DESCRIPTION

TITLE OF INVENTION

Alarm Device and Information Processing System

TECHNICAL FIELD

[0001] The present disclosure relates to an alarm device and an information processing system.

BACKGROUND ART

[0002] Conventionally, a two-way automated meter reading system, such as a gas meter, using a public telephone line is known. For example, a gas meter for automated meter reading attached to each the customer and a center apparatus are connected by a public telephone line equipped with a terminal network controller, and the center apparatus loads, through the telephone line, meter reading information which is obtained by the gas meter. A technology is also proposed which alerts the center apparatus to safety information about the gas meter, as well as the meter reading information about the gas meter.

[0003] For example, Japanese Patent Laying-Open No. 2008-35423 (PTL 1) discloses an alarm notification device which wirelessly receives an alarm telegram from an alarm device, and alerts a center apparatus to an alarm state, via a public telephone line and a terminal network control means, based on the wirelessly received alarm telegram. In order to transmit, in response to the wireless receipt of the alarm telegram, the meter reading information obtained by a gas meter with meter reading functionality and safety monitoring information associated with the gas meter to the center apparatus, the alarm notification device sets a flag of the received alarm telegram, the flag being previously associated with the received alarm telegram, among unused flags in a safety monitoring data flag list, transmits an activation request signal to the terminal network control means, and receives a request telegram from the terminal network control means, and, in response to the receipt of the request telegram, transmits a response telegram which includes the set flag.

CITATION LIST

PATENT LITERATURE

[0004] PTL 1: Japanese Patent Laying-Open No. 2008-35423

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0005] Typically, the meter reading information obtained by the gas meter is transmitted periodically to the center apparatus on a day of meter reading previously designated for each customer. However, if the days of meter reading designated for the customers are concentrated due to the customer demands, communication failure is caused by an increased load of the processing on the center apparatus side or by network congestion or the like, the actual day of meter reading may end up being delayed into a given day from the next day onwards. In that case, the meter-reading time period is from the day of meter reading of the previous time to that given day, which is undesirable in terms of customer service. PTL 1 fails to teach or suggest any technology for solving the above problem.

[0006] An object of the present disclosure according to a certain aspect is to provide an alarm device and an information processing system which allow improved customer service by appropriately obtaining meter reading information by a gas meter.

SOLUTION TO PROBLEM

[0007] According to a certain embodiment, an alarm device is provided, which is located in an indoor space and outputs an alarm when a target gas is detected. The alarm device includes: a first communications means for wirelessly communicating with a gas meter that meters usage of gas used in the indoor space; a second communications means for communicating with a center server; a meter reading information acquisition means that obtains meter reading information for a designated day of meter reading, from the gas meter via the first communications means; a storage means that stores the meter reading information obtained by the meter reading information acquisition means; and a communications control means that transmits the meter reading information of the designated day of meter reading stored in the storage

means to the center server via the second communications means.

[0008] Preferably, the meter reading information acquisition means: as a current date and time reaches a given time of the designated day of meter reading, obtains meter reading information of the current date and time by instructing the gas meter to transmit the meter reading information of the current date and time, via the first communications means; and stores the obtained meter reading information of the current date and time into the storage means as the meter reading information of the designated day of meter reading.

[0009] Preferably, the alarm device further includes a shutoff information acquisition means that obtains shutoff information from the gas meter via the first communications means, the shutoff information indicating that the gas is shut off. When the target gas is detected in the indoor space, the shutoff information acquisition means transmits detection information, indicating that the target gas is detected, to the gas meter and obtains the shutoff information from the gas meter as a response to the detection information, via the first communications means. The communications control means transmits the shutoff information to the center server via the second communications means.

[0010] Preferably, when the transmission of the meter reading information of the designated day of meter reading to the center server is failed, the communications control means re-transmits the meter reading information of the designated day of meter reading to the center server after a given time period has elapsed since the transmission is failed.

[0011] Preferably, when the transmission of the meter reading information of the designated day of meter reading to the center server is successful, the communications control means deletes the meter reading information of the designated day of meter reading stored in the storage means.

[0012] Preferably, the alarm device further includes an electricity storage means that is, normally, charged with power supplied from a commercial power supply, and, when the power from the commercial power supply is lost, functions as an alternative power

source for the alarm device.

[0013] Preferably, the alarm device further includes an imaging information acquisition means that obtains imaging information captured by a camera located in the indoor space. When the target gas is detected in the indoor space, the communications control means transmits the imaging information, obtained by the imaging information acquisition means, to the center server via the second communications means.

[0014] Preferably, the alarm device further includes an operation means that receives operation input from the user. When the operation means receives an emergency indication from the user, the communications control means transmits emergency information to the center server via the second communications means.

[0015] An information processing system according to another embodiment includes: a center server; and a master alarm device having a gas alarm functionality for outputting an alarm when a target gas is detected, the master alarm device being located in an indoor space. The master alarm device: obtains, from a gas meter that meters usage of gas used in the indoor space, meter reading information for a designated day of meter reading, via a first communications means for wirelessly communicating with the gas meter; stores the meter reading information, obtained from the gas meter, into a first memory included in the master alarm device; and transmits the meter reading information of the designated day of meter reading, stored in the first memory, to the center server via a second communications means for communicating with the center server.

