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(54) Title of the Invention: **Method and device for monitoring at least one interior of a building, and assistance system for at least one interior of a building**
Abstract Title: **A means for monitoring the interior of a building**

(57) A means 200 for monitoring the interior of a building 250 by comparing recorded image data from the interior with reference data to generate, depending on the result, monitoring information relevant to a situation in the interior. If a relevant situation or event occurs i.e. a threshold is exceeded then a warning may be transmitted via base station 230 to remote server 240. Image and reference data may be generated by an infrared camera 210 with a time delay between images whilst image processing is performed by device 220. Pattern recognition may be used to discriminate between people, animals and/or an item and to determine movement, speed or behaviour. The threshold may be determined by comparing the difference, between images, of the maximum or minimum value of a pixel or the mean value of several pixels. The arrangement is particularly suited for use as an elderly person assistance system.

Fig. 2

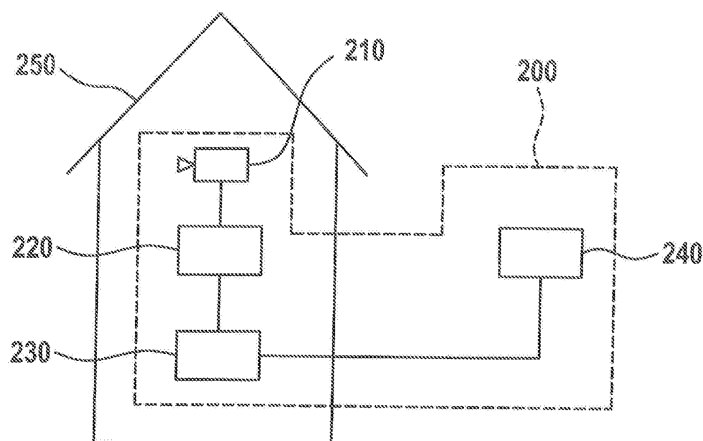


Fig. 1

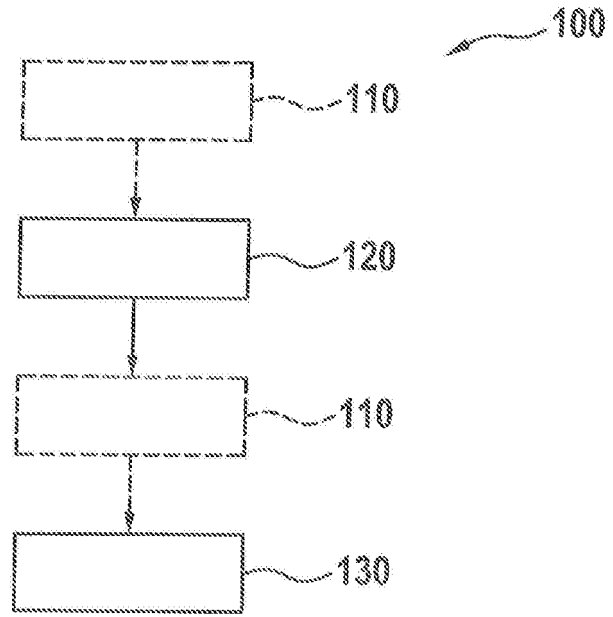


Fig. 2

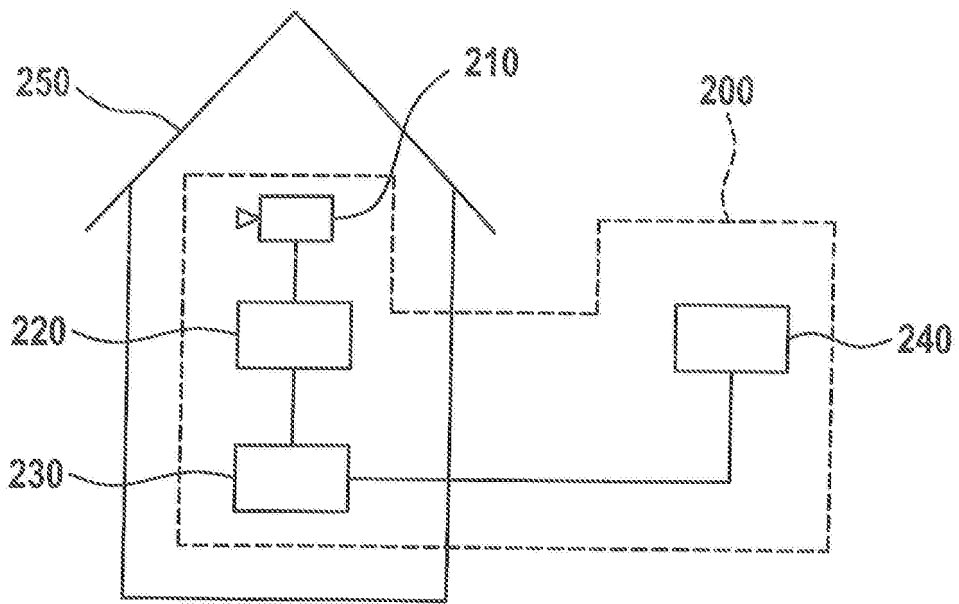


Fig. 3

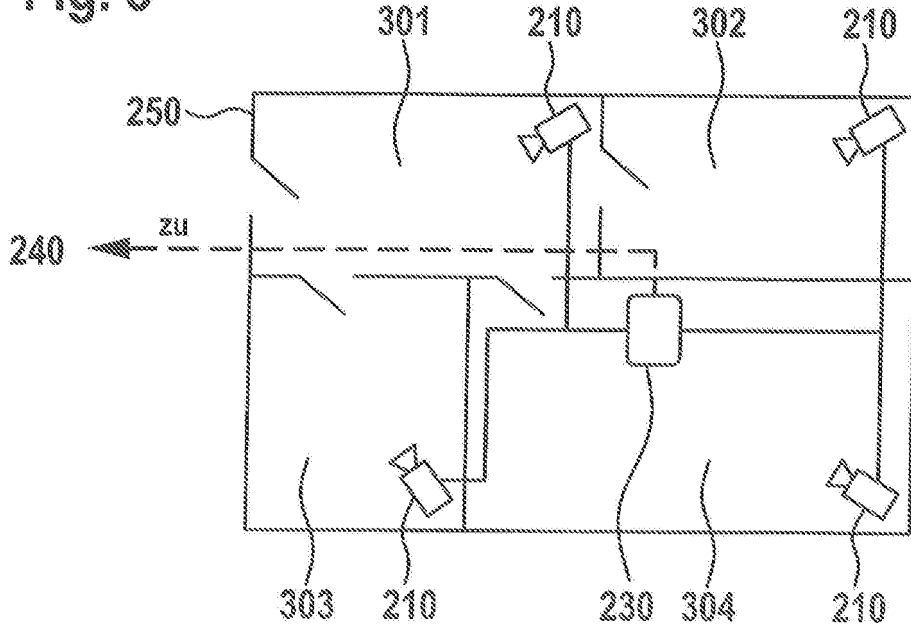


Fig. 4

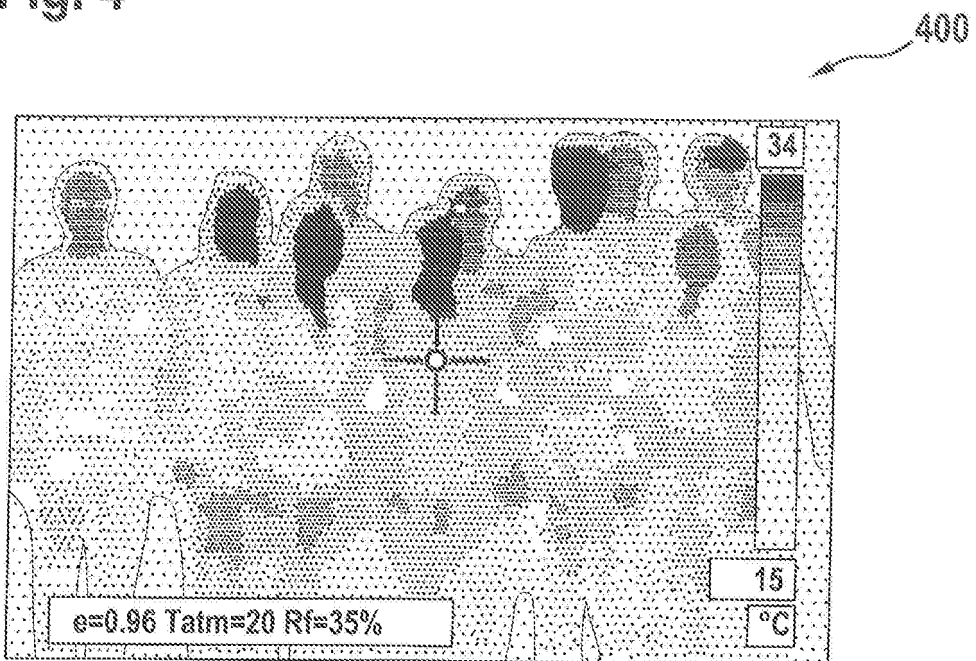


Fig. 5

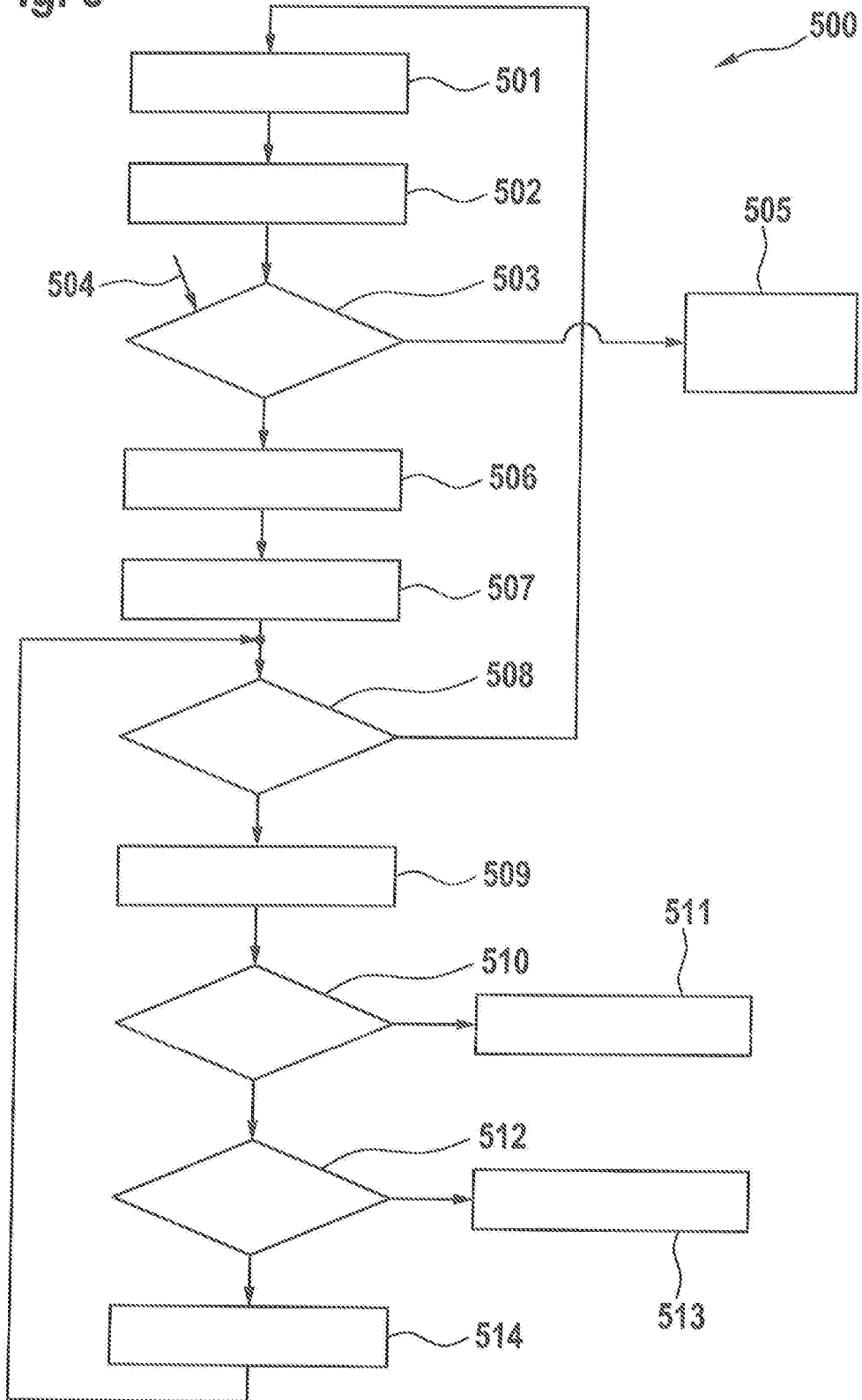


Fig. 6

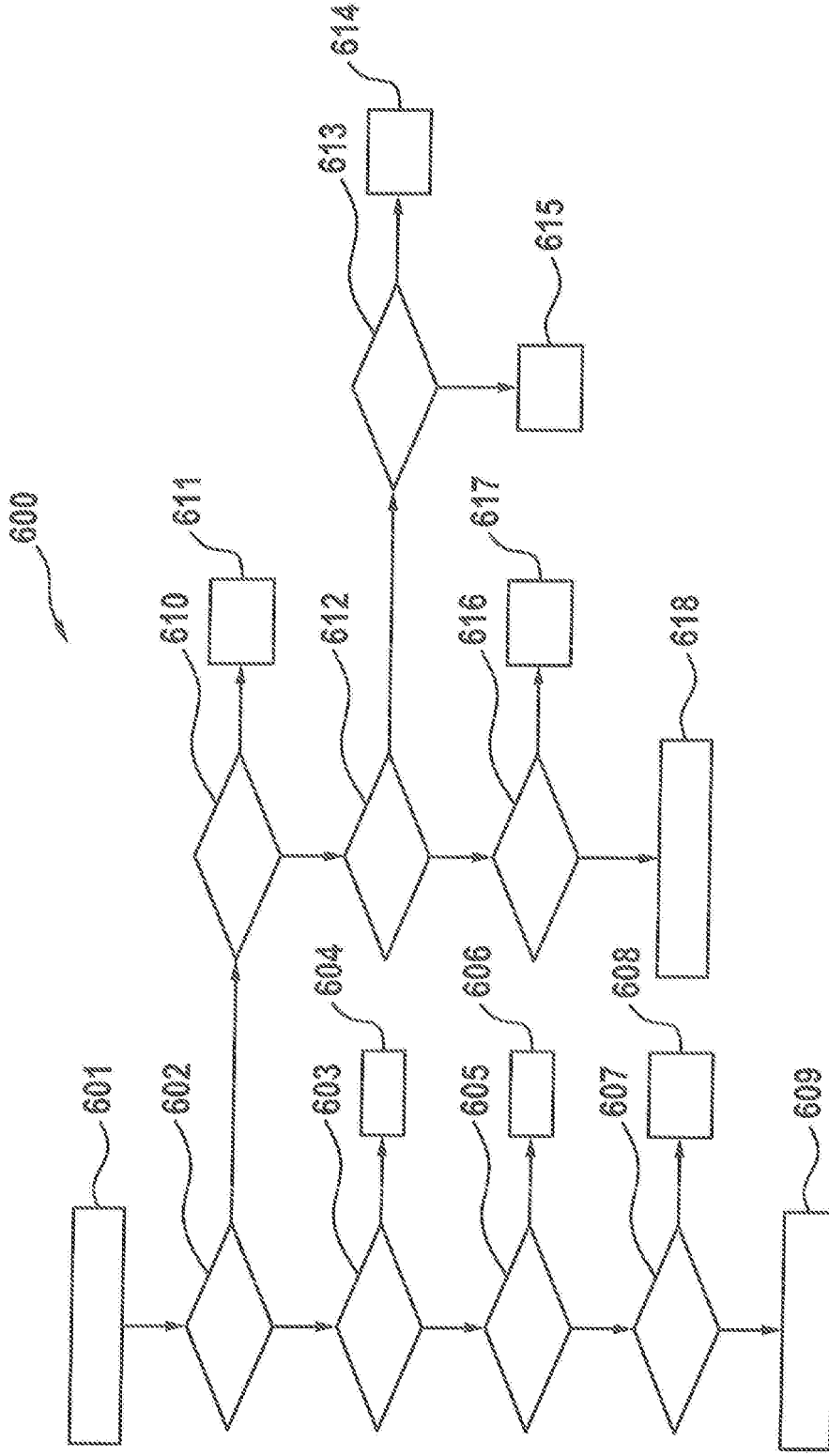


Fig. 7A

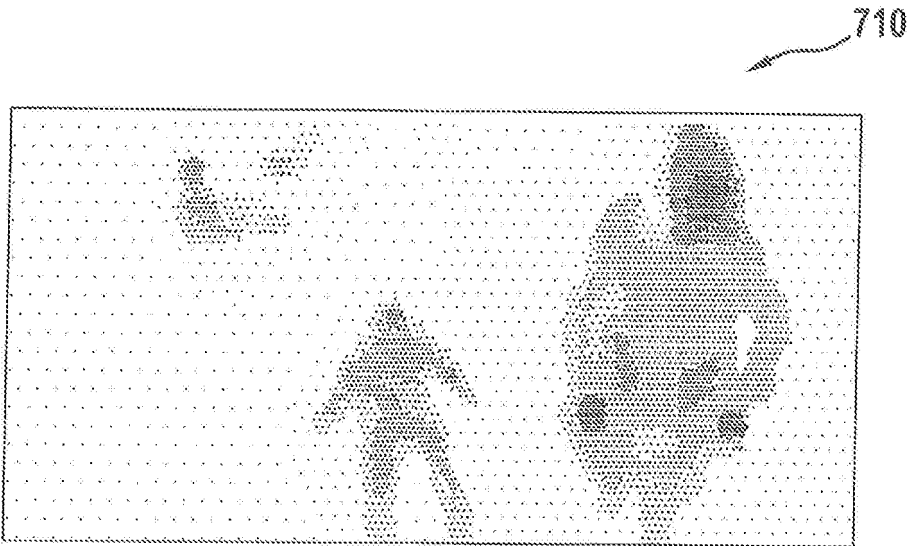


Fig. 7B

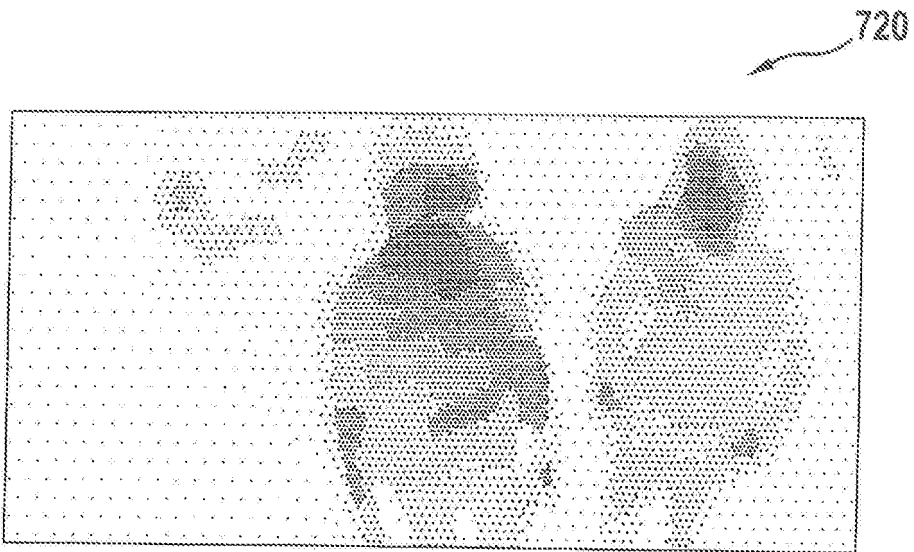


