion sensor data representing a transition from a quiet state to a sleep state via detecting by an absence of triggering of a motion sensor in any room for at least one hour. In another feature, the aspect of loading the acquired motion sensor data into a state machine further comprises loading motion sensor data representing a transition from the wake state to the quiet state by the arrival of evening or night time. In another feature, the transition from a sleep state to a wake state is detected according to a number of triggers of a motion sensor in a period of time. In another feature, the multiple triggers of the sensor indicates a higher density of activity in the day zone living area.

50 **[0008]** In another feature, the aspect of acquiring motion sensor data indicating activity of an individual comprises acquiring motion sensor data and receiving the motion sensor data via wireless communication. In another feature, the aspect of establishing a range of waking up time for the individual based on the determined waking-up times for the individual over the plurality of days comprises determining statistics of early waking-up time and late waking-up times. In another feature, the aspect of detecting when the waking-up time deviates from the range comprises comparing a most recent daily waking-up time to a statistical waking-up time. In another feature, the aspect of reporting the deviation of the waking-up time comprises transmitting a sleep deviation report to a caretaker of the individual. In another feature,
55 the aspect of reporting the deviation of the waking-up time comprises transmitting an alert to a caretaker of the individual.

[0009] In one embodiment, an apparatus to determine a waking-up time of an individual, the apparatus comprises a receiver that receives motion sensor data indicating activity of the individual for a plurality of days, the motion sensor data comprising instances of triggering times of motion sensors located in a night zone living area and a day zone living

area; a state machine to determine a waking-up time for the individual, wherein the waking-up time is associated with a transition from a sleep state to a wake state, the wake state determined from motion sensor data of the day zone living area; a memory to record the determined waking-up time; a processor configured for establishing a range of waking-up time for the individual based on the determined waking-up times for the individual over the plurality of days, wherein the processor detects when a new waking-up time deviates from the range; and a network interface used to communicate alerts notifying of a deviation of the new waking-up time. In another aspect of the configuration, the receiver receives motion sensor data from a wired interface or wireless interface.

[0010] Additional features and advantages of the invention will be made apparent from the following detailed description of illustrative embodiments which proceeds with reference to the accompanying figures. It should be understood that the drawings are for purposes of illustrating the concepts of the disclosure and are not necessarily the only possible configuration for illustrating the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The foregoing summary of the invention, as well as the following detailed description of illustrative embodiments, is better understood when read in conjunction with the accompanying drawings, which are included by way of example, and not by way of limitation with regard to the claimed invention. In the drawings, like numbers represent similar elements.

Figure 1 depicts a functional block diagram of the disclosed configuration;

Figure 2 depicts an example floorplan and sensor location of an elder living area;

Figure 3 depicts an example state diagram of a state machine using the disclosed configuration;

Figure 4 depicts an example flow diagram using principles of the disclosed configuration; and

Figure 5 depicts an example apparatus having features of the configuration.

DETAILED DISCUSSION OF THE EMBODIMENTS

[0012] In the following description of various illustrative embodiments, reference is made to the accompanying drawings, which form a part thereof, and in which is shown, by way of illustration, how various embodiments in the inventive configuration may be practiced. It is to be understood that other embodiments may be utilized and structural and functional modifications may be made without departing from the scope of the configuration.

[0013] Figure 1 depicts an example system diagram 100 encompassing one embodiment of the disclosed concepts. A home gateway 110 has communicative connection to two or more motion sensors. The configuration of Figure 1 includes three motion sensors. Motion sensor 112 is labeled M001, motion sensor 114 is labeled M002, and motion sensor 116 is labeled M003. The communicative interfaces may be either RF, infrared, optical, or cable. A wireless interface, such as RF or infrared is depicted in Figure 1. However, a wired interface, such as optical cable or coax cable is also contemplated. The home gateway is connected to the internet 120 via a typical cable or fiber optic connection 115. Home gateway 110 and motion sensors 112, 114, and 116 are located in a home or caretaking environment 160.

[0014] In one aspect of the disclosure, a state machine is used to determine the waking time of elders based on the processing of motion sensor data within the home or caretaking environment 160. In one embodiment, the state machine (not specifically shown in Figure 1) may be located in the home gateway 110. In another embodiment, the state machine may be located in a web-based location, such as a web-site providing processing resources, or in the caretaker equipment 130 itself. Another web-based location is depicted as a cloud processor 140 connected to the internet 120 via connection 145. The cloud processor 140 and connection are shown in dotted lines to indicate an optional location for the state machine.

[0015] Caretaker equipment 130 is included in the disclosure as an example station or device capable of requesting and displaying information concerning an elder. Such equipment may include a variety of information display equipment including remote terminals, personal computers, console computers, and handheld devices. As such, connection 135 between the Internet 120 and caretaker equipment 130 may be either a wired (cable or fiber optic) or a wireless (RF, infrared, sonic) interface. A local gateway (not separately shown) that supports a personal computer or handheld unit may also be included in the caretaker equipment 135. The location of caretaker equipment 135 is dependent on the needs of the caretaker. In one example, caretaker equipment may be a remote site so as to perform remote monitoring of the elders under observation. In another embodiment, the caretaker equipment may include a portable (wireless) unit that may be carried anywhere including the elder residence.

