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**Fortsættes ...**

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# METHOD AND SYSTEM FOR DETECTING A FALL AND ISSUING AN ALARM

## Technical Field

The claimed invention relates to a method and system for detecting a fall, detecting particular emergency situations and transmitting an alarm in the home environment. The invention relates in particular to a method and system for detecting a fall by means of a passive optical sensor and transmitting a multi-stage alarm in the form of distorted image data.

## Prior art

Falls are a particular accident risk especially for elderly people. These persons are often injured such that they are no longer able to stand up without external help or to request help, which could lead to a life-threatening situation. Preventive measures to avoid falls can be taken, however, falls especially of elderly people living alone can never be ruled out entirely so that the detection of a fall with following assistance can increase the quality of life of the affected group of persons in that they may continue to live in their familiar surroundings and still be supervised by medical personnel and/or relatives.

US 7 248 172 B2 discloses a method and system for fall detection, where the person to be supervised wears a device for fall detection or triggering an alarm at the body. This alarm can be transmitted in the form of radio transmission to a rescue centre.

However, the above systems may cause acceptance problems among the concerned group of persons since the permanent wearing of the devices is awkward and uncomfortable for these people. Furthermore, especially elderly people are prone to possibly simply forget to put the corresponding devices on again, e.g. after bathing.

Detecting a fall is also possible by means of sensors installed in a floor or mats provided with sensors, but realising such a system is very complex and expensive.

A further category of methods for detecting a fall and recognising particular emergency situations are optically based methods. Here the persons are permanently monitored and an optical fall/emergency detection is carried out, comprising a classification by means of common classification algorithms such as Bayes classifiers, neural networks or main

component analysis of a recorded incident and triggering an alarm when a fall/an emergency is detected and transmitting same to a superior instance.

US 20060145874 A1 relates to an optically-based method, wherein the image treatment algorithms determine in particular the percentage share of a person lying on the floor, the position of the person as well as the size of the person. Moreover, the velocity and acceleration of a person falling is determined.

US 20030058341 A1 relates to an optically-based method, wherein an object is separated from a scene, detected and analysed. Here certain properties of the object are analysed by means of comparative values with certain events.

In particular, an event classification via geometric primitives is possible, such as described in "Compressed-Domain Fall Incident Detection for Intelligent Homecare" by Chia-Wen Lin, Zhi-Hong Ling, Yeng-Cheng Chang and Chung J. Kuo submitted to Journal of VLSI Signal Processing-System for Signal, Image and Video Technology.

US 20050146605 A1 relates to an optical surveillance method with geometric primitives and subsequent event analysis by means of event discriminators. Here an alarm can be triggered depending on the detected event.

Methods comprising a permanent video surveillance of a person, however, constitute an encroachment on the right of personality of the person and thus can lead to acceptance problems.

Document WO 2007 139658 A2 is probably the closest prior art of the subject-matter of the invention and discloses a method for fall detection comprising distortion of image data in order to protect a person's privacy.

**Disclosure of the invention**

Therefore, it is the object of the invention to provide a method and system for detecting a fall, which is reliable and operates safely.

This object is achieved with a method and system according to the independent claims 1 and 9. Dependent claims 2 to 8 relate to particular embodiments.

A room is supervised by means of a passive optical sensor, such as a video or infrared camera. Furthermore, an evaluation of the recorded images is conducted with regard to the detection of a fall or a particular emergency situation, wherein, however, the image data are at first transmitted in a distorted manner only to an authorised receiver by triggering an alarm upon detection of a fall. Thus, the supervised person's right to his/her own image is ensured since images of this person are not permanently transmitted but only distorted images when a fall is detected.

When a fall or a particular emergency situation has been detected, a reverse channel is activated first, which verifies the detected situation. The supervised person is enabled to classify a triggered alarm as false alarm.

Only if after a certain period of time an alarm is not classified as false alarm by the supervised person, decoding of the transmitted optical signal is conducted so that the supervised person is depicted. This visual depiction of the situation and person would also be revealed in the moment when a rescue service arrives.

The distortion of the image data is carried out preferably by means of geometric primitives. For example the objects present in a recorded image are each replaced by one or more geometric primitives. Preferably every person present in the recorded image is treated and depicted as at least one geometric primitive. Preferably the fall detection is evaluated for every person by means of the geometric primitive(s).