Fig. 7C

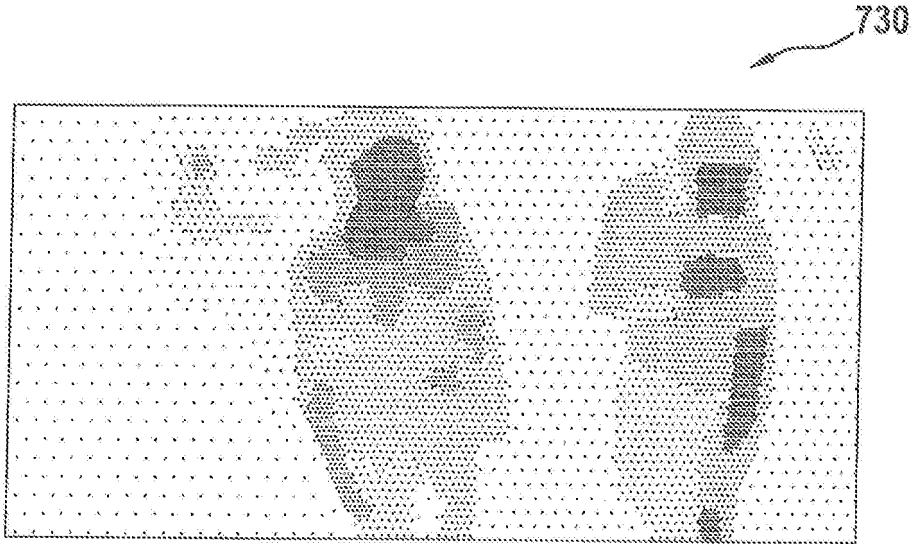


Fig. 7D

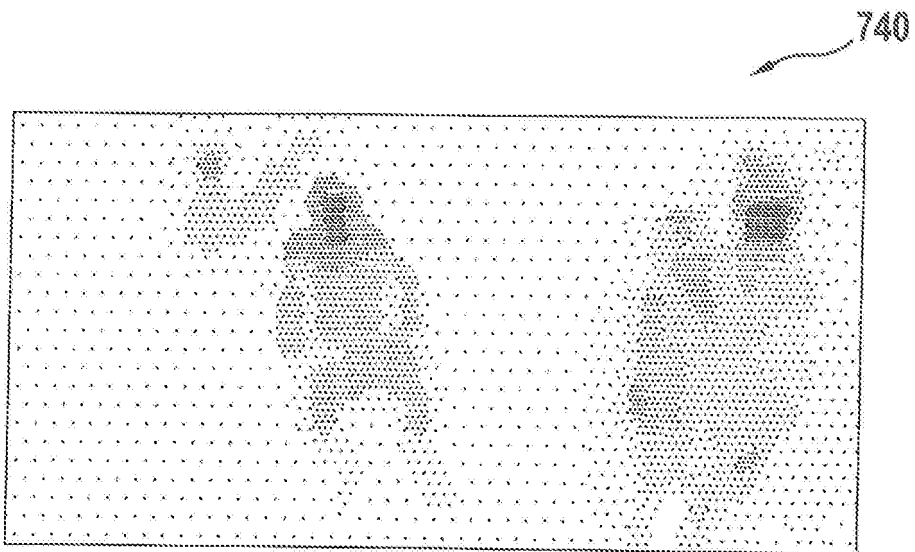


Fig. 7E

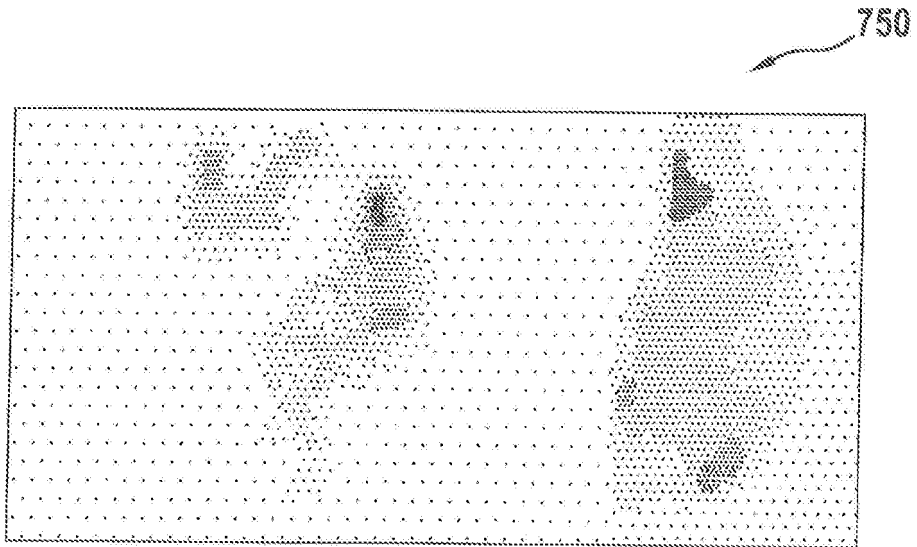
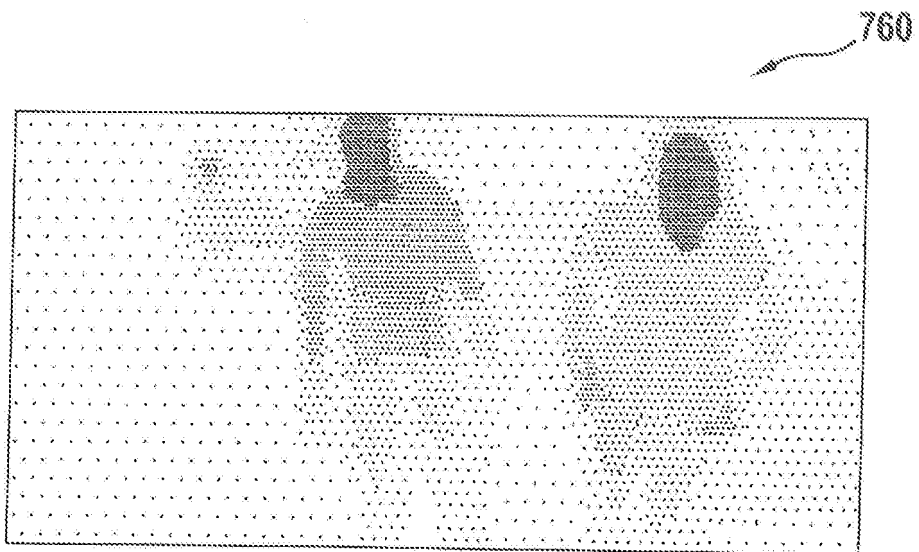


Fig. 7F





The following terms are registered trade marks and should be read as such wherever they occur in this document:

Bluetooth
Zigbee

Description

Title

5 Method and device for monitoring at least one interior of a
building, and assistance system for at least one interior
of a building

Prior art

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The present invention relates to a method for monitoring at least one interior of a building, to a corresponding device, as well as to a corresponding computer program product and to an assistance system for at least one
15 interior of a building.