[0016] In operation, the motions sensors 112, 114, and 116 detect movement reflective of activity within the home or caregiving environment 160. In one example, the motion sensor activity is sent to the home gateway, where it may be processed by a state machine. The state machine may be located in the home gateway. Alternately, the state machine may be located on a web-based resource such as a cloud resource 140 or a web-site (not shown). The determined waking time of the elder may be immediately presented to the caretaker equipment 130. In another embodiment, after

initial processing to determine waking times for the elder under observation, statistics may be calculated on multiple sets of waking times for the elder and any observed deviation from the "normal" waking time are provided to the caretaker equipment.

[0017] Figure 2 depicts a typical living area 200 for an elder under observation with the configuration disclosed herein. In the example living environment of Figure 2, three sensors are installed. One sensor designated as M003 is located in the living room area 220. A second sensor designated as M002 is located in the kitchen area 210. A third sensor designated as M001 is located in the bedroom area 240. The exact location of a motion sensor in a room is not specifically shown in Figure 2. Other areas of the living space do not have sensors, such as bathroom area 230 and hallway area 250. The sensor M001 located in the bedroom is also referred to as a night zone sensor. Sensors M002 and M003 located in the kitchen and living room respectively are also referred to as day zone sensors. In one aspect of the disclosure, a waking time may be detected wherein a transition from a sleep state to a wake state is detected by multiple triggers of a sensor in the day zone. The waking time can be determined regardless of where the elder falls asleep; in a night zone or a day zone.

[0018] The general sensor configuration described in Figures 1 and 2 is an example of a waking time monitoring system that relies on the use of a configuration incorporating two or more motion sensors deployed within the home of an elderly person to be observed. One of the sensors is located in the bedroom defining a night zone living area. The other sensors are deployed in other rooms where there is daytime activity (e.g. kitchen, lounge, dining room), thus defining a day zone living area. The monitoring system 100 records the motion events detected by all of the sensors.

[0019] Actuation events provided by motion sensors are the times at which they are triggered ON by movement of the elder. The sensors return automatically to an OFF state after a period of no more than a few seconds. After this short period (called "blind" period), they are again in a position to be triggered ON by any movement to be detected. This does not directly reflect the frequency at which sensors are triggered. Triggering frequency is an important element which may reveal human activity level, and therefore allows inferring whether the person is awake (i.e. out of bed and moving around) or not. The measurements of triggering (actuation events) over a set time period are referred to as frequency features.

[0020] Initially, the generation of raw frequency features are delivered by the motion sensors. Frequency features can be measured to determine how many times each sensor has been triggered ON in the past period T of time. Typically, a period T is 15 minutes. As an example, the gathered new features are a list with a time, a sensor id, and the number of triggers for this sensor during the last T period. The time corresponds either to the end of a T period, or to a trigger time of the sensor. The following table is an illustrative example for one sensor:

Event	Time	Sensor ID	# of triggers in previous T minutes
End of period T	06:00:00	M002	0
Movement detected	06:14:23	M002	1
End of period T	06:15:00	M002	1
Movement detected	06:15:32	M002	2
...	...	...	...
Movement detected	06:20:56	M002	16
Movement detected	06:21:02	M002	17
Movement detected	06:21:07	M002	18
Movement detected	06:21:11	M002	19
Movement detected	06:21:18	M002	20
Movement detected	06:21:20	M002	21
Movement detected	06:21:24	M002	22
Movement detected	06:21:30	M002	23
Movement detected	06:22:02	M002	24
End of period T	06:30:00	M002	23
End of period T	06:45:00	M002	0

(continued)

Event	Time	Sensor ID	# of triggers in previous T minutes
...	...	...	...

These frequency features (actuation events occurring over T periods of time) are sent by the motion sensors, detected by the home gateway, and sent to a state machine.

[0021] Figure 3 depicts a state diagram 300 of the state machine that is used to determine waking times according to principles of the disclosed configuration herein. As discussed earlier with respect to Figure 1, the state machine may be located in an elder home in a unit such as the home gateway. Alternately, the state machine could be located as a web-accessible entity such as a website or a cloud processor available using internet access.

[0022] Returning to Figure 3, three states are depicted; a quiet state 310, a sleep state 320, and a wake state 330. Transitions from one state to another are determined by state transitions rules. The transition 316 between the wake state 330 and the quiet state 310 is time passage, such as the passage of hours in a day until the arrival of evening or night-time. The transition 312 between the quiet state 310 and sleep state 320 is decided by an absence of triggering (of any sensor) during a long still (quiet) period of time, such as a one hour period of time. The transition 314 between the sleep state 320 and the wake state 330 is decided when the number of firing of motion sensors located in a zone other than in the night zone (e.g. other than the bedroom 240) during the last 15 minutes is higher than a certain threshold. In one example, the threshold may typically be 20 motion sensor actuations or firings.

[0023] In Figure 3, the wake state 330 generally corresponds to a daylight time interval passing to a night time interval. The state machine enters the quiet state 310 from the wake state 330 due to the passage of time throughout a day. Once in the quiet state 310, the state machine 300 will remain in the quiet state 310 until a specific period of time has elapsed since the last detection of movement by motion sensors M001 and M002. In one example the specific period of time is 4000 seconds. At the end of the specific period of time, the state machine transitions from the quiet state 310 to the sleep state 320. Once in the sleep state 320, the state machine seeks to detect activity outside the night zone (bedroom 240). The activity to be detected to exit the sleep state is activity detected in a day zone, such as in a living room or kitchen. The activity is generally above a threshold value of activity to be registered as an entry point to the wake state 330. In one example, a value above a threshold set to 20 motion sensor actuations or triggering events is used. The triggering events are frequency features related to sensors M002 and M003. When this is the case, the state machine returns to the wake state 330.