When a fall or helplessness of a fallen person is recognised in the undistorted image, the authorised receiver can initiate further rescue measures, such as requesting rescue services or instructing medical personnel to care for the fallen person.

The gist of the invention is a method and system for detecting a particular emergency situation, especially a fall, wherein, during the permanent optical surveillance of a person, only in case of an emergency or fall detection, at first distorted and, where appropriate, encoded image data of this person and/or this room are transmitted to an authorised instance

by triggering an alarm. Only after having established a reverse channel and in the absence of an alarm classification as false alarm by the supervised person will an undistorted image of the situation or person be transmitted to an authorised instance.

This method and system are advantageous in that they do not restrict the physical freedom of action of a person to be monitored, they are comfortable for the person and ensure the person's right to his/her own image as part of the general right of personality and are moreover cost effective and easily workable for medical personnel and/or relatives.

## Brief description of the drawings

The method and the corresponding system of the invention are described in more detail in the following by means of embodiments and the drawings.

They show:

Figure 1 a system for detecting a particular emergency situation or a fall detection with a server and a Universal Standard Gateway and an array of optical sensors,

Figure 2 a system for detecting a particular emergency situation or a fall detection with a HealthBox and an Health platform and an array of optical sensors, and

Figure 3 a system for detecting a particular emergency situation or a fall detection with a Logic HealthBox and a Health platform, wherein the algorithms for video analysis and fall detection are implemented in an optical sensor.

## Detailed description of the embodiments

Figure 1 shows an embodiment of the system. Images of a person to be monitored 118 are permanently recorded by means of a plurality of optical sensors 11 having individual camera sensors 11.1 to 11.n. The camera sensors 11.1 to 11.n can be arranged in a room to be monitored such that the person to be monitored is detected by at least one camera sensor at all times. The optical sensors 11 are connected via an interface 19 to a server 13. The server 13 comprises a logic 12, wherein the algorithms are implemented for splitting the images recorded by means of the sensors 11 into geometric primitives as well as algorithms for detection of a fall or a particular emergency situation. When a fall or an emergency situation is detected, a distorted image is transmitted via means and method for encoding and authentication, which may contain a firewall 15, through a TCP/IP interface 17 and the internet 113 to an authorised group of people 117, where appropriate via a Universal Standard

Gateway 114, wherein the transmission can be effected bidirectionally wireless 115 or by wire 116.

If a particular emergency situation or a fall is detected, an alarm will be triggered, which the monitored person 118 can invalidate (classify as false alarm). To this end a reverse channel is established between the supervised room and the authorised receiver via data or telephone connection. If, after a certain period of time, an alarm is not classified as false alarm, an undistorted transmission of the image or a sequence of images will be transmitted to the authorised group of people. The transmission by wire 116 or wireless transmission 115 is also effected in encoded manner. A further additional possibility for establishing a reverse channel is by means of an acoustic means 14 and a sound card 18 integrated in the system. An acoustic connection between the authorised group of people 117 is established via the internet 113 and the server 13 via the sound card 18 and the acoustic means 14, such as a loudspeaker and a microphone, wherein the connection can be bidirectional. Further sensors 112 or user menus 111 can be connected via the interface 19 to the server 13 which is provided with an additional logic in this implementation as PC.

In the embodiment of Figure 1, the logic 12 comprises the software for conducting the video image analysis, the fall or emergency detection analysis and the encoding as well as data communication.

Figure 2 shows a further embodiment. In this embodiment, the server 13 of Figure 1 is a so-called HealthBox 26, i.e. a device for monitoring the state of health of a person. The image processing as well as the data processing of all health sensors and the data encoding is executed in a Logic HealthBox 25, which is embedded in the HealthBox 26. The authentication and routing of the information is carried out in an external HealthPlatform 27, which may be a system for monitoring a plurality of people. HealthBox 26 and HealthPlatform 27 are connected via the internet 113. The alarm or the distorted and in a further step undistorted images are transmitted in encoded form either wirelessly 115, e.g. to smartphones, or by wire 116, e.g. to a telephone or an external computer, to an authorised group of people 117. The optical sensors 11.1 to 11.n are connected to the HealthBox 26 via an interface 19. The camera sensors only record the images. The server of the first embodiment of Figure 1 with the further means is implemented in this second embodiment in form of the HealthBox 26. The HealthPlatform 27 of this second embodiment furthermore

comprises the functionality of the Universal Standard Gateway 114 of the first embodiment. As far as the further elements of this embodiment are concerned, reference is made to Figure 1.