Domestic emergency-call systems are technical systems by means of which, in particular, elderly or disabled persons can make an emergency call to a telephone control centre.
20 The triggering of an emergency call may be activated manually, via a button, or automatically, via sensors, e.g. fall sensors.

Disclosure of the invention

25

Against this background, the approach presented here presents a method for monitoring at least one interior of a building, in addition a device that employs this method, as well as, finally, a corresponding computer program product,
30 and finally an assistance system for at least one interior of a building, according to the main claims. Advantageous designs are given by the respective dependent claims and the following description.

According to embodiments of the present invention, at least one interior of a building can be monitored, in particular, by analysis of image data in respect of presence of a
5 situation that is defined as relevant to the monitoring. In particular, in this case a camera system, or optical sensor system, may be used or provided for interior monitoring. In this case, for example, an optical sensor may be used in the surroundings of the home or house, with
10 automated evaluation of sensor signals, for example per apartment or per room, from one or more sensors enabling the realization of an assistance system, or assistance functions.

15 Advantageously, according to embodiments of the present invention, at least one interior of a building can be monitored in a reliable and accurate manner. In this case, monitoring-relevant situations can be reliably identified and distinguished from each other, in particular by
20 automated optical monitoring. Identification of situations can be improved in terms of compliance with or deviation from normal situations. In particular in this case, robustness of monitoring can also be increased, such that occurrence of false alarms can be reduced. Moreover, it is
25 possible to realize a great variety of assistance and support systems that are based on reliable situation identification or space monitoring.

A method is presented for monitoring at least one interior
30 of a building, the method having the following step:

Comparing recorded image data, which represent the at least one interior, with reference data that represent a

reference situation (defined as normal or as abnormal), in order to generate, in dependence on a comparison result, monitoring information that represents a monitoring-relevant situation in the at least one interior.

5

In the step of comparing, the monitoring information in this case may be generated if the image data deviate from reference data that represent a reference situation defined as normal. In the step of comparing, the monitoring
10 information may also be generated if the image data corresponds, at least partially, with reference data that represent a reference situation defined as abnormal. The monitoring-relevant situation in this case may be a situation defined as relevant according to a designated
15 monitoring objective. The method may have a step of reading-in the recorded image data or the reference data. The method may also have a step of recording the image data.

20 In the step of comparing in this case, infrared image data recorded by an infrared camera may be used as the recorded image data. The infrared camera may be a camera, or thermal camera, for representing thermal radiation, such as that used, for example, for temperature measuring
25 instruments or night-vision devices. The infrared camera may be designed for far-infrared operation. The infrared image data may represent image data recorded in the far-infrared range. Such an embodiment offers the advantage that an infrared image protects the privacy of occupants of
30 the building to a significantly greater extent than an image in the visible light range. Moreover, infrared cameras are not sensitive to differences in brightness, and also function in darkness. By means of image processing,

significantly more information can be extracted from the images of an infrared sensor, or infrared camera, than from signals from simple motion detectors, thus, for example, information for identification of persons, counting of
5 objects or persons, directional information, temperature information, etc.

Thus, compared with some known sensors such as, for example, motion detectors or cameras that record in the
10 visible light range, the use of infrared image data, or an infrared camera, makes it possible, advantageously, to avoid infringing personal privacy, to eliminate or reduce sensitivity in respect of changes in brightness, to enable identification of persons who are not moving, etc. In
15 particular, compared with cameras that operate, for example with CCD or CMOS technology, in the visible light range, it is possible to reduce computation in image processing and to reduce sensitivity for variable light conditions. Infrared cameras can also provide meaningful image data in
20 darkness. Infrared cameras make it possible to avoid infringing the privacy of the occupants. Moreover, infrared cameras can be available at low cost. Compared with conventional motion sensors based, for example, on radar, ultrasound or infrared technology, infrared cameras
25 can provide sensor data with a high information content. In addition, with the use of infrared image data, it is possible to distinguish between different persons, or occupants, of the building, e.g. husband, wife, care personnel. Moreover, domestic pets can be identified in a
30 reliable manner, and such domestic-pet immunity can reduce error susceptibility and increase robustness in monitoring. In addition, with the use of infrared image data, it is possible to identify a direction of movement of persons or

objects, e.g. it is possible to distinguish between entering and exiting the at least one space. Moreover, with the use of infrared image data, it is also possible to identify a stationary state of an object, for example in
5 the case of a motionless person.

According to an embodiment, in the step of comparing, the image data are compared with reference data that represent at least one object pattern, in order to identify at least
10 one object, represented by the image data, that represents a person, an animal or an item. Object identification can thus be performed with the use of reference data and recorded image data. In this case, objects can be identified and distinguished from each other, such that a
15 robustness and accuracy of the method can be increased. In particular, it is also possible to distinguish individual persons. A important quality feature in this case is the high accuracy, since robust classification of situations is possible, in particular also in the case of households
20 having a plurality of occupants.

In this case, in the step of comparing, first image data can be compared with second image data recorded with a time interval delay relative to the first image data, in order
25 to determine a position, a movement, a speed and, additionally or alternatively, a behaviour of a person identified in the image data. For this purpose, a relationship or deviation between the first image data and the second image data in the region of the person
30 identified in the image data may be determined. Such an embodiment offers the advantage that, in particular, it is possible to identify occurrences of rising, with speed and

direction of movement, and to monitor activities of the daily life of at least one person.

It is thus possible, in particular, to achieve an
5 improvement in classification of situations, in terms of situational awareness, for the earliest possible identification of inactivity or of a deviation from the normal behaviour, as well as a reduction of false alarms, including as a result of the identification of persons,
10 better distinction between entry to and exit from a space, as well as the identification of departure from an apartment, or the return of occupants to the home, and a domestic-pet immunity, and an extension of monitoring to households having a plurality of persons. For such an
15 extension, single-person models can be learned, which can then be used separately or in any combination in the application. The term situational awareness may be understood to mean an automatic evaluation of sensor data for the purpose of determining a current state of occupants
20 and/or of their surroundings.

In addition, in the step of comparing, first image data can be compared with second image data recorded with a time interval delay relative to the first image data, in order
25 to determine a difference between values of at least one pixel represented in the first image data and the second image data. The monitoring information in this case can be generated in dependence on a comparison of the difference with a threshold value. Such an embodiment offers the
30 advantage that, in particular, hazardous or potentially hazardous monitoring-relevant situations can be identified, and distinguished from harmless situations, in a reliable and inelaborate manner.

The threshold value in this case may be related to the time interval, to a maximum value of the at least one pixel, to a minimum value of the at least one pixel, to a value
5 gradient of the at least one pixel, to a mean value of a plurality of pixels and, additionally or alternatively, to a position of the at least one pixel. Such an embodiment offers the advantage that, owing to the multiplicity of reference values to which the threshold value may relate, a
10 multiplicity of situations can also be identified in a reliable manner.

Moreover, the method may also have a step of generating the reference data by use of predefined pattern data, compared
15 image data, at least one item of monitoring information and, additionally or alternatively, ambient data of the at least one interior. The reference data in this case may be trained in the step of generating. The ambient data may be, for example, weather data or the like. Such an
20 embodiment offers the advantage that reference data, enabling monitoring-relevant situations to be identified in a precise manner, matched to a multiplicity of application cases, are available or can be provided.

