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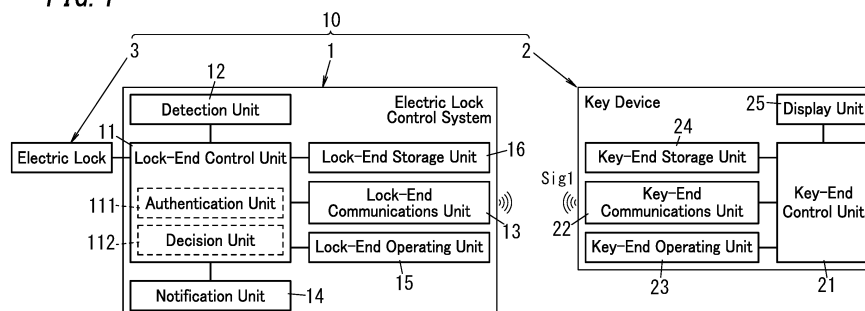
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(54) **ELECTRONIC LOCK CONTROL SYSTEM, ELECTRONIC LOCK SYSTEM, CONTROL METHOD FOR ELECTRONIC LOCK CONTROL SYSTEMS, AND PROGRAM**

(57) An object of the present disclosure is to contribute to improving security performance. An electric lock control system (1) includes: a lock-end communications unit (13) to communicate wirelessly with a key device (2); and a lock-end control unit (11) to control an electric lock (3) in accordance with information that the lock-end communications unit (13) has received from the key device (2). When finding a decision condition satisfied while presence of any key device (2) is detected, according to quality of communication between the lock-end commu-

nications unit (13) and the key device (2), within a predetermined communication range, the lock-end control unit (11) performs first processing of shutting or opening the electric lock (3). On the other hand, when finding the decision condition unsatisfied for a predetermined wait time or more while the key device (2) is present within the communication range, the lock-end control unit (11) performs predetermined, second processing, which is different from the first processing.

FIG. 1



Description

Technical Field

[0001] The present disclosure generally relates to an electric lock control system, an electric lock system, a method for controlling the electric lock control system, and a program. More particularly, the present disclosure relates to an electric lock control system, an electric lock system, a method for controlling the electric lock control system, and a program, all of which are configured or designed to control an electric lock used to lock or unlock an opening/closing member provided for a building.

Background Art

[0002] An electric lock system for locking and unlocking a building's door has been known (see, for example, Patent Literature 1). The electric lock system of Patent Literature 1 includes a controller for controlling shutting and opening a main lock and auxiliary lock provided for the door. The controller transmits, at regular intervals, a startup signal that turns an electronic key ON. On receiving the startup signal, the electronic key turns ON and transmits ID information to the controller. On receiving the ID information from the electronic key, the controller performs authentication based on the ID information received. When the authentication is done successfully, the controller opens the main and auxiliary locks that have been shut.

[0003] In the electric lock system of Patent Literature 1, as long as the user who holds the electronic key stays within a range where the electronic key is able to receive the startup signal from the controller, the ID information is transmitted from the electronic key to the controller. When the authentication is done successfully, the main and auxiliary locks are opened. This could allow a third party who happens to be present near the door at that time to open the door and enter the building.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 2016-20606 A

Summary of Invention

[0005] It is therefore an object of the present disclosure to provide an electric lock control system, an electric lock system, a method for controlling the electric lock control system, and a program, all of which contribute to improving security performance.

[0006] An electric lock control system according to an aspect of the present disclosure includes a lock-end communications unit and a lock-end control unit. The lock-end communications unit communicates wirelessly with a key device. The lock-end control unit controls, in ac-

cordance with information that the lock-end communications unit has received from the key device, an electric lock. The electric lock is used to lock or unlock an opening/closing member provided at an opening of a building.

When finding a decision condition satisfied while presence of any key device is detected, according to quality of communication between the lock-end communications unit and the key device, within a predetermined communication range, the lock-end control unit performs first processing of shutting or opening the electric lock. On the other hand, when finding the decision condition unsatisfied for a predetermined wait time or more while the key device is present within the communication range, the lock-end control unit performs predetermined, second processing, which is different from the first processing.

[0007] An electric lock system according to another aspect of the present disclosure includes the electric lock control system described above; and an electric lock to be controlled by the lock-end control unit.

[0008] A method for controlling an electric lock control system according to still another aspect of the present disclosure includes performing first processing and performing predetermined, second processing. The first processing includes shutting or opening an electric lock when a decision condition is satisfied while presence of any key device is detected, according to quality of communication with the key device, within a predetermined communication range. The second processing is different from the first processing and performed when the decision condition is unsatisfied for a predetermined wait time or more while the key device is present within the communication range.