The logic HealthBox 25 in the embodiment of Figure 2 comprises the software for executing the video image analysis, the fall or emergency detection analysis, the data processing of all sensors, in particular health sensors and the encoding as well as data communication.

Figure 3 shows a third embodiment of the system. The optical sensors are made in the form of one master 30 and a plurality of slaves 41, 42. The optical sensor operating as master 30 has a camera part 31, an internal interface 32, a SmartCamera logic 33 and an interface 34. Contrary to the first and second embodiments, in this embodiment the software and the corresponding evaluation unit, implementing the algorithms for video analysis and fall or emergency detection, are integrated in the SmartCamera logic 33 of the optical sensor operating as master. The SmartCamera logic 33 is internally connected via the interface 32 to the camera part 31. The SmartCamera logic 33 is further connected to the other optical sensors 41, 42 of the system operating as slaves via the interface 34 and to the HealthBox 26 via the interface 19. Reference is made to Figure 1 and Figure 2 regarding the remaining elements and functionality of the embodiment.

The SmartCamera logic 33 in the embodiment of Figure 3 comprises the software for executing the video image analysis and fall detection analysis. The logic HealthBox 35 has the remaining functions which are comprised in the logic HealthBox 25 of the embodiment of Figure 2. This includes the software for the data processing of all sensors, in particular health sensors and the encoding and data communication.

In the following, the invention will be explained in further detail on the basis of functions and properties.

The optical sensors are to be preferably positioned in the room such that an optimal covering of the room to be monitored is achieved, also in case of narrow rooms with complex structure. When necessary, more than one optical sensor is to be used for one room area. Preferably, an active energy management is implemented so that only optical sensors are in the activated mode which are currently required.

The optical sensors are configured in such a manner that they are robust against variable light conditions such as reflections and backlight. Moreover, they can be configured in form of infrared sensors in order to be able to detect falls and emergency situations also in the dark.

The fall detection algorithms are implemented such that they can detect any kind of falls, such as slumping down, a heavy fall and a slowed-down fall. These types of falls are clearly defined beforehand and part of a library of activated fall detection algorithms ("patterns"). The detection of emergency situations is primarily effected by algorithms evaluating the static condition of a person relative to the home surroundings and in particular detect an abnormal static condition.

The detection algorithms are implemented such that they are robust against other persons or animals present in the room as well as against the positions of the optical sensors and a covering of the person to be monitored by furniture and/or other persons or animals. Moreover, they are able to not classify quick movements of objects as falls of persons.

The detection algorithms comprise methods for separating a person from the background and vectorizing and splitting the image of a person into geometric primitives and detecting the position in the room either in the server or the optical sensor. In this case, the fall detection makes use of the dynamic of a fall. It is analysed how fast the position of these geometric primitives changes within an image sequence. The image processing can take place centrally in a determined HealthBox and be connected with a cloud to minimize maintenance cost and to simply expand the evaluation patterns.

The system is construed such that within a certain period of time all people of an authorised group of people are informed. This authorised group of people has exclusively access to personal data and status information about the person to be monitored. The system is construed in a way that the authorised group of people can be supplemented with further persons or restricted by certain persons. In case of a validated alarm, the system provides the authorised persons with, i.a. the time of the fall, the location of the fall, a still image and, where applicable, a video.

In order to ensure the privacy, the system reports at various places when image or video material leaves the room to be monitored. The recording of image or video data of the person to be monitored is preferably conducted only for a period of time which is absolutely necessary for the functionality of the fall detection system. The security level of the telecommunication is preferably scalable so that it can be chosen among various security levels of the system, starting from low-end security level to high-end security level.

On the platform the system can contain additionally appropriate features for administration, billing, routing and client administration. In particular, the system is configured such that it is easily maintainable from outside by means for an automatic upgrade of firmware and drivers as well as algorithms.

The system is configured preferably in a scalable manner so that additional optical and non-optical sensors can be added to or removed from the system, which supplement the functional properties and performance of the system.