25 The method may also have a step of outputting warning information and, additionally or alternatively, action information for remedying the monitoring-relevant situation in dependence on the monitoring information. In this case, the warning information and, additionally or alternatively,
30 the action information may be generated by use of the monitoring information. The warning information may be designed, upon processing by an appropriate device, to cause an alarm to be emitted, inside or outside of the

building, wherein the alarm may have a command that can be executed automatically, a message, an acoustic alarm signal and, additionally or alternatively, an optical alarm signal or the like. The action information may be designed, upon
5 processing by an appropriate device, to cause an acoustic message to be output and, additionally or alternatively, an optical message, inside or outside of the building. Such an embodiment offers the advantage that there can be automatic triggering of an alarm, or initiation or
10 prompting of counter-measures, in response to identification of a critical monitoring-relevant situation, e.g. a motionless person.

The approach presented here additionally creates a device
15 designed to perform, or convert, the steps of a variant of a method presented here, in corresponding means. Likewise, by means of this embodiment variant of the invention, in the form of a device, the object on which the invention is based can be achieved in a rapid and efficient manner.

20

A device may be understood in this case to mean an electrical appliance that processes sensor signals and, in dependence thereon, outputs control and/or data signals. The device may have an interface, which may be designed as
25 hardware and/or software. If designed as hardware, the interfaces may be, for example, part of a so-called system ASIC, which contains a great variety of functions of the device. It is also possible, however, for the interfaces to be separate, integrated circuits or to be composed, at
30 least partially, of discrete components. If designed as software, the interfaces may be software modules that are present, for example, on a microcontroller, in addition to other software modules.

Additionally presented is an assistance system for at least one interior of a building, the assistance system having the following features:

5

at least one camera, which is disposed in the at least one interior, the at least one camera being designed to record and provide image data; and

10 an embodiment of the aforementioned device, which is connected with data transmission capability to the at least one camera.

The assistance system may be a domestic emergency-call
15 system or the like. In the building, at least one camera per interior may be disposed in at least one interior. In combination with the assistance system, an embodiment of the aforementioned device for monitoring may be employed, or used, in an advantageous manner. In this case,
20 advantageously, by use of the at least one camera and the device for monitoring, it is possible to perform a multiplicity of monitoring functions that, conventionally, are performed by means of a plurality of sensors, e.g. fire alarms, gas sensors, motion detectors, cameras, etc. It is
25 thus possible to realize assistance, security and support functions, which are also known, for example, under the term Ambient Assisted Living.

According to an embodiment, the device may be designed as
30 part of the at least one camera, or as an independent device, separate from the at least one camera. The independent device may be disposed in the building. Such an embodiment offers the advantage that the main monitoring

functions can be performed in the building itself, such that a connection to the outside is not absolutely necessary.

5 The assistance system may also have a base station, disposed in the building, and a server disposed separately from the building. The base station in this case may be connected with data transmission capability to the at least one camera. The server may be connected with data
10 transmission capability to the base station. The base station in this case may be disposed in the building. The server may also be connected with data transmission capability to at least one further base station in at least one further building. The device in this case may be
15 designed as part of the base station or of the server. Such an embodiment offers the advantage that monitoring, or image evaluation, can be effected centrally for a building or for a plurality of buildings.

20 Also advantageous is a computer program product or computer program, having program code that can be stored on a machine-readable carrier or storage medium, such as a semiconductor memory, a hard disk-drive memory or an optical memory, and that can be used to perform, convert
25 and/or control the steps of the method according to any one of the previously described embodiments, in particular if the program product or program is realized on a computer or a device.

30 The approach presented here is explained exemplarily in greater detail in the following on the basis of the appended drawings. There are shown in:

Fig. 1 a sequence diagram of a method for monitoring at least one interior of a building, according to an exemplary embodiment of the present invention;

5 Fig. 2 a schematic representation of an assistance system for at least one interior of a building, according to an exemplary embodiment of the present invention;

Fig. 3 a schematic representation of an assistance system,
10 according to an exemplary embodiment of the present invention, in a building;

Fig. 4 an image of a plurality of persons, recorded by an infrared camera;

15

Fig. 5 a sequence diagram for an object identification in the case of a method for monitoring at least one interior of a building, according to an exemplary embodiment of the present invention;

20

Fig. 6 a sequence diagram for a classification of situations in the case of a method for monitoring at least one interior of a building, according to an exemplary embodiment of the present invention; and

25

Figures 7A to 7F images of persons in differing situations, recorded by an infrared camera.

In the following description of favourable exemplary
30 embodiments of the present invention, the same or similar references are used for the elements represented, and having similar functions, in the various figures, without repetition of the description of these elements.

Fig. 1 shows a sequence diagram of a method 100 for monitoring at least one interior of a building, according to an exemplary embodiment of the present invention. The method 100 has a step 110 of generating reference data, which represent a reference situation defined as normal or as abnormal, by use of predefined pattern data, compared image data, at least one item of monitoring information and, additionally or alternatively, ambient data of the at least one interior. The method 100 also has a step 120 of comparing recorded image data, which represent the at least one interior, with the reference data, in order to generate, in dependence on a comparison result, monitoring information that represents a monitoring-relevant situation in the at least one interior. The method 100 additionally has a step 130 of outputting warning information and, additionally or alternatively, action information for remedying the monitoring-relevant situation in dependence on the monitoring information.

20

According to an exemplary embodiment of the present invention, in the step 120 of comparing, infrared image data recorded by an infrared camera are used as the recorded image data.

25

In this case, the step 110 of generating may be performed before and, additionally or alternatively, after the step 120 of comparing. Optionally, the step 110 of generating and, additionally or alternatively, the step 130 of outputting may also be skipped. Thus, the method 100 may have a sequence of steps that, according to an exemplary embodiment, comprises the step 110 of generating, the step 120 of comparing and the step 130 of outputting, according

30

to a further exemplary embodiment comprises the step 120 of comparing, the step 110 of generating and the step 130 of outputting, according to yet a further exemplary embodiment comprises the step 110 of generating, the step 120 of
5 comparing, the step 110 of generating and the step 130 of outputting, according to a further exemplary embodiment comprises the step 120 of comparing and the step 130 of outputting, and according to yet a further exemplary embodiment comprises the step 120 of comparing.

10

According to an exemplary embodiment, in the step 120 of comparing, the image data may be compared with reference data that represent at least one object pattern, in order to identify at least one object, represented by the image
15 data, that represents a person, an animal or an item.

In this case, according to an exemplary embodiment, in the step 120 of comparing, first image data may be compared with second image data recorded with a time interval delay
20 relative to the first image data, in order to determine a position, a movement, a speed and, additionally or alternatively, a behaviour of a person identified in the image data.

25 In addition, according to an exemplary embodiment, in the step 120 of comparing, first image data may be compared with second image data recorded with a time interval delay relative to the first image data, in order to determine a difference between values of at least one pixel represented
30 in the first image data and the second image data. In this case, in the step 120 of comparing, the monitoring data may be generated in dependence on a comparison of the difference with a threshold value. The threshold value may

be related to the time interval, to a maximum value of the at least one pixel, to a minimum value of the at least one pixel, to a value gradient of the at least one pixel, to a mean value of a plurality of pixels and, additionally or
5 alternatively, to a position of the at least one pixel.

Fig. 2 shows a schematic representation of an assistance system 200 for at least one interior of a building, according to an exemplary embodiment of the present
10 invention. Of the assistance system 200, there are shown in this case, merely as an example and for reasons of representation, a camera 210, a device 220 for monitoring at least one interior of a building, a base station 230 and a server 240. Also shown in Fig. 2 is a building 250. The
15 device 220 is designed to execute the steps of the method for monitoring, from Fig 1. Even if not explicitly shown in Fig. 2, the device 220 may have appropriate means designed to execute the steps of the method for monitoring, from Fig. 1.

20

According to the exemplary embodiment of the present invention represented in Fig. 2, the assistance system 200 has the camera 210, the device 220, the base station 230 and the server 240. In this case, the camera 210, the
25 device 220 and the base station 230 are disposed in the building 250. The server 240 is spatially separate, or at a distance, from the building 250. According to an exemplary embodiment, the assistance system 200 has a plurality of cameras 210.

30

The camera 210 is designed, for example, as an infrared camera. The camera 210 in this case is disposed in an interior, or room, of the building 250 that is not shown,

merely for reasons of representation. The camera 210 is designed to record and provide image data. The camera 210 is also connected with data transmission capability, for example by means of a communication interface in the form of a cable, wireless connection or the like, to the device 5 220. The device 220 is connected with data transmission capability, for example by means of communication interfaces in the form of cables, wireless connection or the like, to the camera 210 and to the base station 230. 10 The base station 230 in this case is connected with data transmission capability, for example by means of communication interfaces in the form of cables, wireless connection or the like, to the device 220 and to the server 240. Even if not shown explicitly in Fig. 2, the server 15 240 can thus be connected with data transmission capability to at least one further base station of at least one further building.