[0016] Preferably, the information processing system further includes a plurality of alarm devices including a plurality of the master alarm devices and a plurality of slave alarm devices having the gas alarm functionality. The plurality of slave alarm devices each: obtain the meter reading information of the designated day of meter reading from the gas meter via the first communications means; store the obtained meter reading information into a second memory of the slave alarm device; and search alarm devices present around the slave alarm device, and transmits the meter reading information of the designated day of meter reading stored in the second memory to a first alarm device

found through the search. When the first alarm device is the master alarm device, the first alarm device transmits the meter reading information of the designated day of meter reading stored in the second memory to the center server via the second communications means.

ADVANTAGEOUS EFFECTS OF INVENTION

[0017] According to the present disclosure, the customer service can be improved by appropriately obtaining the meter reading information by the gas meter.

BRIEF DESCRIPTION OF DRAWINGS

[0018] Fig. 1 is a diagram illustrating an example of an overall configuration of an information processing system according to Embodiment 1.

Fig. 2 is a block diagram showing one example hardware configuration of an alarm device according to Embodiment 1.

Fig. 3 is a flowchart for illustrating a scheme for transmitting meter reading information, according to Embodiment 1.

Fig. 4 is a flowchart for illustrating a scheme for transmitting shutoff information, according to Embodiment 1.

Fig. 5 is a block diagram showing one example functional configuration of the alarm device according to Embodiment 1.

Fig. 6 is a diagram for illustrating a multi-hop communications scheme according to Embodiment 2.

Fig. 7 is a diagram showing a situation in which a master device of Fig. 6 is failed.

DESCRIPTION OF EMBODIMENTS

[0019] Hereinafter, embodiments according to the present invention will be described, with reference to the accompanying drawings. In the following description, like reference signs refer to like parts. Their names and functionalities are also the same. Thus, detailed description thereof will not be repeated.

[0020] [Embodiment 1]

<System Configuration>

Fig. 1 is a diagram illustrating an example of an overall configuration of an information processing system 1000 according to Embodiment 1. Referring to Fig. 1, information processing system 1000 includes alarm devices 10, 11, gas meters 20A, 20B, a home appliance 30, a camera 31, a network 40, and a center server 50.

[0021] In the following, for ease of description, alarm device 10, 11 will be described as being located in indoor spaces. However, for example, alarm device 10, 11 may be located in respective rooms of an apartment, or located in various stores. In other words, alarm devices 10, 11 may be located in anywhere insofar as they are in indoor spaces.

[0022] In the indoor space of a house 201, alarm device 10 having a gas alarm functionality for outputting an alarm when a target gas is detected, home appliance 30, and camera 31 are located. Typically, gas meter 20A is located outside the house 201.

[0023] In the indoor space of a house 202, alarm device 11 is located. Note that, as with house 201, a home appliance, a camera, etc. may be located in the indoor space of house 202. Gas meter 20B is located outside the house 202.

[0024] Alarm device 10 is capable of communications with gas meter 20A, home appliance 30, camera 31, and alarm device 11. Alarm device 10 is also capable of communications with center server 50 via network 40. Alarm device 10 has a gateway functionality for providing data exchange between multiple communication standards, and controls so that data can be exchanged smoothly between networks that have different protocols. Similarly, alarm device 11 may also have a gateway functionality.

[0025] Alarm device 10 wirelessly communicates with gas meter 20A, home appliance 30, and camera 31 through communication schemes using, for example, Bluetooth (registered trademark) or Wi-Fi (registered trademark), which is wireless LAN (Local Area Network). Note that alarm device 11 wirelessly communicates with gas meter 20B through these communication schemes.

[0026] Alarm device 10 is also capable of communications with center server 50 via network 40, using, for example, cellular communication schemes, such as 3G (3rd

Generation) and LTE (Long Term Evolution), or LTE-M (Long Term Evolution for Machines) or NB-IoT (Narrow Band IoT) which are included in LPWA (Low Power Wide Area) which is a wireless communication scheme expected to be prevailing in the future. Network 40 includes cellular carrier networks and the Internet networks.

[0027] Furthermore, alarm device 10 uses, for example, Wi-SUN (registered trademark) (Wireless Smart Utility Network) to wirelessly communicate with alarm device 11. Wi-SUN is a specified low-power radio scheme using a frequency band of 920 MHz. Characteristics of Wi-SUN include lower power consumption and a longer range than Wi-Fi (registered trademark), and less likely to cause a wave interference with other radios. The scheme using the frequently band of 920 MHz also has an advantage of a higher communication speed than other specified low-power radio scheme (400 MHz band). Note that alarm device 10 may use Wi-SUN to wirelessly communicate with gas meter 20A, home appliance 30, and camera 31.

[0028] Gas meter 20A meters an amount of gas used within house 201. Gas meter 20A has a gas flow metering functionality, a shut-off valve blocking functionality, a communication functionality, and a clock functionality.