The overall system is configured such that any impression of supervision is avoided with regard to optics and design and blends unobtrusively into the living ambiance.

The invention has been explained in more detail on the basis of examples and the Figures, wherein this explanation is not intended to restrict the invention. Naturally, skilled persons may perform amendments and modifications without leaving the scope of the following claims.

## Patentkrav

**1.** Fremgangsmåde til identificering af nødssituationer og identificering af fald og videregivelse af en alarm med følgende trin:
a) overvåge et rum ved hjælp af mindst en optisk sensor, såsom et videokamera eller et infrarødt kamera,
b) påvise en nødssituation eller et personfald i det overvågede rum ved hjælp af analyse af billederne, der optages med den optiske sensor,
c) gøre billeddataene uigenkendelige, og
d) udløse en alarm og sende de uigenkendelige billeddata, når et nødstilfælde/personfald påvises i det overvågede rum, til mindst en autoriseret modtager
e) aktivere en returkanal via hvilken der etableres en data-/telefonforbindelse mellem det overvågede rum og modtageren, hvor den udløste alarm eventuelt kan kendetegnes som fejlalarm via returkanalen,
f) genkendelig overførsel af mindst et frosset billede og/eller en videosekvens, der optages af den optiske sensor i rummet, der skal overvåges, til den mindst ene modtager efter udløb af et forudbestemt tidsrum efter udløsning af alarmen i det tilfælde, at alarmen efter etablering af returkanalen ikke kendetegnes som fejlalarm.

**2.** Fremgangsmåde ifølge krav 1, hvor billeddataene gøres uigenkendelige, idet i det mindste de personer, der optages i det overvågede rum, omdannes til geometriske primitiver, og disse geometriske primitiver i alarmens første stadie overføres til den mindst ene modtager.

**3.** Fremgangsmåde ifølge et af kravene 1 eller 2, hvor yderligere data overføres til den mindst ene modtager i krypteret form samtidig med de billeddata, der er gjort uigenkendelige, hvor disse yderligere data omfatter mindst et frosset billede og/eller en videosekvens fra et overvåget rum, og hvor de krypterede data fortrinsvis først kan afkrypteres og vises efter bekræftelse af alarmen af modtageren.

**4.** Fremgangsmåde ifølge et af kravene 1 til 3 med de yderligere trin:
gemme billederne og/eller en videosekvens af et bestemt tidsrum før og efter påvisning af et fald i en hukommelse i den optiske sensor og overføre de

gemte billeder og/eller videosekvensen som billeddata, der er gjort uigenkendelige, og/eller som krypterede data til mindst en af modtagerne.

**5.** Fremgangsmåde ifølge et af kravene 1 til 4 med de yderligere trin:
sende alarmen og eksisterende tillægsinformation til mindst en autoriseret modtager, der udvælges afhængigt af fastlagte kriterier blandt personer, der i pågældende tilfælde er ansvarlige og autoriserede, såsom privatpersoner, plejepersonale og vagtlæge, ved hjælp af en specielt etableret administrations- og transmissionsplatform.

**6.** Fremgangsmåde ifølge et af kravene 1 til 5 med de yderligere trin:
påvise en nødssituation eller et personfald i det overvågede rum ved hjælp af ikke-optiske sensorer, fortrinsvis accelerationssensorer, som personen bærer på kroppen, og/eller ved hjælp af sensorer på eller i gulvet i det overvågede rum og/eller en alarmindretning, der kan aktiveres af en person, og/eller en akustisk indretning.

**7.** Fremgangsmåde ifølge et af kravene 1-6, hvor en statisk nødssituation påvises ved anvendelse af et husnødkald eller analyse af akustiske signaler.

**8.** Fremgangsmåde ifølge et af kravene 1 til 7 med de yderligere trin:
vise om billeddata, der er gjort uigenkendelige, og/eller krypterede data er sendt og/eller gemme begivenheder og fortrinsvis beskytte hele indretningen mod misbrug af data og information.