[0024] The state machine decision rules disclosed above allow a determination of entry into the sleep state 320 in a room other than the bedroom. Consider an instance where the elder user is watching TV in the living room and is falling asleep in her sofa. After a transition to the quiet state 310, and then after about 4000 seconds, using the present disclosure, she is considered in the sleep state 320. In some previous solutions that use motion sensors, an equivalent sleep state is only considered when a last motion sensor firing occurs in the bedroom. Thus, the herein disclosed solution allows the flexibility of determining a sleep state in any sensor-equipped room.

[0025] The state machine, considering the regular rhythm of life of elderly people, waits for the change of day (from day to evening to night) before seeking to detect a sleep state. Thus, a sleep state generally occurs in the nighttime hours of the day. The person is considered to be in a sleep state 320 if there is no movement detected during a period of time in the quiet state 310. That is, a change of state from quiet to sleep occurs if frequency features are below a threshold close to zero during a period of time in the quiet state 310. Once the sleep state 320 is entered, the state machine 300 is in a position to detect the waking time. Waking is detected when motion is detected elsewhere than in the bedroom. That is, a wake state 330 is entered when frequency features for a room other than the bedroom are above a certain threshold for a certain period of time. The detected time at which the state machine enters the wake state 330 is then considered as the waking time of the person. Specifically, the wake time is the start of the T period.

[0026] Figure 4 is a flow diagram 400 illustrating an example method of the disclosure. At step 405, motion sensor data is acquired. In one embodiment, motion sensors transmit their data when an actuation of the sensor occurs. Thus, upon detection of motion, the motion sensor is triggered and sends information to the home gateway or other suitable receiver. The motion sensor data transmission can be a wired or a wireless transmission. The receiver of the transmitted motion sensor data can be a dedicated motion sensor receiver or may be a receiver built into a component such as a home gateway.

[0027] After the motion sensor data is acquired, it is loaded into a state machine at step 410. The sensor data loading into the state machine can occur immediately after sensor data reception from the sensor. Alternately, the data loading into the state machine can occur on a batch basis where sensor data is collected by the home gateway over some period of time, such as 15 minutes or longer, and then transmitted to the home gateway for state machine use. After receiving the sensor data by the state machine, the state machine can determine the waking time of the elder under observation at step 415.

[0028] In one embodiment, the waking time is determined from the time of occurrence of a transition of the state machine from a sleep state 320 to a wake state 330. This occurs using criterion such as detecting a multitude of motion sensor activation information (triggering on then off) where the motion sensors are monitored from a day zone. Night zone motion sensor actuations, such as those that occur from a bedroom motion sensor, are not used in wake time determination. In one example, 20 or more activation or triggering events are detected by day zone motions sensors such as sensor M002 and /or sensor M003 over a defined time interval, such as a 15 minute time interval. In one aspect of the invention, since wake state detection occurs by observation of day zone motion sensors, then the person being monitored can fall asleep in either a day zone or a night zone and waking times will be correctly determined. As discussed earlier, the state machine can be located with the home gateway or as part of a web-site or cloud-based processing element.

[0029] At step 420 the recorded waking time is recorded. Over time, when a multiplicity of waking times are determined and recorded, then statistical information may be obtained from the set of waking times. Such statistics can include average waking time, median waking time, and high and low limits of waking times.

[0030] In the instance of receiving and recording a batch of sensor data collected over time, then each set of sensor data is processed individually to determine waking time. Accordingly each individual waking time for the set is recorded. This recordation of sets of waking times allows step 425 to establish a range a waking times. In one embodiment, a range can be established by looking at minimum (early) and maximum (late) waking times; the range bounded by the two extremes. In another embodiment, statistics can be processed to determine the mean and standard deviation of the detected waking times over a period of days or weeks. The range may then be determined using a statistical variance from the mean waking time, such as 1.5 or 2.0 standard deviations. The waking time statistics can be recalculated depending on factors such as seasonal variations. Although the state machine 300 is responsible for detecting waking times, a processor is used to determine the statistics of waking times. Such a processor can be either co-located or remotely located with respect to the state machine location.

[0031] At step 430, the detection of a deviation of waking times is detected based on the range of waking times detected. As such, a deviation outside of a normal variance may indicate a change of health of the elder person. Such a variation can be reported in real-time at step 435 to provide an alert to a possible change in condition of the elder person. Reporting may also include a full set of statistics to date as well as the deviation. As an alternative to reporting just a deviation from normal waking time, a reporting can also be made of individual waking times in real-time or sets of waking times presented over time.

[0032] In the instance where the state machine is located at the home gateway 110, then reporting includes packetizing data for transfer through medium 115 and via the Internet 120 via interface 135 to caretaker equipment 130. Caretaker equipment may include a display to inform monitors of the statistics, current state status, or waking condition of the elder person being monitored. In the instance where the state machine is located as a web resource, such as a website or a cloud-based processing entity, then reporting starts at the web-based resource. After the state machine located in the web-based resource calculates the waking time, then the web-based resource, such as the cloud processor 140 would communicate via link 145, across the internet 120, to caretaker equipment 130 via link 135. In either event, the caretaker equipment receives an indication of the waking status of the elder person.