[0029] Specifically, gas meter 20A is capable of communications with alarm device 10 by a communication scheme, such as Bluetooth (registered trademark). Gas meter 20A meters gas flowing from a gas bottle (not shown) to a gas appliance (not shown) provided in house 201, and transmits the meter reading information to alarm device 10. The meter reading information may be an integrated value of amounts of gas flowing from the gas bottle to the gas appliance, data representing an amount of gas used, or a combination of two or more of them.

[0030] Gas meter 20B is capable of communications with alarm device 11, meters the gas flowing to a gas appliance (not shown) provided in house 202, and transmits the meter reading information to alarm device 11.

[0031] Home appliance 30 is capable of communications with alarm device 10. Examples of home appliance 30 include a lighting device, a fan, a vacuum cleaner, a refrigerator, an air conditioner, a television, a personal computer, a microwave oven,

and an air washer. For example, home appliance 30 performs given controls in accordance with various instructions from alarm device 10, transmits various information to alarm device 10.

[0032] Camera 31 is capable of communications with alarm device 10, and captures an image of the indoor space of house 201, in accordance with instruction information from alarm device 10. Camera 31 also transmits the captured image to alarm device 10. Camera 31 is implemented by, for example, a CCD (Charge Coupled Device)-based camera, a CMOS (Complementary Mental Oxide Semiconductor)-based camera, or any other camera. Note that camera 31 has functionalities, such as a zoom function for changing zoom magnification and a focus function for adjusting the focal length.

[0033] Center server 50 is connected to network 40. Center server 50 is a server apparatus for remotely monitoring and controlling alarm device 10 and gas meter 20A. For example, center server 50 requests gas meter 20A to meter the gas via alarm device 10, thereby obtaining information held by gas meter 20A, and request gas meter 20A to shut off a gas, thereby causing gas meter 20A to shut off the gas. Note that center server 50 can also request gas meter 20B to meter a gas or shut off the gas via alarm device 10 and alarm device 11.

[0034] Note that, in addition to the above, for example, a fire alarm, a watching-over robot, or a health device which allows acquisition of biometric information, such as a heart rate, may be located in the indoor space of house 201. In this case, alarm device 10 is capable of communications with these devices by communication schemes, such as Bluetooth (registered trademark), and can exchange various information with them.

[0035] <Hardware Configuration>

Fig. 2 is a block diagram showing one example hardware configuration of alarm device 10 according to Embodiment 1. Referring to Fig. 2, alarm device 10 includes a main control unit 100, a communication unit 110, a gas sensor 131, a loudspeaker 132, an operational interface (I/F) 133, a GPS module 134, a light emitting diode (LED) 135, and a battery 136.

[0036] Main control unit 100 primarily controls an entirety of processing performed by

alarm device 10. Main control unit 100 includes a processor 102, a main memory 104, and a nonvolatile memory 106, as primarily components.

[0037] Processor 102 includes a central processing unit (CPU), etc., deploys a program stored in nonvolatile memory 106 to main memory 104 and executes the program. Processor 102 implements the processing of alarm device 10, described below, by executing the program.

[0038] Main memory 104 is configured of, for example, a DRAM (Dynamic Random Access Memory) or an SRAM (Static Random Access Memory), and carries data in a volatile manner. Nonvolatile memory 106 is configured of, for example, a flash memory or an EEPROM (Electrically Erasable Programmable Read-Only Memory), and carries data in a non-volatile manner. In the following, main memory 104 and nonvolatile memory 106 are also collectively referred simply to as a "memory."

[0039] Main control unit 100 may be implemented as a system LSI (Large Scale Integration) that includes the above-described components. In this case, main control unit 100 may be implemented in the form of a SoC (System-on-a-Chip) on which the components are integrated together.

[0040]Communication unit 110 includes a Bluetooth module 111, an LTE module 112, a Wi-SUN module 113, and a Wi-Fi module 114.

[0041] Bluetooth module 111 is connected to an antenna 121 and provides a wireless communication functionality for exchanging data over short distances, conforming to a Bluetooth standard. For example, Bluetooth module 111 is capable of wireless communications conforming to a BLE (Bluetooth Low Energy) standard, and wireless communications conforming to a Classic Bluetooth standard. Typically, processor 102 communicates with gas meter 20A, home appliance 30, and camera 31 via Bluetooth module 111.

[0042] LTE module 112 is connected to an antenna 122, and provides a wireless communication functionality according to wireless access schemes, such as LTE, 3G, LTE-M, NB-IoT, etc. Typically, LTE module 112 and antenna 122 are used by alarm device 10 to communicate with center server 50.

[0043] Wi-SUN module 113 is connected to an antenna 123, and provides a specified low-power radio communication functionality using the frequently band of 920 MHz. Typically, Wi-SUN module 113 and antenna 123 are used by alarm device 10 to communicate with alarm device 11. Wi-Fi module 114 is connected to an antenna 124, and provides a wireless communication functionality according to a wireless access scheme, such as a wireless LAN.

[0044] Gas sensor 131 detects presence or absence of a target gas. For example, the target gas may be a combustible gas, an LP gas comprising primarily propane and butane, or a city gas comprising primarily methane.