**9.** System til identificering af en særlig nødssituation eller identificering af fald og videregivelse af en alarm, hvilket system omfatter:
a. mindst en optisk sensor, såsom et videokamera eller et infrarødt kamera, til at overvåge et rum,
b. påvisningsmidler til at påvise en særlig nødssituation eller et personfald i det overvågede rum og analysemidler til analyse af billederne, der optages med den optiske sensor,
c. uigenkendeliggørelsesmidler til at gøre billeddata uigenkendelige og
d. midler til at udløse en alarm og sende de uigenkendelige billeddata, når et personfald påvises i det overvågede rum, til mindst en autoriseret modtager,

e. aktiveringsmidler til at aktivere en returkanal via hvilken der etableres en data-/telefonforbindelse mellem det overvågede rum og modtageren, hvor den udløste alarm eventuelt kan kendetegnes som fejlalarm via returkanalen,
f. overføringsmidler til genkendelig overførsel af mindst et frosset billede og/eller en videosekvens, der optages af den optiske sensor i rummet, der skal overvåges, til den mindst ene modtager efter udløb af et forudbestemt tidsrum efter udløsning af alarmen i det tilfælde, at alarmen efter aktivering af returkanalen ikke kendetegnes som fejlalarm.

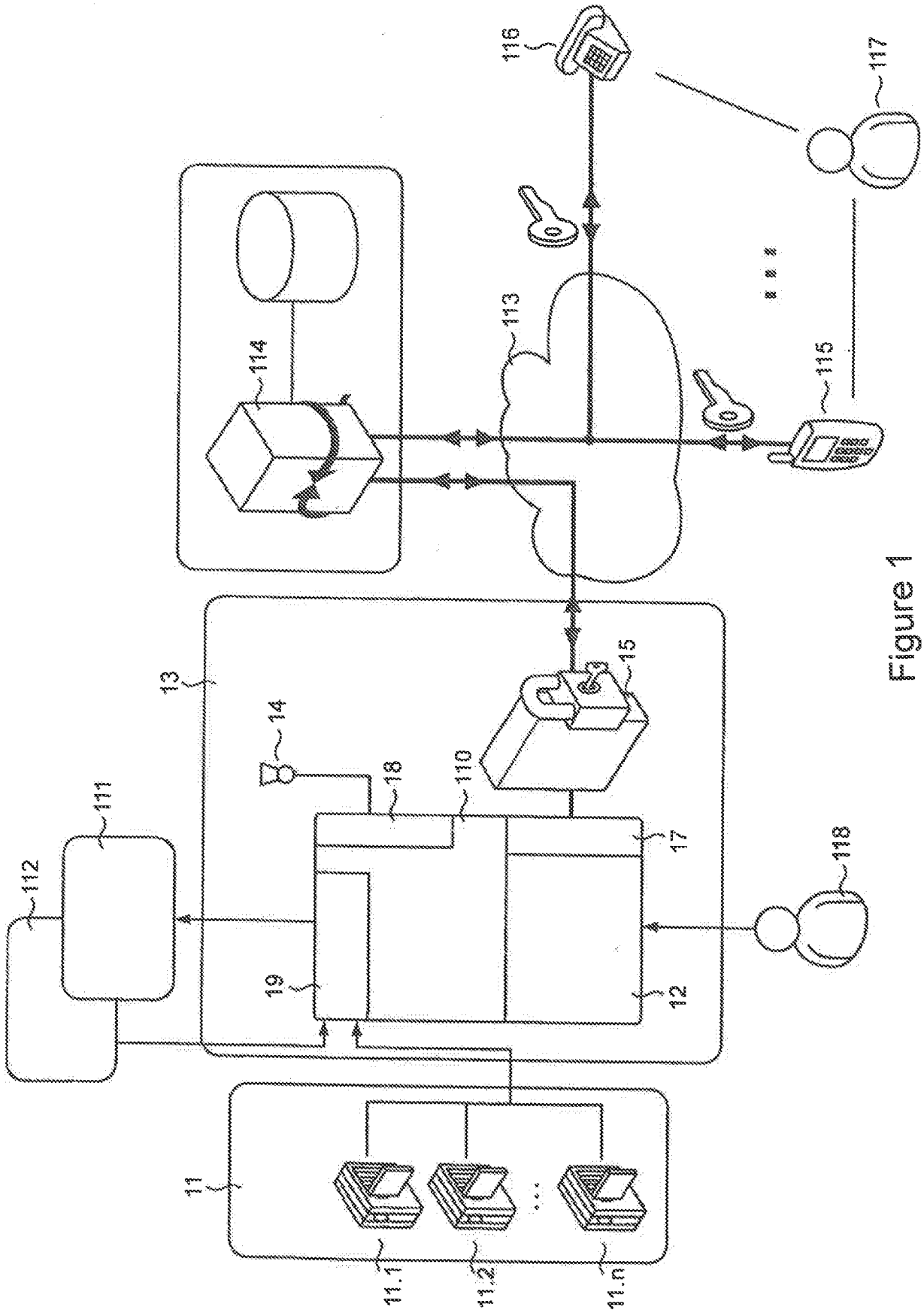
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Figure 1