According to the exemplary embodiment of the present invention represented in Fig. 2, the device 220 is designed 20 as an independent device. According to other exemplary embodiments, the device 220 may be designed, or realized, as part of the at least one camera 210, or as part of the base station 230, or as part of the server 240, the at 25 least one camera 210 and the base station 230 being directly connected to each other with data transmission capability.

Fig. 3 shows a schematic representation of an assistance 30 system for at least one interior of a building, according to an exemplary embodiment of the present invention, in a building. The assistance system in this case is an assistance system similar to the assistance system from

Fig. 2. In this case, of the assistance system in Fig. 3, four cameras 210, a base station 230 and a line to a server 240 are shown, merely as an example. Also shown is a building 250, which is, for example, an apartment having, merely as an example, four rooms, or interiors, 301, 302, 303 and 304. According to the exemplary embodiment of the present invention represented in Fig. 3, the device for monitoring at least one interior of a building may be designed as part of the camera 210, of the base station 230 or of the server 240.

A first of the cameras 210 is disposed in a first interior 301, and designed to record and provide image data that represent, or depict, the first interior 301. A second of the cameras 210 is disposed in a second interior 302, and designed to record and provide image data that represent, or depict, the second interior 302. A third of the cameras 210 is disposed in a third interior 303, and is designed to record and provide image data that represent, or depict, the third interior 303. A fourth of the cameras 210 is disposed in a fourth interior 304, and is designed to record and provide image data that represent, or depict, the fourth interior 304. For example, the first interior 301 is a hall, the second interior 302 is a bedroom, the third interior 303 is a bathroom, and the fourth interior 304 is a combined living room and kitchen, or a living room with an open kitchen.

According to the exemplary embodiment of the present invention represented in Fig. 3, the base station 230 is disposed in the fourth interior 304. The base station 230 is connected with data transmission capability to each of the cameras 210. More precisely, the base station 230 is

designed to receive image data from each of the cameras 210, if the device for monitoring is realized in the base station 230 or in the server 240. If the device for monitoring is realized in the cameras 210, the base station 5 230 is designed to receive processed image data, for example monitoring information, warning information and/or action information, from the cameras 210. The base station 230 is also connected with data transmission capability to the server 240, which, for reasons of representation, is 10 merely indicated in Fig. 3.

According to an exemplary embodiment, the cameras 210 are designed as infrared cameras. In other words, the cameras 210, or optical sensors, are based on infrared camera 15 modules. The cameras 210, or infrared cameras, in this case are preferably sensitive in the far-infrared range. Far-infrared sensors detect, in particular, a thermal characteristic radiation from persons and objects, i.e. a received signal is dependent, or recorded images are 20 dependent, on a temperature of a radiating surface.

In other words, Fig. 3 shows a building 250, or an apartment, having an installed assistance system, or camera system. In this case, Fig. 3 shows an apartment, 25 consisting of a hall 301, bathroom 303, bedroom 302 and living room 304 with an open kitchen. A respective optical sensor, or a camera 210, is installed in each of the rooms, or interiors, 301, 302, 303 and 304. The sensors, or cameras 210, are connected by cable or by wireless 30 connection, e.g. WLAN, Bluetooth, Zigbee, to the base station 230 of the assistance system, which is designed in a manner similar to a domestic emergency-call system. Via a telecommunication connection, the base station 230 is

connected, e.g. by analog means, by Ethernet, GSM, 3G, etc., to the server 240, which may be realized, for example, on the Internet, as part of a telephone control centre, etc. Each of the cameras 210 has, for example, at least one optical sensor, a lens, a computing unit, e.g. a microcontroller, ASIC or similar, an energy supply, e.g. a mains electrical connection, a battery or similar, and a communication unit, e.g. a cable connection, WLAN, Bluetooth, Zigbee or similar. The cameras 210 are designed to record images, in particular infrared images, of the interiors 301, 302, 303 and 304. The images are represented by image data. These image data are filtered, analyzed and interpreted, for example by image processing algorithms. Such an image processing system may be realized in the device for monitoring, and may be effected in the cameras 210 themselves, in a separate device, in the base station 230 or on the server 240. According to an exemplary embodiment, the server 240 may also be disposed locally, instead of remotely. The interpreted image signal, or for example monitoring information, e.g. "lifeless person identified", may serve as an input signal for assistance functions and/or further assistance systems.

Fig. 4 shows an image 400 recorded by an infrared camera, or an image of an infrared sensor. In this case, the image 400, or thermal image, shows a plurality of persons, being ten persons, merely as an example. One of the cameras from Fig. 2 or Fig. 3 may be designed to record an image such as the image 400. The image 400 can thus be recorded by one of the cameras from Fig. 2 or Fig. 3. In the image 400 in Fig. 4, differing temperature patterns are identifiable, which correspond to the different persons.

Fig. 5 shows a sequence diagram 500 for an object identification in the case of a method for monitoring at least one interior of a building, according to an exemplary embodiment of the present invention. In this case, a
5 sequence of the object identification, represented in the sequence diagram 500, can be executed as part of the method for monitoring, from Fig. 1. The sequence of the object identification shown in the sequence diagram 500 represents a cyclic sequence.

10

The sequence of the object identification illustrated in the sequence diagram 500 has a block 501, in which image recording is effected. Then, in a block 502, image pre-processing, or image segmentation, is effected. In a
15 branch block 503, leading to which there is an optional entry 504 into the sequence, it is determined whether there is a significant change in image data statistics. If there is a significant change in the image data statistics, a transition is made from the block 503 to a block 505, in
20 which a further processing, which is dependent on an application case, or use case, is effected. If there is no significant change in the image data statistics, a transition is made from the block 503 to a block 506, in which a number N of objects is determined in the image
25 data.

There follows a block 507, in which a running index i is set to 1 ($i:=1$). In a subsequent branch block 508 it is checked whether the running index i is less than or equal
30 to the number N of objects ($i \leq N$). If this condition is not fulfilled, the sequence jumps back to the image recording in the block 501. If the condition is fulfilled, a transition is made from the block 508 to a block 509, in

which classification, and possibly object tracking, is performed for the object having the running index i .

There then follows a branch block 510, in which it is
5 decided whether the object is an animal. If the object is
an animal, the sequence goes from the block 510 to a block
511, in which special processing, for the case of an
animal, is effected. If the object is not an animal, a
transition is made from the block 510 to a branch block
10 512, in which it is decided whether the object is a person.
If the object is a person, the sequence goes from the block
512 to a block 513, in which special processing, for the
case of a person, is effected. The block 513 may lead to a
sequence shown in Fig. 6, or comprise the latter. If the
15 object is not a person, a transition is made from the block
512 to a block 514, in which the running index i is
incremented by 1 ($i:=i+1$). There is then a jump from the
block 514 to before the block 508.

20 In a highly simplified implementation, it would likewise be
possible to omit the blocks 506 to 514, and after block 503
to jump back directly to block 501, i.e. only evaluation of
the image data statistics with corresponding reaction.

25 Owing to correction of the return position, the sequence of
506 and 507 is irrelevant. It would therefore also be
possible for 506 and 507 to be combined in one block.

Fig. 6 shows a sequence diagram 600 for a classification of
30 situations in a method for monitoring at least one interior
of a building, according to an exemplary embodiment of the
present invention. In this case, a sequence of the
classification of situations, represented in the sequence

diagram 600, can be executed as part of the method for monitoring, from Fig. 1, and if necessary in combination with the sequence of the object identification from Fig. 5.

5 The sequence of the classification of situations, represented in the sequence diagram 600, may comprise, as an input of start, the block, shown in Fig. 5, of the special further processing for the case of a person. In this case, the sequence of the classification of
10 situations, represented in the sequence diagram 600, is dependent on a respective application case. Decisions in the case of branches in this case are effected on a basis of a set of rules or a classifier.

15 Classification of a body position is effected in a block 601. In a succeeding branch block 602, it is checked whether a person is lying down. If it is determined in the block 602 that the person is lying down, a branch block 603 follows, in which it is checked whether the person is lying
20 down in an atypical location. If the person is lying down in an atypical location, the sequence goes from the block 603 to a block 604, in which an alarm is triggered. If the person is not lying down at an atypical location, the sequence goes from the branch block 603 to a branch block
25 605, in which it is determined whether there is marked decrease in a body temperature of the person. If this is confirmed, an alarm is triggered in a block 606. However, if there is no marked decrease in the body temperature, the sequence goes from the branch block 605 to a branch block
30 607, in which it is checked whether, for example, the person is sitting up in bed and/or whether their feet are on the floor. If this is confirmed, further procedure is effected, in a block 608, in dependence on the application

case and, for example, an alarm is triggered or a light is switched on. If the check in the branch block 607 produces a negative result, the cyclic sequence is continued in a block 609. The sequence of the blocks 603, 605 and 607 is
5 merely exemplary, and may be varied in any manner.