[0045] Loudspeaker 132 outputs a sound in accordance with an instruction given from processor 102. For example, when gas sensor 131 detects the target gas, processor 102 outputs an alarm sound through loudspeaker 132.

[0046] Operational interface 133 receives various instructions from a user. Typically, operational interface 133 includes a button for an emergency call, a switch for stopping the alarm, an inspection switch, etc.

[0047] GPS module 134 receives a location signal (a positioning signal) from a GPS signal or the base station to obtain the location information of alarm device 10. GPS module 134 inputs the obtained location information to main control unit 100.

[0048] LED 135 blinks or turns on, in accordance with an instruction from processor 102. For example, if gas sensor 131 detects the target gas, processor 102 causes LED 135 to blink or turn on, thereby raising an alarm.

[0049] Battery 136 is a rechargeable power storage element configured of a secondary battery, typically, a lithium-ion battery or a nickel-hydrogen battery. Alarm device 10 is connected to a commercial power supply 150 through an alternative-current (AC) power cable, and battery 136 is charged by commercial power supply 150. Specifically, under normal conditions (when power is supplied from commercial power supply 150), power from commercial power supply 150 is charged to battery 136, and battery 136 serves as an alternative power source for alarm device 10 in the event of losing power from commercial power supply 150.

[0050] Note that alarm device 11 has the same hardware configuration as alarm device 10, except that alarm device 11 does not include LTE module 112 (and antenna 122) of Fig. 2.

[0051] <Process Steps>

Steps of various processes performed by alarm device 10 are now described.

[0052] (Scheme for Transmitting Meter Reading Information)

Fig. 3 is a flowchart for illustrating a scheme for transmitting the meter reading information, according to Embodiment 1. Here, a scheme is described in which alarm device 10 transmits meter reading information of a designated day of meter reading to center server 50.

[0053] Referring to Fig. 3, processor 102, included in alarm device 10, determines whether a meter reading timing based on a pre-designated day of meter reading (a designated day of meter reading) has arrived (step S10).

[0054] Specifically, processor 102 determines that the meter reading timing has arrived if processor 102 receives an instruction to read a meter on a designated day of meter reading from center server 50 via LTE module 112 and network 40. Alternatively, processor 102 may determine whether the meter reading timing has arrived based on comparison of a designated day of meter reading, pre-stored in nonvolatile memory 106, with the current date and time.

[0055] Processor 102 instructs gas meter 20A to transmit the meter reading information of the current time to alarm device 10 (step S12). Specifically, processor 102 transmits instructional information indicative of that instruction to gas meter 20A via Bluetooth module 111.

[0056] Processor 102 receives the meter reading information of the current time from gas meter 20A via Bluetooth module 111 (step S14). Processor 102 stores the meter reading information, received from gas meter 20A, as meter reading information of the designated day of meter reading into a memory (e.g., nonvolatile memory 106) (step S16).

[0057] Processor 102 transmits the meter reading information of the designated day of

meter reading stored in the memory to center server 50 via LTE module 112 (step S18). Subsequently, processor 102 determines whether the transmission of the meter reading information to center server 50 is successful (step S20).

[0058] For example, if processor 102 does not receive a response from center server 50 for a period of time after the transmission of the meter reading information (i.e., reception timeout), processor 102 determines that the meter reading information has failed to reach center server 50 (i.e., transmission failed). Otherwise, processor 102 determines that the transmission of the meter reading information is successful.

[0059] If the transmission of the meter reading information is successful (YES in step S20), processor 102 ends the process. If the transmission of the meter reading information is failed (NO in step S20), processor 102 determines whether a given time period (e.g., one day) has elapsed since the transmission of the meter reading information is failed (step S22). If the given time period has not elapsed (NO in step S22), processor 102 performs the process of step S22.

[0060] If the given time period has elapsed (YES in step S22), processor 102 performs the process of step S18. In other words, processor 102 re-transmits the meter reading information of the designated day of meter reading stored in the memory to center server 50.

[0061] According to the above, alarm device 10 stores the meter reading information of the designated day of meter reading, obtained from gas meter 20A, into the memory. Then, even if communication failure is caused by an increased load on the processing on the center server 50 side or by network congestion or the like, and the transmission of the meter reading information is failed on a designated day of meter reading, alarm device 10 transmits the meter reading information of the designated day of meter reading stored in the memory to center server 50 at a moment the communication with center server 50 is permitted. This can prevent the meter-reading time period from being shifted, thereby improving the customer service.

[0062] (Scheme for Transmitting Shutoff information)

Fig. 4 is a flowchart for illustrating a scheme for transmitting shutoff

information, according to Embodiment 1. Here, a scheme is described in which alarm device 10 transmits gas shutoff information to center server 50 upon detection of the target gas.

[0063] Referring to Fig. 4, processor 102, included in alarm device 10, determines whether the target gas is detected by gas sensor 131 in the indoor space of house 201 (step S30). If no target gas is detected (NO in step S30), processor 102 performs the process of step S30.