[0033] Figure 5 depicts an example apparatus 110 which provides the home gateway function for the configuration of Figure 1. In the embodiment of Figure 5, the home gateway 110 houses the state machine 300 in one or more forms. Figure 5 depicts a bus-based architecture device having a processor 510, network interface 502, motion sensor receiver module 506, and display device 520.

[0034] The network interface 502 allows the device 110 to interface to the internet via connection 115. Motion sensors are communicatively connected to the motion sensor receiver 506. This communication connection is depicted as an RF or IR interface, but other interfaces including a wired or optical are also contemplated. A display device 520 and a user control interface 516 are presented to render information of the gateway and its operation to a user. The user may gain access to the device 110 by addressing the user control interface 516, which may be a keyboard, audio interface, keyboard or mouse and monitor the operation of the gateway via the display device 520.

[0035] Processor 510 connects to all elements of the device 110 via a bus 526. For example, access to internet resources may be gained by the processor via bus 526 using network interface 502. Sensor data may be routed to storage device 507 via bus 526, and the user interface gains access to processor control via bus 526. Processor 510 can use cache memory 514 to prefetch instructions or simply access instructions for operations. State machine 504 represents a hardware and software implementation of the state machine 300 of Figure 3, which can result in fast operation if data from the motion sensors is routed from the motion sensor data receiver 506 or from storage 507. As such state results can be obtained by processor 510 in order to perform statistics on the waking time of elders being observed.

[0036] As an alternate embodiment, the state machine need not be a separate bus-accessible module such as depicted in 504. Instead, the state machine may be a software-implemented state machine located in Processor 510, or manipulated by processor 510 and places in storage device 506. As an additional embodiment, the state machine may be

implemented as a web-based processor. In that instance, the state machine 504 need not be present in device 110, but may be accessed via network interface 502.

[0037] Operation of the device 110 is according to the method of Figure 4, where motion sensor data is acquired via receiver 506. The state machine may be represented as module 504, computer instructions for processor 510, or a web-based state machine implementation. Recordation of waking times is performed using storage 507 and deviations from waking times are determined by applying computer instruction via processor 510 to determine abnormal waking times. In addition, processor 510 may be used to generate alerts or a report of waking times to be sent over network interface 502 to a receiver, such as caretaker equipment 130.

[0038] The implementations described herein may be implemented in, for example, a method or process, an apparatus, or a combination of hardware and software. Even if only discussed in the context of a single form of implementation (for example, discussed only as a method), the implementation of features discussed may also be implemented in other forms. For example, implementation can be accomplished via a hardware apparatus, or via a combination of a hardware and software apparatus. An apparatus may be implemented in, for example, appropriate hardware, software, and firmware. The methods may be implemented in, for example, an apparatus such as, for example, a processor, which refers to one or more of any processing devices, including, for example, a computer, a microprocessor, an integrated circuit, or a programmable logic device.

[0039] Additionally, the methods may be implemented by instructions being performed by a processor, and such instructions may be stored on a processor or computer-readable media such as, for example, an integrated circuit, a software carrier or other storage device such as, for example, a hard disk, a compact diskette ("CD" or "DVD"), a random access memory ("RAM"), a read-only memory ("ROM") or any other magnetic, optical, or solid state media. The instructions may form an application program tangibly embodied on a computer-readable medium such as any of the media listed above or known to those of skill in the art. The instructions thus stored are useful to execute elements of hardware and software to perform the steps of the method described herein.

Claims

1. A method to determine a waking-up time of an individual, the method comprising:

acquiring motion sensor data indicating activity of an individual for a plurality of days, the motion sensor data comprising instances of triggering of at least one motion sensor located in at least one day zone living area (405); loading the acquired motion sensor data into a state machine, wherein a transition from a sleep state to a wake state is detected by multiple triggers of a sensor in the day zone living area (410); determining a waking-up time for the individual associated with the transition from the sleep state to the wake state, wherein the determination is performed by the state machine (415); recording the determined waking-up time (420); establishing a range of waking up time for the individual based on the determined waking-up times for the individual over the plurality of days (425); detecting when a new waking-up time deviates from the range (430); and reporting the deviation of the new waking-up time (435).

2. The method of claim 1, wherein loading the acquired motion sensor data into a state machine further comprises loading motion sensor data representing a transition from a quiet state to a sleep state via detecting by an absence of triggering of a motion sensor in any room for at least one hour.

3. The method of claim 1, wherein loading the acquired motion sensor data into a state machine further comprises loading motion sensor data representing a transition from the wake state to the quiet state by the arrival of evening or night time.

4. The method of claim 1, wherein the transition from a sleep state to a wake state is detected according to a number of triggers of a motion sensor in a period of time.

5. The method of claim 4, wherein the multiple triggers of the sensor indicates a higher density of activity in the day zone living area.

6. The method of claim 1, wherein acquiring motion sensor data indicating activity of an individual comprises acquiring motion sensor data and receiving the motion sensor data via wireless communication.