[0009] A program according to yet another aspect of the present disclosure is designed to make a computer system execute first processing and predetermined, second processing. The first processing includes shutting or opening an electric lock when a decision condition is satisfied while presence of any key device is detected, according to quality of communication with the key device, within a predetermined communication range. The second processing is different from the first processing and performed when the decision condition is unsatisfied for a predetermined wait time or more while the key device is present within the communication range.

Brief Description of Drawings

[0010]

FIG. 1 is a block diagram of an electric lock system including an electric lock control system according to an exemplary embodiment of the present disclosure;

FIG. 2 illustrates how the electric lock system may be used;

FIG. 3 illustrates how the electric lock system may be used;

FIG. 4 is a sequence chart showing the procedure in which the electric lock system performs first processing;

FIG. 5 is a sequence chart showing the procedure in which the electric lock system performs second processing;

FIG. 6 is a sequence chart showing an exemplary flow of operation of an electric lock control system according to a fourth variation of the exemplary embodiment of the present disclosure; and

FIG. 7 is a sequence chart showing another exemplary flow of operation of the electric lock control system according to the fourth variation.

Description of Embodiments

(1) Overview

[0011] An overview of an electric lock system including an electric lock control system according to an exemplary embodiment will be described. As shown in FIG. 1, an electric lock system 10 according to this embodiment includes an electric lock control system 1 and a key device 2. The electric lock system 10 further includes an electric lock 3 to be controlled by the electric lock control system 1.

[0012] The electric lock control system 1 according to this embodiment is a system for controlling the electric lock 3. The electric lock 3 is a device for locking or unlocking an opening/closing member 5 (see FIGS. 2 and 3). The opening/closing member 5 is provided at an opening 40 of a building 4. As used herein, the "opening/closing member 5" refers to a door or a window separating the inside of the building 4 (hereinafter referred to as "the inside 41") from the outside of the building 4 (hereinafter referred to as "the outside 42") and may be a main entrance door, a back door (which may be either a hinged door or a sliding door), or a patio door, for example. In this embodiment, the opening/closing member 5 is a main entrance door. The electric lock control system 1 and the electric lock 3 are installed on the opening/closing member 5. The electric lock control system 1 is configured to be ready to communicate with the key device 2. The electric lock control system 1 is also configured to electrically switch the state of the electric lock 3 from a shut state (where the opening/closing member 5 is locked) into an opened state (where the opening/closing member 5 is unlocked), and vice versa, by communicating with the key device 2.

[0013] The key device 2 has the capability of communicating with the electric lock control system 1. In this embodiment, the method of communication between the electric lock control system 1 and the key device 2 is wireless communication via radio waves. The key device 2 is a battery-driven mobile telecommunications device, for example. In this embodiment, the electric lock control system 1 is also powered by a battery. In this embodiment, the building 4 may be a single-family dwelling

house, for example. Therefore, the user 6 is someone who holds the key device 2 and who may be a resident of the building 4 or any of his or her family members, relatives, friends, or acquaintances. When there are a plurality of users 6, each of the plurality of users 6 may hold the key device 2. In that case, the electric lock system 10 includes the plurality of key devices 2.

[0014] In accordance with a lock signal or unlock signal supplied from a lock-end control unit 11 (to be described later) of the electric lock control system 1, the electric lock 3 locks or unlocks the opening/closing member 5 electrically. In other words, in accordance with the lock signal or unlock signal supplied from the lock-end control unit 11, the electric lock 3 is switched from the shut state (where the opening/closing member 5 is locked) to the opened state (where the opening/closing member 5 is unlocked), and vice versa.

[0015] The electric lock control system 1 and electric lock system 10 according to this embodiment have the following configuration in order to improve security performance.

[0016] As shown in FIG. 1, the electric lock control system 1 according to this embodiment includes a lock-end communications unit 13 and the lock-end control unit 11.

[0017] The lock-end communications unit 13 communicates wirelessly with the key device 2.

[0018] The lock-end control unit 11 controls, in accordance with information that the lock-end communications unit 13 has received from the key device 2, the electric lock 3 used to lock or unlock the opening/closing member 5. The lock-end control unit 11 determines, based on the quality of communication between the lock-end communications unit 13 and the key device 2, whether or not the key device 2 is present within a predetermined communication range A1 (see FIGS. 2 and 3). As used herein, the "predetermined communication range A1" may refer to a range where the received signal strength indicator (RSSI) of a wireless signal that the lock-end communications unit 13 receives from the key device 2 is equal to or greater than a predetermined first threshold value, for example. In this embodiment, the "first threshold value" may be set at a value corresponding to the received signal strength indicator of a wireless signal received from the key device 2 located at a distance of a few meters from the site of installation of the electric lock control system 1.