[0064] If the target gas is detected (YES in step S30), processor 102 transmits gas detection information indicative of the detection of the target gas to gas meter 20A via Bluetooth module 111 (step S32). As gas meter 20A receives the gas detection information, gas meter 20A shuts a shut-off valve and stops supply of the gas through the gas bottle. Gas meter 20A then transmits shutoff information, indicating that the shut-off valve is shut, to alarm device 10 via the Bluetooth module.

[0065] Processor 102 receives the shutoff information from gas meter 20A via Bluetooth module 111 (step S34), and stores the shutoff information into the memory, in association with the current date and time (step S36). Specifically, processor 102 stores shutoff-related information into the memory, the shutoff-related information including the shutoff information, and shutoff date and time at which the shut-off valve is shut.

[0066] Processor 102 transmits the shutoff-related information stored in the memory to center server 50 via LTE module 112 (step S38). Subsequently, processor 102 determines whether the transmission of the shutoff-related information to center server 50 is successful (step S40).

[0067] If the transmission of the shutoff-related information is successful (YES in step S40), processor 102 ends the process. If the transmission of the shutoff-related information is failed (NO in step S40), processor 102 determines whether a given time period has elapsed since the transmission of the shutoff-related information is failed (step S42). If the given time period has not elapsed (NO in step S42), processor 102 performs the process of step S42.

[0068] After the elapse of the given time period (YES in step S42), processor 102 performs the process of step S38. In other words, processor 102 re-transmits the shutoff-related information stored in the memory to center server 50.

[0069] According to the above, alarm device 10 stores the shutoff-related information, indicating when the shut-off valve is shut by gas meter 20A, in the memory. In the event of disasters in which the communication with center server 50 is lost and alarm device 10 is unable to transmit the shutoff-related information, alarm device 10 transmits the shutoff-related information to center server 50 at a moment the communication with center server 50 is permitted. This allows center server 50 to accurately know the moment the gas is shut off.

[0070] <Functional Configuration>

Fig. 5 is a block diagram showing one example functional configuration of alarm device 10 according to Embodiment 1. Referring to Fig. 5, as a primarily functional configuration, alarm device 10 includes a meter reading information acquisition unit 301, a storage unit 303, a gas detection unit 305, a shutoff information acquisition unit 307, an imaging information acquisition unit 309, an operating unit 311, a communication control unit 313, and a device-to-device communication unit 315. Storage unit 303 is implemented by main memory 104 and nonvolatile memory 106.

[0071] Meter reading information acquisition unit 301 obtains the meter reading information of a designated day of meter reading from gas meter 20A via a first communication module (e.g., Bluetooth module 111) which is for wirelessly communicating with gas meter 20A.

[0072] In a certain aspect, when the current date and time reach a given time of the designated day of meter reading, meter reading information acquisition unit 301 instructs gas meter 20A to transmit meter reading information (i.e., read the meter) of the current date and time via the first communication module, thereby obtaining the meter reading information of the current date and time. Meter reading information acquisition unit 301 stores the obtained meter reading information of the current date and time into storage unit 303 as the meter reading information of the designated day of

meter reading. Meter reading information acquisition unit 301 is primarily implemented by processor 102 and communication unit 110.

[0073] Gas detection unit 305 detects presence or absence of the target gas in the indoor space of house 201. Gas detection unit 305 is primarily implemented by processor 102 and gas sensor 131.

[0074] Shutoff information acquisition unit 307 obtains shutoff information, indicating that the gas is shut-off, from gas meter 20A via the first communication module. In a certain aspect, if gas detection unit 305 detects the target gas, shutoff information acquisition unit 307 transmits detection information, indicating that the target gas is detected, to gas meter 20A via the first communication module, and obtains the shutoff information from gas meter 20A as a response to the detection information. Note that shutoff information acquisition unit 307 may store into storage unit 303 the shutoff-related information in which the shutoff information and the current date and time (i.e., a gas shutoff date and time) is associated with each other,.

[0075] Imaging information acquisition unit 309 obtains imaging information, captured by camera 31, via the first communication module. Imaging information acquisition unit 309 stores the imaging information into storage unit 303. Imaging information acquisition unit 309 is primarily implemented by processor 102 and communication unit 110.

[0076] In a certain aspect, when a gas is detected by gas detection unit 305, imaging information acquisition unit 309 may transmit an instruction to actuate camera 31 and obtain the imaging information captured by the actuated camera 31. With this, information indicating the state of the indoor space in the event of emergency, that is, gas leakage, can be stored in storage unit 303, and, since, normally, the imaging information is not stored in storage unit 303, the capacity of storage unit 303 can be efficiently used.

[0077] Operating unit 311 receives operation input from the user. In a certain aspect, operating unit 311 receives an emergency indication from the user. Operating unit 311 is primarily implemented by processor 102 and operational interface 133.

[0078] Communication control unit 313 communicates various information with center server 50 via a second communication module (e.g., LTE module 112). Communication control unit 313 is primarily implemented by processor 102 and communication unit 110.