7. The method of claim 1, wherein establishing a range of waking up time for the individual based on the determined waking-up times for the individual over the plurality of days comprises determining statistics of early waking-up time and late waking-up times.
8. The method of claim 1, wherein detecting when the waking-up time deviates from the range comprises comparing a most recent daily waking-up time to a statistical waking-up time.
9. The method of claim 1, wherein reporting the deviation of the waking-up time comprises transmitting a sleep deviation report to a caretaker of the individual.
10. The method of claim 1, wherein reporting the deviation of the waking-up time comprises transmitting an alert to a caretaker of the individual.
11. An apparatus to determine a waking-up time of an individual, the apparatus comprising:
 - a receiver that receives motion sensor data indicating activity of the individual for a plurality of days, the motion sensor data comprising instances of triggering times of motion sensors located in a night zone living area and a day zone living area (506);
 - a state machine to determine a waking-up time for the individual, wherein the waking-up time is associated with a transition from a sleep state to a wake state, the wake state determined from motion sensor data of the day zone living area (504);
 - a memory to record the determined waking-up time (506);
 - a processor configured for establishing a range of waking-up time for the individual based on the determined waking-up times for the individual over the plurality of days, wherein the processor detects when a new waking-up time deviates from the range (510); and
 - a network interface used to communicate alerts notifying of a deviation of the new waking-up time (502).
12. The apparatus of claim 11, wherein the receiver receives motion sensor data from a wired interface or wireless interface.
13. The apparatus of claim 11, wherein the state machine determines a transition from a quiet state to a sleep state by detecting an absence of triggering of a motion sensor in any room for at least one hour.
14. The apparatus of claim 11, wherein the state machine determines a transition from the wake state to the quiet state by the arrival of evening or night time.
15. The apparatus of claim 11, wherein the state machine determines a transition from the sleep state to a wake state according to a number of triggers of a motion sensor in a period of time.