If it is determined in the branch block 602 that the person is not lying down, the sequence goes to a branch block 610, in which it is checked whether there is a person entering
10 the room. If this is the case, further procedure is effected in a block 611, in dependence on the application case. If there is no person entering the room, the branch block 610 is followed by a branch block 612, in which it is determined whether the person is leaving the room or the
15 building or the apartment. The sequence of the blocks 610, 612 and 616 is merely exemplary, and may be varied in any manner.

If the determination in the block 612 produces a positive
20 response, it is determined, in a branch block 613, whether a temperature distribution is salient and/or whether clothing is inadequate. If this is the case, in a block 614 an alarm to a control centre is triggered, or a warning to a person is triggered. If the temperature distribution
25 is not salient and/or the clothing is adequate, further procedure is effected, in a block 615, in dependence on the application case.

If the determination in the block 612 produces a negative
30 response, it is then checked, in a branch block 616, whether a temperature distribution is salient and/or clothing is wet. If this is the case, in a block 617 an alarm to a control centre is triggered, or a warning to a

person is triggered. If the temperature distribution is not salient and/or clothing is not wet, the cyclic sequence is continued in a block 618.

5 Figures 7A to 7F show images of persons, in differing situations, recorded by an infrared camera. One of the cameras from Fig. 2 or Fig. 3 may be designed to record images such as the images from Figures 7A to 7F. The images from Figures 7A to 7F may thus be recorded by one of
10 the cameras from Fig. 2 or Fig. 3. Moreover, the images from Figures 7A to 7F, or the image data on which the images are based, may be used by a method such as the method for monitoring, from Fig. 1, and if appropriate by at least one of the sequences from Fig. 5 and Fig. 6. In
15 other words, Figures 7A to 7F show recordings, made by an infrared camera, of persons in various situations. Image processing algorithms of the method from Fig. 1, or of the sequences from Fig. 5 and Fig. 6, are designed to identify the situations on the basis of these images.

20

Fig. 7A shows a thermal image 710 of two persons, of which the person depicted on the left in the figure is seated, and the person depicted on the right in the figure is standing. Fig. 7B shows a thermal image 720 of two
25 standing persons. Fig. 7C shows a thermal image 730 of two persons, of which the person represented on the right in the figure is in the process of rolling up a sleeve.

Fig. 7D shows a thermal image 740 of two persons, of which
30 the person depicted on the left in the figure is seated, in a frontal view. Fig. 7E shows a thermal image 750 of two persons, of which the person represented on the left in the figure is seated, in a side view. Fig. 7F shows a thermal

image 760 of two persons, of which the person depicted on the left in the figure is standing again.

Various exemplary embodiments of the present invention are explained in summary, and in different terms, with reference to Figures 1 to 7F.

According to an exemplary embodiment, at least one camera 210, or device 220, is used to realize an assistance system 200 that reliably identifies a current situation of occupants of a building 250 ("situational awareness"). A sequence of the identification of the occupants by the at least one camera 210, the device 220, or the assistance system 200, is represented in Fig. 5. An objective for the assistance system 200 is, for example, earliest possible identification of inactivity, or identification of deviations from previously analyzed or learned activity defined as normal. With this, it is possible not only to trigger an alarm if no activity is ascertained, but also to identify this separately for a plurality of persons. Moreover, it is possible to provide early warning if there is still activity, but if the latter deviates from activity defined as normal. The assistance system 200 is thus not susceptible to error, or is only minimally susceptible, caused by domestic pets. In addition to the identification of activity, the following situations can also be identified in this case: whether a person enters the room, whether a person leaves the room, how many persons are present in a room, which person is present in a room, as well as identification of domestic pets in the room. Identification of a number of persons and identification of domestic pets are effected, for example, according to the sequence represented in Fig. 5. Assuming sufficient

resolution, different persons can be distinguished from each other relatively easily, since typical outlines of persons are easily identifiable in the thermal image, as can be seen in Fig. 4 and Fig. 7A to 7F. Re-identification or identification of, for example, a plurality of persons in a household can be realized by calibration to the persons. Once this has been done, identification of the persons can be effected on the basis of individually differing distributions of a skin temperature.

10

According to an exemplary embodiment, at least one camera 210, or device 220, is used to realize an assistance system 200 that reliably identifies persons who have fallen or are motionless, and that triggers an alarm. A mode of functioning of the identification of such a situation follows, for example, the sequence represented in Fig. 6. Unlike the case of ultrasound or radar, if a thermal image is used a person can also be identified if they are not moving. A person who has fallen, for example because of a seizure, can be detected in the thermal image as a person lying down at a location not intended for this purpose, in particular in distinction from a scenario in which, for example, an occupant is lying and sleeping on a couch. With the aid of continuous monitoring of the object, or occupant, it is also possible, in principle, to monitor a vitality state. Thus, by execution of the method 100 for monitoring, it can be identified that, in the case of a constant ambient temperature, depending on the latter a body temperature of a person drops only slightly during sleep, whereas, for example, a circulatory collapse results in a comparatively clear and rapid reduction of the body temperature.

30

According to an exemplary embodiment, at least one camera 210, or device 220, is used to realize an assistance system 200 for persons at high risk of falling, which system can identify, for example, occurrences of rising from a bed, a chair or a sofa, and can then alert care personnel. The care personnel can then accompany the person to the destination, e.g. bathroom, kitchen, in order to minimize the risk of a fall. Illumination may also be switched on, on the basis of the monitoring information. The assistance system 200 may be designed to infer an occurrence of rising, e.g. from a combination of the person-related events, rising and feet on the floor, in a manner comparable to the sequence from Fig. 6. The action of rising by an occupant results, on the one hand, in a clear change in shape of the so-called hot spot in the thermal image and, on the other hand, a shift in position within a short time interval. The assistance system 200 may be designed to evaluate this statistically in the overall image, there being no need for use of highly developed image identification algorithms, and the image data and the monitoring information being dependent on the respective scenario. In the simple case of a person who, for example, has been sitting on an armchair for a relatively long period in a living room of normal temperature, see, for example, Fig. 7D or Fig. 7E, a proportion of warm pixels, i.e. pixels having values that represent a high temperature, is greater in the image directly after rising than before rising, because the armchair has warmed up significantly and therefore emits more thermal radiation than a top side of the person previously seated thereon, see, for example, Fig. 7F. If, in the case of the method 100 for monitoring, a mean value is formed in this case over all pixels of the image data and is tracked over time,

the mean value will rise significantly in an abrupt manner in the case of such an occurrence of rising.

According to an exemplary embodiment, at least one camera
5 210, or device 220, is used to realize an assistance system
that is designed to monitor activities of daily life.
These include, for example, the time and duration of
personal hygiene, e.g. hand-washing at the wash basin in
the bathroom, food intake of hot meals, e.g. eating at the
10 table, use of kitchen appliances, such as cooker,
refrigerator, sink, etc., and social contacts, e.g. visits,
as well as monitoring of therapies, e.g. regular movement
exercises in the case of persons with walking impairment.
By means of sensor information, or the image data, such
15 activities can be quantified by the assistance system 200,
or the method 100 for monitoring. In addition, a clothing
state can also be checked by the assistance system 200, or
the method 100. In particular, evaporating liquid results
in a local decrease in temperature in the region of an
20 outer surface of the clothing. For the assistance system
200, this can be detected as a change in image data. The
assistance system 200 can thus be designed to identify
moisture on the basis of spillage of liquid in the intake
of food, e.g. drinks, liquid food, or in the case of
25 incontinence, and the sequence from Fig. 6 may also be used
for this purpose. In addition, the assistance system 200
may also be designed to identify, by linking with external
information, or ambient information, whether occupants are
dressed in a manner appropriate for current weather
30 conditions outside of the building 250 or for a temperature
inside the building 250. For example, the assistance
system 200 may be designed to check, upon exit from the
building 250, whether, for example, a coat and shoes are

worn. Such monitoring information can be compared with data of a weather forecast, for example from the Internet, and this also can be effected in combination with the sequence from Fig. 6. In a whole-body thermal image, parts
5 of the body inadequately covered with clothing can be identified, for example, on the basis of their higher temperature in the building 250, as can be seen in Fig. 7C. In particular, in the image data, a jacket, directly after having been put on, is virtually at room temperature,
10 whereas, for example, a T-shirt worn on the body is identifiable as warmer.