[0079] In a certain aspect, communication control unit 313 transmits the meter reading information of the designated day of meter reading stored in storage unit 303 to center server 50 via the second communication module. If the transmission of the meter reading information of the designated day of meter reading is failed, communication control unit 313 re-transmits the meter reading information of the designated day of meter reading to center server 50 after a given time period (e.g., a day later) has elapsed since the transmission to center server 50 is failed. Note that if the transmission of the meter reading information of the designated day of meter reading to center server 50 is successful, communication control unit 313 may delete the meter reading information of the designated day of meter reading stored in storage unit 303 immediately after the successful transmission thereof or a period of time (e.g., a few month later) after the successful transmission. This allows the capacity of storage unit 303 to be efficiently utilized.

[0080] In another aspect, communication control unit 313 transmits the shutoff information, obtained by shutoff information acquisition unit 307, to center server 50 via the second communication module. Specifically, communication control unit 313 transmits the shutoff-related information stored in storage unit 303 to center server 50.

[0081] In still another aspect, if the target gas is detected in the indoor space of house 201, communication control unit 313 transmits the imaging information, obtained by imaging information acquisition unit 309, to center server 50 via the second communication module.

[0082] In still another aspect, as operating unit 311 receives an emergency indication from the user, communication control unit 313 transmits emergency information to center server 50 via the second communication module. The emergency information indicates that some emergency has occurred. This allows the user to report the

emergency directly to center server 50.

[0083] Device-to-device communication unit 315 wirelessly communicates with alarm device 11. Typically, device-to-device communication unit 315 wirelessly communicates with alarm device 11 via a third communication module (e.g., Wi-SUN module 113). For example, device-to-device communication unit 315 receives various information (e.g., the meter reading information, the shutoff-related information, the imaging information, the emergency information, etc.), from alarm device 11. Communication control unit 313 transmits the various information, obtained by device-to-device communication unit 315, to center server 50 via the second communication module.

[0084] Here, among the functional configurations of alarm device 10 described above, alarm device 11 includes all the functional configurations (i.e., meter reading information acquisition unit 301, storage unit 303, gas detection unit 305, shutoff information acquisition unit 307, imaging information acquisition unit 309, operating unit 311, device-to-device communication unit 315), except for communication control unit 313. Specifically, alarm device 11 obtains the meter reading information of the designated day of meter reading, the shutoff-related information, the imaging information, emergency indication information, etc. The device-to-device communication unit of alarm device 11 transmits such information to alarm device 10 via Wi-SUN the module.

[0085] <Advantageous Effects>

According to Embodiment 1, even if the meter reading information of a designated day of meter reading is unable to transmit on the designated day, the meter reading information of the designated day of meter reading stored in the memory is transmitted to center server 50 at a moment the communication between alarm device 10 and center server 50 is permitted. Thus, the meter-reading time period is not shifted, and the customer service improves.

[0086] Even if the shutoff information cannot be transmitted when the gas is shut off, alarm device 10 can transmit the shutoff-related information stored in the memory to

center server 50 at a moment the communication with center server 50 is permitted. This allows center server 50 to accurately know when the gas is shut off.

[0087] A problem with the scheme, in which the meter reading information by the gas meter is loaded using a public telephone line, that is, the communication is not permitted while the telephone line is in use for conversation, is also solved. Moreover, since battery 136 is typically charged with power from the commercial power supply, and in case of loss of power from the commercial power supply, battery 136 is used as an alternative power source, there is no need to be aware of power consumed by alarm device 10 for communications.

[0088] [Embodiment 2]

Embodiment 2 will be described, with reference to a multi-hop communications scheme employed between alarm device 10 and multiple alarm devices 11. As noted above, alarm device 10 and alarm device 11 are capable of two-way communications using, for example, a communication scheme according to Wi-SUN. In Wi-SUN, multiple devices relay data in a bucket-brigade manner. Wi-SUN also supports a multi-hop communication that connects remote locations. Consequently, alarm device 10 and multiple alarm devices 11 can transfer data therebetween by a multi-hop scheme.

[0089] In the following description, alarm device 10 that is equipped with an LTE module 112 and wirelessly communicable with a center server 50 is also referred to as a "master device 10," and alarm device 11 that is not equipped with LTE module 112 is also referred to as a "slave device 11."

[0090] Fig. 6 is a diagram for illustrating a multi-hop communications scheme according to Embodiment 2. Referring to Fig. 6, master devices 10A, 10B, 10C are master devices of groups A, B, C, respectively. Communication ranges 401, 402, 403 indicate respective communication ranges of master devices 10A, 10B, 10C for communications using Wi-SUN.

[0091] Slave devices 11A, 11B, 11C are within communication range 401, and thus belong to group A. Slave devices 11C, 11D, 11E are within communication range 402, and thus belong to group B. Thus, slave device 11C belongs to groups A and B.

Slave devices 11G, 11F are within communication range 403, and thus belong to group C.

[0092]For example, in order to establish a communication route with master device 10, slave device 11, that is wishing to newly join a network, needs to obtain routing information, including the communication route, the communication quality, etc., from master device 10 or slave device 11 that is already joined the network. Hence, slave device 11, that is wishing to newly join the network, broadcasts a beacon request signal for searching for master device 10 or other slave devices 11 around slave device 11.