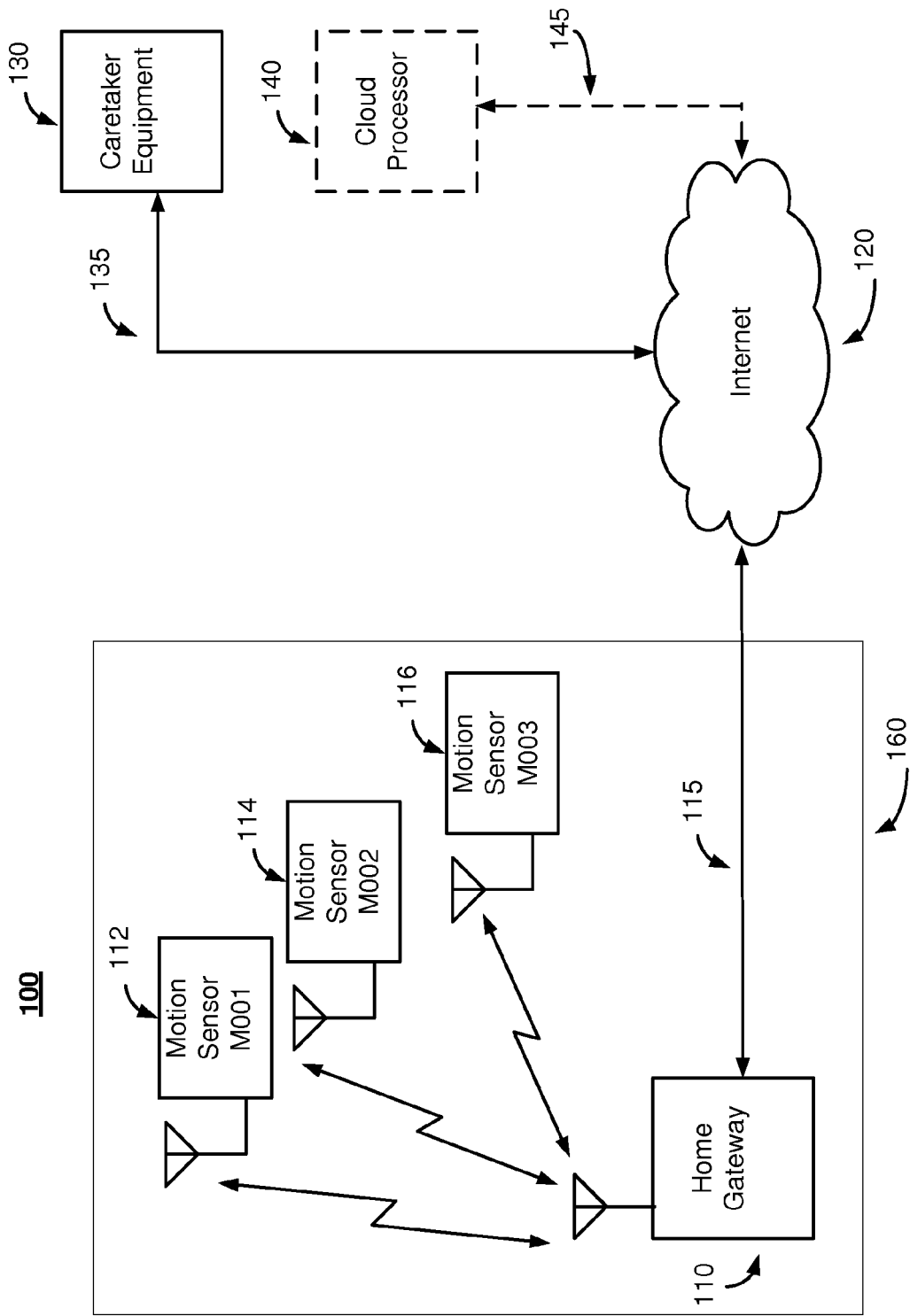


Fig. 1

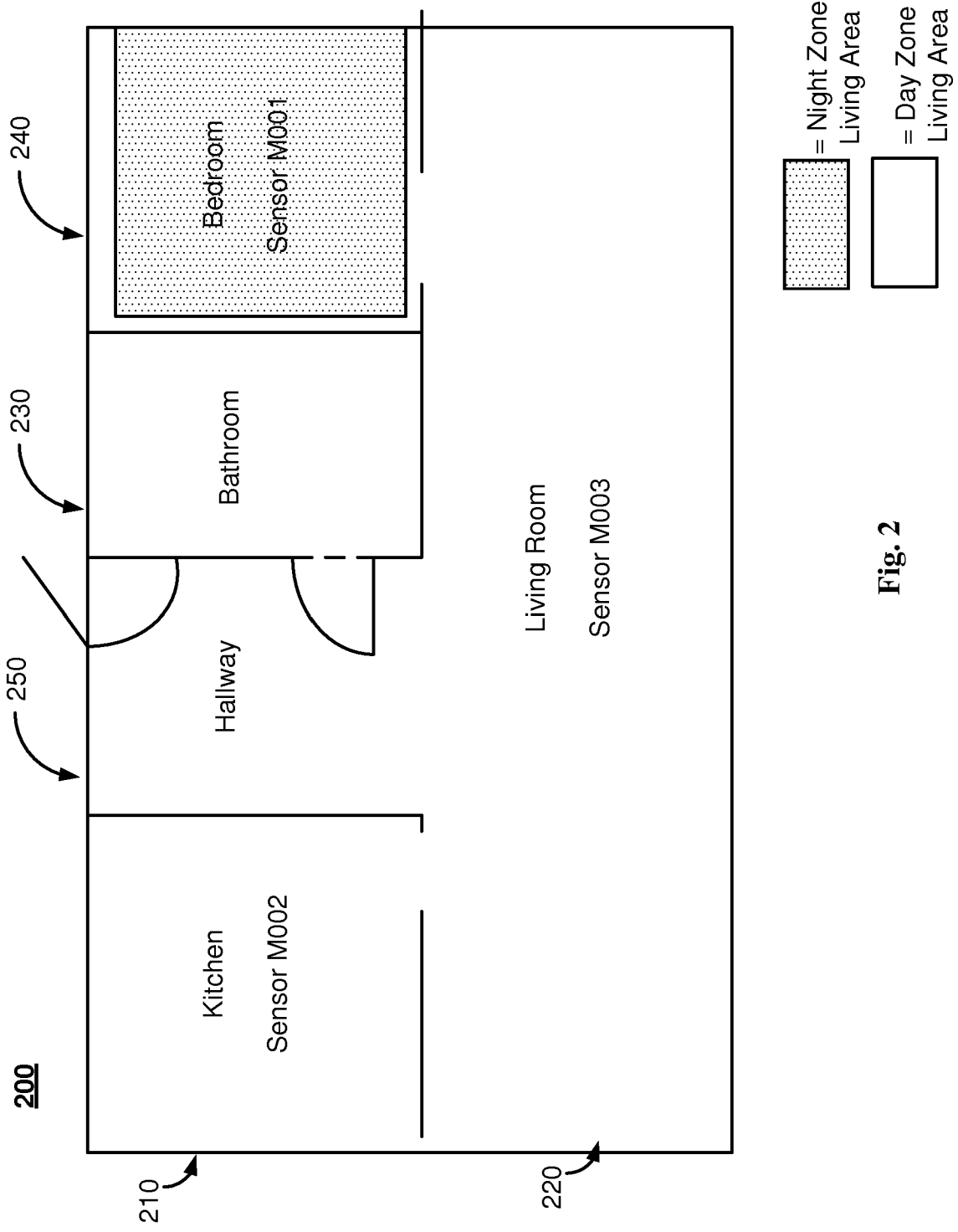


Fig. 2