According to an exemplary embodiment, at least one camera 210, or device 220, is used to realize an assistance system
15 200 that is designed to identify hazards. For example, an alarm may be triggered if burning items, such as candles, cigarettes, etc., or active electrical appliances, e.g. irons, cooker, television, are identified and it has simultaneously been detected that there is no person
20 present in the apartment, or in the building 250. An alarm may also be triggered if certain temperature thresholds are exceeded, e.g. 140 °C. Also possible is a warning of hot water, for example of a water boiler or hot shower water, or excessively hot food and drinks. In addition, the at
25 least one camera 210, or device 220, may be used to detect a presence of non-authorized persons in the building 250. A non-authorized person may be identified by identification/non-identification, or identification by image processing, unusual behaviour, or panic activity of
30 an occupant/occupants, and/or an unusual situation, for example if a person enters the building 250, despite no further persons being expected at this time of day and on this day of the week.

According to an exemplary embodiment, the assistance system 200 may be used as a mobile assessment system. This means that an assistance system 200, having an appropriate number
5 of cameras 210 and a recording means, is set up in a building, for a defined period of time for a person. Recorded monitoring information can be used to determine how much assistance, and what type of assistance, this person should receive, e.g. for the purpose of assessing
10 the level of care.

According to an exemplary embodiment, the at least one camera 210, or device 220, of the assistance system 200 may be used as a movement motivator, in a manner similar to
15 video games. With this, movement/activity can be fed back interactively for the purpose of analyzing an activity and motivating a user.

Considered in summary, the described method 100 for
20 monitoring, or the assistance system 200, represents, inter alia, an essential improvement of so-called situational awareness. It is possible in this case to achieve improved automatic identification of monitoring-relevant situations such as, for example, exit from and return to an apartment.
25 The situational awareness can also be improved for households having more than one person. It is possible to identify, not only inactivity (situational awareness), but also activity deviations from a defined or learned normal case such as, for example, slow, rapid, different movement
30 routes, etc. It is also possible, in combination with the method 100 for monitoring, or the assistance system 200, to realize additional assistance and support functions such as, for example, a robust identification of falls, and

identification of motionless persons, identification of occurrences of rising, e.g. from a bed, for the purpose of notifying care personnel, or for lighting control for the purpose of minimizing the risk of falling, e.g. in the case of going to the toilet, thus an accompanied toilet visit, monitoring of activities of daily life (Activities of Daily Living, ADL) such as, for example, personal hygiene, food intake, social interactions, e.g. number of contacts with other people, in addition alarm systems, based on measurement of temperatures, e.g. body temperature, temperature of objects and appliances, e.g. cooker, for a fire alarm or the like, control of lighting or heating in dependence on persons present, monitoring of whether, and for how long, windows and doors are open, and identification of activities such as movements, speed of movement, body posture, and with this also the possibility to give warning in the case of deviations from the normal behaviour/normal situations, or also to send a request to a user to change a behaviour or a situation. The method for monitoring, or the assistance system 200, may also be used for gesture identification (for example, but not limited thereto, also in the dark), e.g. for the purpose of triggering an emergency call if it is established by the monitoring that a person can no longer stand up.

25

The exemplary embodiments described and shown in the figures have been selected merely as examples. Differing exemplary embodiments may be combined with each other, either in full or in respect of individual features. One exemplary embodiment may also be supplemented by features of another exemplary embodiment.

30

Moreover, the method steps presented here may be repeated and executed in a sequence other than that described.

If an exemplary embodiment includes an "and/or" link
5 between a first feature and a second feature, this is to be construed that the exemplary embodiment according to one embodiment comprises both the first feature and the second feature, and according to a further embodiment comprises either only the first feature or only the second feature.

Claims

1. Method (100) for monitoring at least one interior (301, 302, 303, 304) of a building (250), the method
5 (100) having the following step:

comparing (120) recorded image data, which represent the at least one interior (301, 302, 303, 304), with reference data that represent a reference situation,
10 in order to generate, in dependence on a comparison result, monitoring information that represents a monitoring-relevant situation in the at least one interior (301, 302, 303, 304).
- 15 2. Method (100) according to Claim 1, in which, in the step (120) of comparing, infrared image data recorded by an infrared camera (210) is used as the recorded image data.
- 20 3. Method (100) according to either one of the preceding claims, in which, in the step (120) of comparing, the image data are compared with reference data that represent at least one object pattern, in order to identify at least one object, represented by the image
25 data, that represents a person, an animal and/or an item.
4. Method (100) according to Claim 3, in which, in the
30 step (120) of comparing, first image data are compared with second image data recorded with a time interval delay relative to the first image data, in order to determine a position, a movement, a speed and/or a behaviour of a person identified in the image data.

5. Method (100) according to any one of the preceding claims, in which, in the step (120) of comparing, first image data are compared with second image data recorded with a time interval delay relative to the first image data, in order to determine a difference between values of at least one pixel represented in the first image data and the second image data, the monitoring information being generated in dependence on a comparison of the difference with a threshold value.
5
10
6. Method (100) according to Claim 5, in which the threshold value is related to the time interval, to a maximum value of the at least one pixel, to a minimum value of the at least one pixel, to a value gradient of the at least one pixel, to a mean value of a plurality of pixels and/or to a position of the at least one pixel.
15
20
7. Method (100) according to any one of the preceding claims, having a step (110) of generating the reference data by use of predefined pattern data, compared image data, at least one item of monitoring information and/or ambient data of the at least one interior (301, 302, 303, 304).
25
8. Method (100) according to any one of the preceding claims, having a step (130) of outputting warning information and/or action information for remedying the monitoring-relevant situation in dependence on the monitoring information.
30

9. Device (220) which is designed to perform, convert and/or control all steps of a method (100) according to any one of the preceding Claims 1.
- 5 10. Assistance system (200) for at least one interior (301, 302, 303, 304) of a building (250), the assistance system (200) having the following features:
- 10 at least one camera (210), which is disposed in the at least one interior (301, 302, 303, 304), the at least one camera (210) being designed to record and provide image data; and
- 15 a device (220) according to Claim 9, which is connected with data transmission capability to the at least one camera (210).
11. Assistance system (200) according to Claim 10, in which the device (220) is designed as part of the at least one camera (210), or as an independent device, separate from the at least one camera (210).
- 20 12. Assistance system (200) according to any one of Claims 10 to 11, having a base station (230), disposed in the building (250), and a server (240) disposed separately from the building (250), the base station (230) being connected with data transmission capability to the at least one camera (210), the server (240) being connected with data transmission capability to the base station (230), the device (220) being designed as part of the base station (230) or of the server (240).
- 25 30

13. Computer program, which is set up to perform all steps of a method (100) according to Claim 1.
- 5 14. Machine-readable storage medium, having a computer program according to Claim 13 stored thereon.
15. A method for monitoring at least one interior, the method being substantially as described herein with reference to, or as shown in, the Figures.
10
16. A device which is designed to perform, convert and/or control all steps of a method according to any one of the preceding claims 1 to 8, the device being substantially as described herein with reference to, or as shown in, the Figures.
15
17. An assistance system for at least one interior of a building, the assistance system being substantially as described herein with reference to, or as shown in, the Figures.
20
18. A computer program, which is set up to perform all steps of a method according to Claim 1, the computer program being substantially as described herein with reference to, or as shown in, the Figures.
25
19. A machine-readable storage medium, having a computer program according to Claim 13 or Claim 18 stored thereon, the machine-readable storage medium being substantially as described herein with reference to, or as shown in, the Figures.
30



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Claims searched: 1-19

Date of search: 24 August 2015

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-14.	WO2010/055205 A (KORTESALMI) Whole document especially figures, page 4 lines 6-17, page 7 lines 17-19, page 8 line 1-9 and page 9 lines 6-22.
X	1-4, 7-14.	US2008/144884 A (HABIBI) Figures, paragraphs 66 and 67.
X	1-4, 7-14.	WO2003/036581 A (HAUGLI et al.) Whole document especially figures 2&4, page 1 line 6 and page 8 lines 19-20.
X	1-4, 7, 9, 10, 13-14.	US2006/132485 A (MILINUSIC) Figures, paragraphs 21 and 38-41.
X	1-4, 7-11, 13-14.	US2004/120581 A (OZER et al.) Figure 3, paragraphs 53 and 54.
X	1, 3-5, 7-11, 13-14.	US2002/061134 A (COFER et al.) Whole document especially figures 2, 13&14, paragraphs 53 and 85.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

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Worldwide search of patent documents classified in the following areas of the IPC

G08B

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC



International Classification:

Subclass	Subgroup	Valid From
G08B	0013/196	01/01/2006
G08B	0021/04	01/01/2006