[0093] If master device 10 or other slave device 11 can receive the beacon request signal, master device 10 or slave device 11 that has received the beacon request signal broadcasts a beacon response signal in response to the beacon request signal. As slave device 11, that is wishing to newly join the network, receives the beacon response signal, slave device 11 transmits/receives the routing information to/from the source of the beacon response signal, and constructs a communication route to the source.

[0094] Typically, master device 10 receives various information from each slave device 11 belonging to the same group, and transmits the various information to center server 50. Here, each slave device 11 receives meter reading information of a designated day of meter reading from a corresponding gas meter, and stores the received meter reading information in an internal memory of the slave device. Note that each slave device stores the above-described shutoff-related information and imaging information, etc. in the internal memory.

[0095] For example, master device 10A receives the meter reading information and the shutoff information stored in the internal memory of each of slave devices 11A, 11B, 11C from slave device 11. Master device 10A transmits the meter reading information and the shutoff information of each of slave devices 11A, 11B, and 11C to center server 50.

[0096] Note that since slave device 11C also belongs to group B, the information stored in the internal memory of slave device 11C may be transmitted to center server 50 via master device 10B.

[0097] Here, consider the case where a certain master device 10 is unable to communicate with center server 50 and the other slave devices 11, due to a factor such as failure of the master device 10.

[0098] Fig. 7 is a diagram showing a situation in which a master device 10 of Fig. 6 is failed. Referring to Fig. 7, master device 10B is unable to communicate with center server 50 and the other slave devices 11, due to a factor such as failure of master device 10B. In this case, slave devices 11D and 11E, belonging to group B, are unable to transmit information to center server 50 via master device 10B.

[0099] For this reason, slave device 11E, for example, emits a beacon request signal to search for other devices that are present around slave device 11E, and establishes a communication with slave device 11D that responds (that is found through the search). Similarly, slave device 11D establishes a communication with slave device 11C. Slave device 11C can communicate with master device 10A via slave device 11B. In other words, slave device 11E can communicate with master device 10A via slave devices 11D, 11C, 11B.

[0100] Accordingly, slave device 11E transmits the meter reading information (or the shutoff information, etc.) stored in the internal memory to master device 10A. Master device 10A transmits the meter reading information (or, the shutoff information), received from slave device 11E, to center server 50.

[0101] As such, slave device 11 transmits various information P, stored in the internal memory, to a device K1 found through the search. If device K1 is master device 10, device K1 transmits various information P stored in the internal memory of the slave device 11 to center server 50. In contrast, if device K1 is slave device 11, device K1 further searches for a device and transmits various information P stored in the internal memory of device K1 to a device K2 found through the search.

[0102] Note that the communication routes shown in Figs. 6 and 7 are by way of example, and other communication routes may be employed. For example, if slave device 11E finds slave device 11C through the search, slave device 11E establishes a communication with slave device 11C, without passing through slave device 11D.

Furthermore, if slave device 11C finds master device 10A through the search, slave device 11C establishes a communication with master device 10A, without passing through slave device 11B. In this case, slave device 11E can communicate with master device 10A via slave device 11C.

[0103] [Other Embodiment]

(1) While in the above embodiments, alarm devices 10, 11 obtain the meter reading information by the gas meter, alarm devices 10, 11 may further obtain meter reading information by various meters other than the gas meter, by communicating with the various meters. For example, alarm devices 10, 11 may obtain meter reading information (e.g., data indicating water usage) from a water meter which meters water usage, or obtain meter reading information (e.g., data indicating electricity usage) from an electricity meter which meters electricity (power) usage, via a Bluetooth module. Alarm device 10 transmits these pieces of meter reading information to center server 50. As such, the meter reading information of lifelines, which are gas, electricity, and water, are centrally managed, thereby further improving the customer service.

[0104] (2) In the above embodiments, programs can also be provided, which cause the computer to function and performs the controls as described with reference to the flowcharts described above. Such a program can be recoded in a non-transitory computer readable recording medium included in the computer, such as a flexible disk, a CD (Compact Disk Read Only Memory), a secondary memory device, a primary memory device, or a memory card, and provided as a program product. Alternatively, such a program can be recorded in a recording medium built in a computer, such as a hard disk, and provided. Such a program can also be provided through downloading of the program via a network.

[0105] Among program modules provided as part of the operating system (OS) of the computer, the program may call necessary modules in a given order at any given moment and causes the modules to perform processes. In such a case, the program itself does not contain the modules and the processes are performed in cooperation with the OS. Such a program that does not contain the modules can also be included in the

program according to the present embodiment.

[0106] Moreover, the program according to the present embodiment may be incorporated as part of another program and provided. In such a case also, the program itself does not contain modules that is included in the other program, and the processes are performed in cooperation with the other program. The program incorporated in such another program can also be included in the program according to the present embodiment.

[0107] (3) The configurations illustrated as the embodiments above are one example of the configurations according to the present invention, can be combined with other known technologies and modifications can be made, such as omitting part thereof, without departing from the spirit of the present invention. Moreover, in the above embodiments, the processing and configurations described in other embodiments can be employed as appropriate and implemented.