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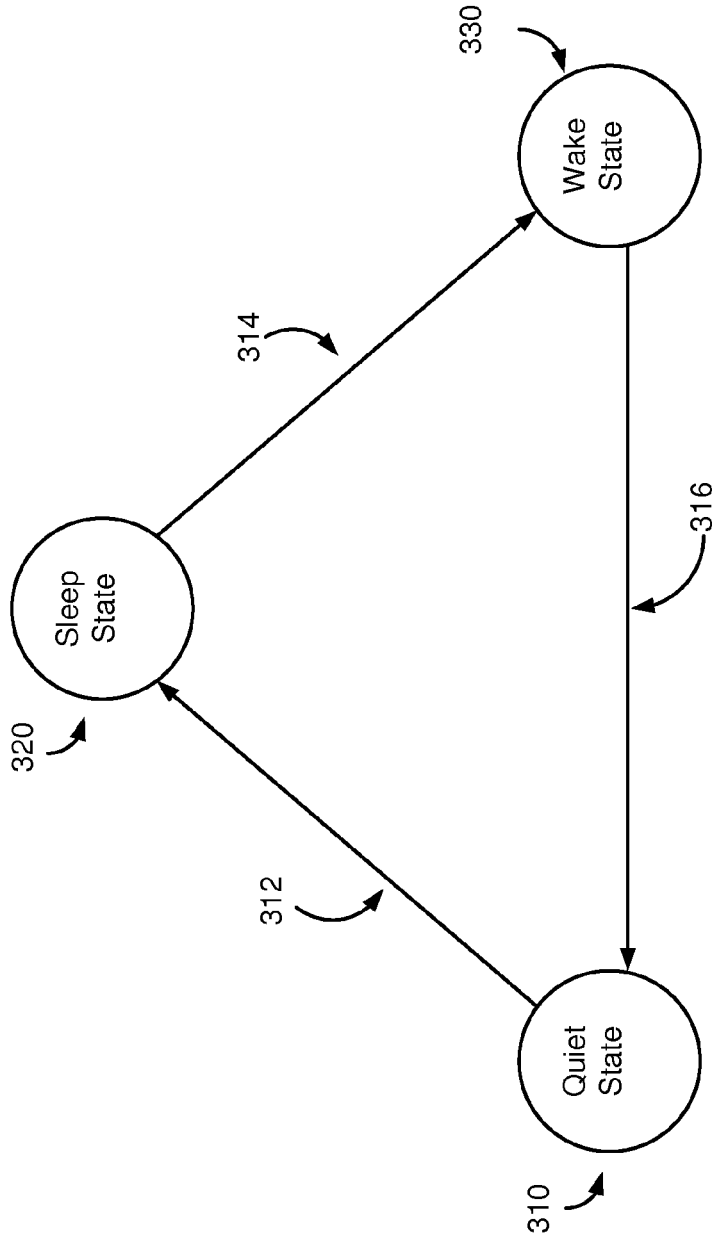
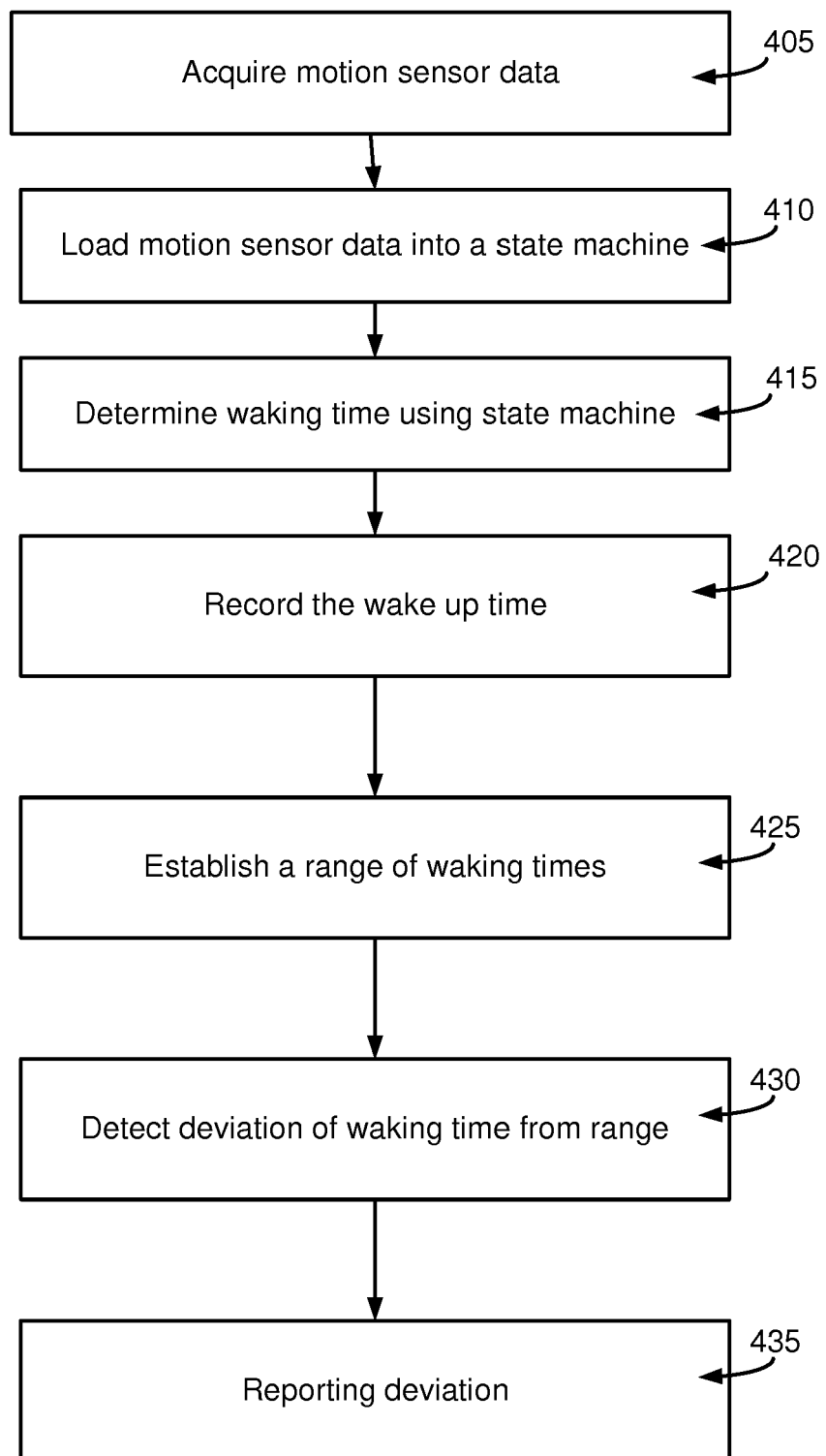