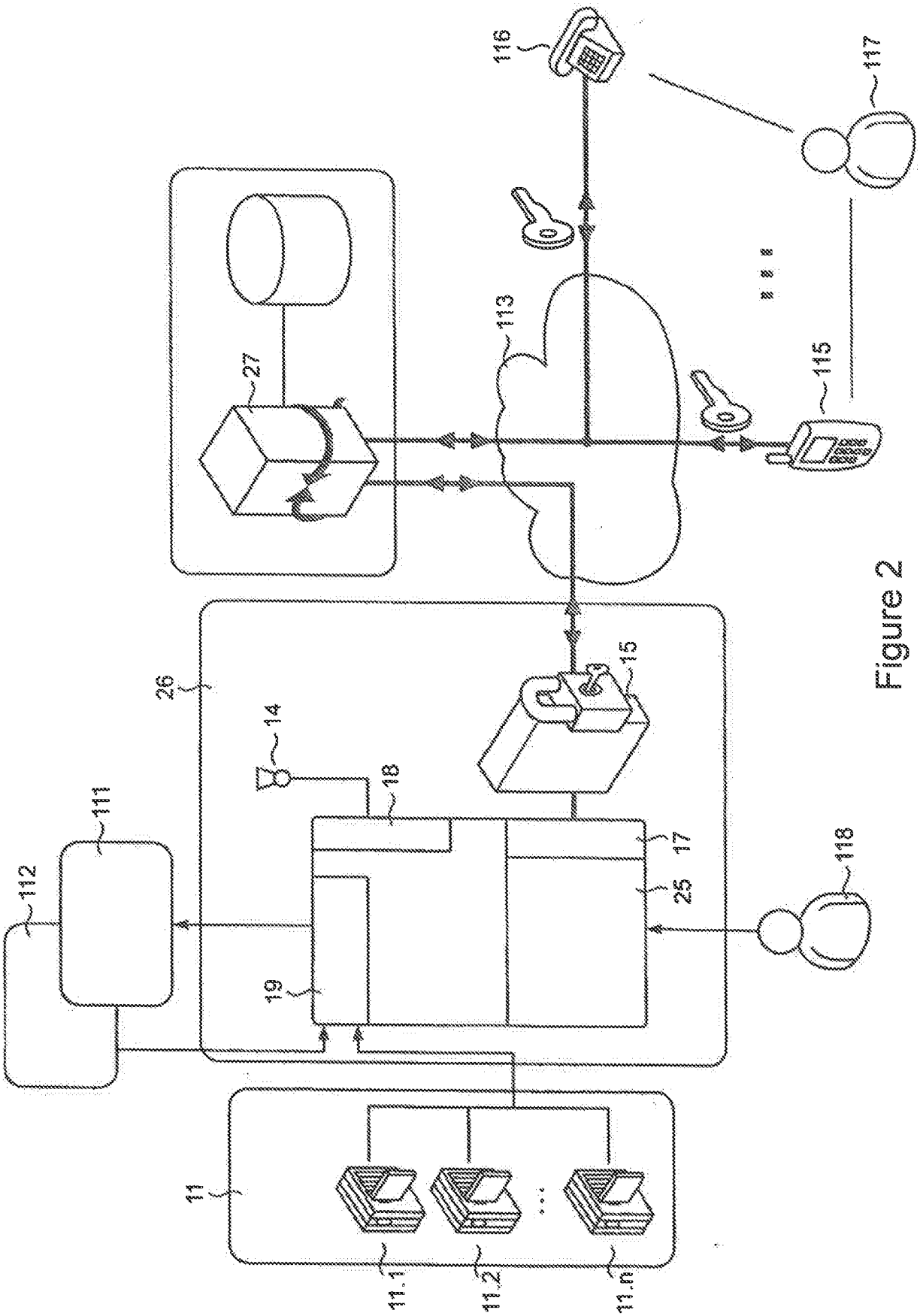


Figure 2

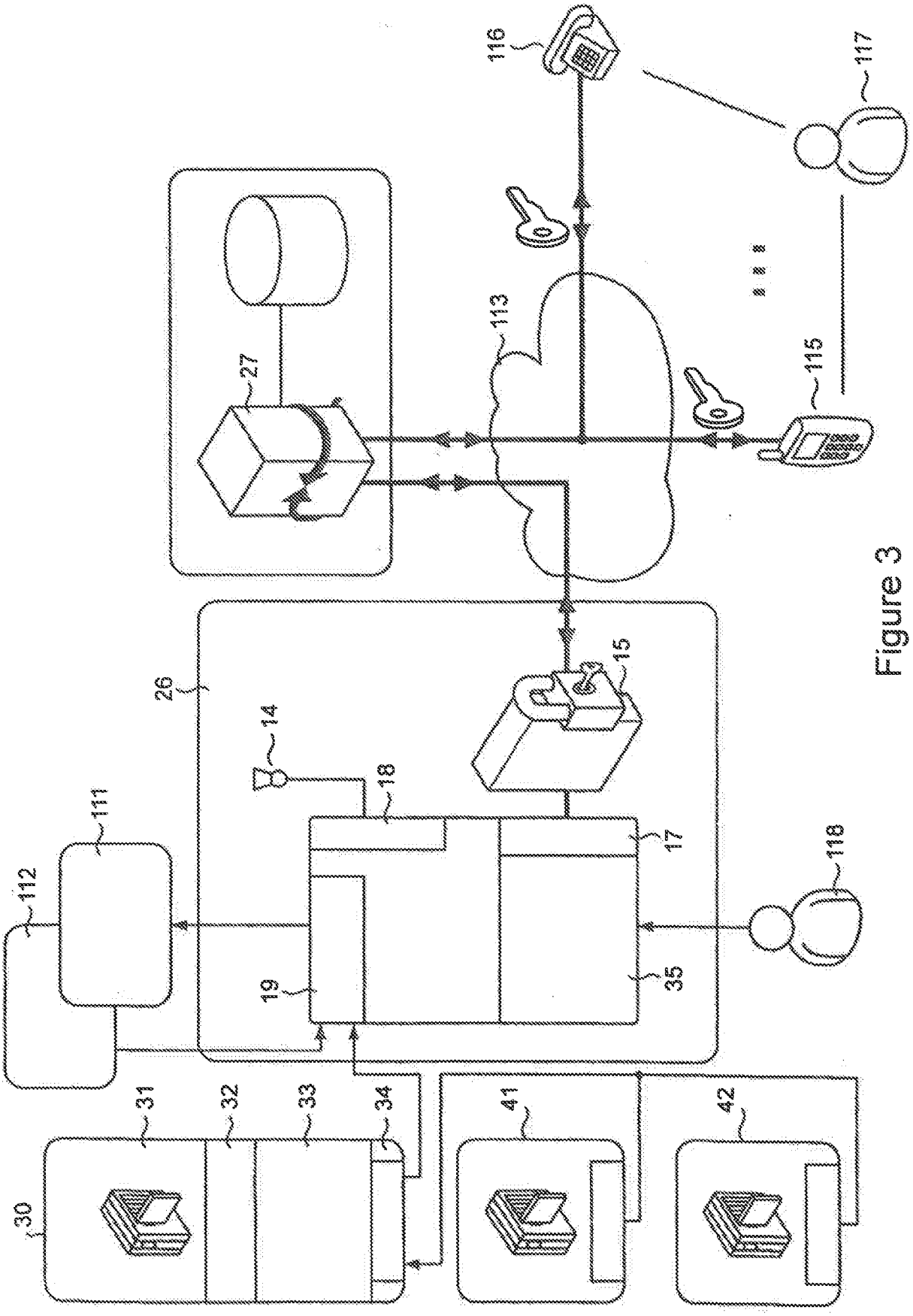
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Figure 3