[0108] The presently disclosed embodiments should be considered in all aspects as illustrative and not restrictive. The scope of the present invention is indicated by the appended claims, rather than by the description above, and all changes that come within the scope of the claims and the meaning and range of equivalency of the claims are intended to be embraced within their scope.

REFERENCE SIGNS LIST

[0109] 10, 11 alarm device; 20A, 20B gas meter; 30 home appliance; 31 camera; 40 network; 50 center server; 100 main control unit; 102 processor; 104 main memory; 106 nonvolatile memory; 110 communication unit; 111 Bluetooth module; 112 LTE module; 113 Wi-SUN module; 114 Wi-Fi module; 121, 122, 123, 124 antenna; 131 gas sensor; 132 loudspeaker; 133 operational interface; 134 GPS module; 136 battery; 150 commercial power supply; 201, 202 house; 301 meter reading information acquisition unit; 303 storage unit; 305 gas detection unit; 307 shutoff information acquisition unit; 309 imaging information acquisition unit; 311 operating unit; 313 communication control unit; 315 device-to-device communication unit; 401, 402, 403 communication range; and 1000 information

processing system.

CLAIMS

1. An alarm device which is located in an indoor space, and outputs an alarm when a target gas is detected, the alarm device comprising:

a first communications means for wirelessly communicating with a gas meter that meters usage of gas used in the indoor space;

a second communications means for communicating with a center server;

a meter reading information acquisition means that obtains meter reading information for a designated day of meter reading, from the gas meter via the first communications means;

a storage means that stores the meter reading information obtained by the meter reading information acquisition means; and

a communications control means that transmits the meter reading information of the designated day of meter reading stored in the storage means to the center server via the second communications means.

2. The alarm device according to claim 1, wherein

the meter reading information acquisition means:

as a current date and time reaches a given time of the designated day of meter reading, obtains meter reading information of the current date and time by instructing the gas meter to transmit the meter reading information of the current date and time, via the first communications means; and

stores the obtained meter reading information of the current date and time into the storage means as the meter reading information of the designated day of meter reading.

3. The alarm device according to claim 1 or 2, further comprising

a shutoff information acquisition means that obtains shutoff information from the gas meter via the first communications means, the shutoff information indicating

that the gas is shut off, wherein

when the target gas is detected in the indoor space, the shutoff information acquisition means transmits detection information, indicating that the target gas is detected, to the gas meter and obtains the shutoff information from the gas meter as a response to the detection information, via the first communications means, and

the communications control means transmits the shutoff information to the center server via the second communications means.

4. The alarm device according to any one of claims 1 to 3, wherein

when the transmission of the meter reading information of the designated day of meter reading to the center server is failed, the communications control means re-transmits the meter reading information of the designated day of meter reading to the center server after a given time period has elapsed since the transmission is failed.

5. The alarm device according to any one of claims 1 to 4, wherein

when the transmission of the meter reading information of the designated day of meter reading to the center server is successful, the communications control means deletes the meter reading information of the designated day of meter reading stored in the storage means.

6. The alarm device according to any one of claims 1 to 5, further comprising

an electricity storage means that is, normally, charged with power supplied from a commercial power supply, and, when the power from the commercial power supply is lost, functions as an alternative power source for the alarm device.

7. The alarm device according to any one of claims 1 to 6, further comprising

an imaging information acquisition means that obtains imaging information captured by a camera located in the indoor space, wherein

when the target gas is detected in the indoor space, the communications control

means transmits the imaging information, obtained by the imaging information acquisition means, to the center server via the second communications means.

8. The alarm device according to any one of claims 1 to 7, further comprising an operation means that receives operation input from the user, wherein

when the operation means receives an emergency indication from the user, the communications control means transmits emergency information to the center server via the second communications means.

9. An information processing system, comprising:

a center server; and

a master alarm device having a gas alarm functionality for outputting an alarm when a target gas is detected, the master alarm device being located in an indoor space, wherein

the master alarm device:

obtains, from a gas meter that meters usage of gas used in the indoor space, meter reading information for a designated day of meter reading, via a first communications means for wirelessly communicating with the gas meter;

stores the meter reading information, obtained from the gas meter, into a first memory included in the master alarm device; and

transmits the meter reading information of the designated day of meter reading, stored in the first memory, to the center server via a second communications means for communicating with the center server.

10. The information processing system according to claim 9, further comprising

a plurality of alarm devices including a plurality of the master alarm devices and a plurality of slave alarm devices having the gas alarm functionality, wherein

the plurality of slave alarm devices each:

obtain the meter reading information of the designated day of meter reading from the gas meter via the first communications means;

store the obtained meter reading information into a second memory of the slave alarm device; and

search alarm devices present around the slave alarm device, and transmit the meter reading information of the designated day of meter reading stored in the second memory to a first alarm device found through the search, wherein

when the first alarm device is the master alarm device, the first alarm device transmits the meter reading information of the designated day of meter reading stored in the second memory to the center server via the second communications means.