Fig. 3

400**Fig. 4**

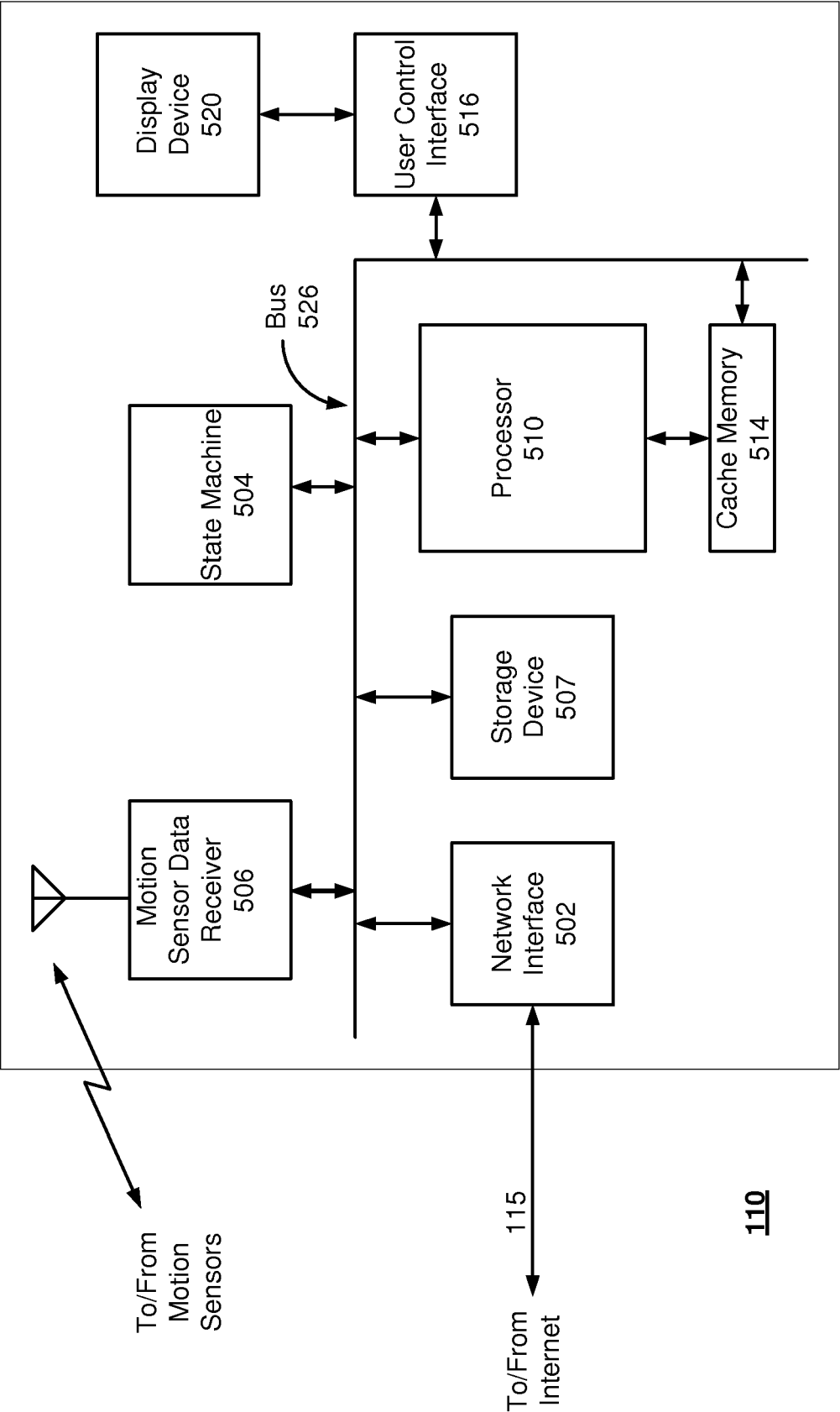


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 15 30 6868

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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	US 2005/137465 A1 (CUDDIHY PAUL E [US] ET AL) 23 June 2005 (2005-06-23) * abstract * * paragraph [0022] * * paragraph [0024] - paragraph [0027]; figure 1 * * paragraph [0044] - paragraph [0049]; figures 5-7 *	1-15	INV. G08B21/04
X	US 2005/125403 A1 (WAKABAYASHI NOBORU [JP]) 9 June 2005 (2005-06-09) * abstract * * paragraph [0019] - paragraph [0020]; figures 1,2 * * paragraph [0023]; figure 3 *	1-15	
Y	US 2005/181771 A1 (CUDDIHY PAUL E [US] ET AL) 18 August 2005 (2005-08-18) * abstract * * paragraph [0021] - paragraph [0032]; figures 1,2,4,5 *	1-15	
Y	US 2005/278409 A1 (KUTZIK DAVID M [US] ET AL) 15 December 2005 (2005-12-15) * paragraph [0021] - paragraph [0023]; figure 1 * * paragraph [0036] - paragraph [0039]; figure 3 * * paragraph [0042] - paragraph [0043] * * figure 11B * * paragraph [0123] - paragraph [0124] *	1-15	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 27 April 2016	Examiner Heß, Rüdiger
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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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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