[0019] When finding a decision condition satisfied while detecting the presence of the key device 2 within the communication range A1, the lock-end control unit 11 performs first processing. The "first processing" is processing of shutting or opening the electric lock 3. On the other hand, when finding the decision condition unsatisfied for a predetermined wait time T1 or more while the key device 2 is present within the communication range A1, the lock-end control unit 11 performs predetermined, second processing, which is different from the first processing.

[0020] In this embodiment, the "wait time T1" may be

one to five minutes, for example, and may be changed as appropriate according to the setting of the communication range A1 and the operating environment, for example.

[0021] The "decision condition" is a condition for locking or unlocking the electric lock 3. Examples of the decision conditions include a condition that the received signal strength indicator of a wireless signal received from the key device 2 should be equal to or greater than a predetermined second threshold value and further include, in this embodiment, a condition that a command should be entered into a lock-end operating unit 15 (to be described later) of the electric lock control system 1. In this case, the "key device 2" may be a key device authorized to shut or open the electric lock 3, for example.

[0022] The "second threshold value" is set at a value larger than the first threshold value. In the outside 42, an authentication area A2, which is narrower than the communication range A1, is set in the vicinity of the opening 40. The authentication area A2 refers herein to a range where the distance from the opening/closing member 5 is within approximately 1 meter. The second threshold value is set such that the strength of the signal that the lock-end communications unit 13 receives from the key device 2 present within the authentication area A2 becomes equal to or greater than the second threshold value. Therefore, examples of the decision condition described above include the condition that the key device 2 should be present within the authentication area A2 and further include, in this embodiment, the condition that a command should be entered into the lock-end operating unit 15.

[0023] The "second processing" is different from the first processing of shutting or opening the electric lock 3. For example, the second processing may be processing of changing the decision condition. This prevents, when the decision condition is unsatisfied for the predetermined wait time T1 or more while the key device 2 is present within the communication range A1 as described above, the first processing of shutting or opening the electric lock 3 from being performed, thus improving security performance.

[0024] In this embodiment, the second processing is processing of changing the decision condition such that the decision condition is satisfied less easily, and may be the processing of changing the threshold value (second threshold value) of the received signal strength indicator into a value larger than the threshold value before the decision condition is changed. In this case, changing the threshold value (second threshold value) of the received signal strength indicator into a value larger than the threshold value before the decision condition is changed turns the authentication area A2 into an area A22, which is narrower than the area A21 before the decision condition is changed (see FIGS. 2 and 3). In the following description, the authentication area A2 before the second processing is performed (i.e., before the decision condition is changed) will also be hereinafter re-

ferred to as an "authentication area A21" and the authentication area A2 after the second processing has been performed (i.e., after the decision condition has been changed) will also be hereinafter referred to as an "authentication area A22." For example, if the user 6 is present inside the authentication area A21 but outside the authentication area A22, the second processing may be performed to change the decision condition such that the authentication area A2 is narrowed down from the authentication area A21 to the authentication area A22. Then, the decision condition is unsatisfied. In that case, the electric lock 3 is not opened, thus improving security performance.

(2) Details

[0025] Next, configurations for the electric lock control system 1 and electric lock system 10 according to this embodiment will be described.

(2.1) Electric lock control system

[0026] As shown in FIG. 1, the electric lock control system 1 includes the lock-end control unit 11, a detection unit 12, the lock-end communications unit 13, a notification unit 14, the lock-end operating unit 15, and a lock-end storage unit 16. In the electric lock control system 1 according to this embodiment, the lock-end control unit 11, the detection unit 12, the lock-end communications unit 13, the notification unit 14, the lock-end operating unit 15, and the lock-end storage unit 16 are housed in a single casing 17 (see FIGS. 2 and 3).

[0027] The detection unit 12 detects opening or closing of the opening/closing member 5 (which may be a main entrance door in this embodiment). The detection unit 12 includes: a magnet attached to a door frame of the main entrance door; and a magnetic sensor installed on the main entrance door so as to face the magnet when the main entrance door is closed. The detection unit 12 determines, based on the result of detection of magnetism by the magnetic sensor, whether the main entrance door (opening/closing member 5) is opened or closed, and outputs the result of detection to the lock-end control unit 11.

[0028] The lock-end communications unit 13 includes an antenna and a communications circuit, for example, and establishes wireless communication via radio waves. The lock-end communications unit 13 is configured to establish short-range wireless communication compliant with the Bluetooth® Low Energy (BLE) protocol. The BLE is the name of a set of low power specifications (of version 4.0 or any other later version) according to Bluetooth®, which is a wireless Personal Area Network (PAN) technology standard. The lock-end communications unit 13 transmits, in accordance with an instruction from the lock-end control unit 11, an advertising signal (beacon signal) intermittently (at an interval of 1 second, for example). In addition, the lock-end communica-

tions unit 13 also receives an acknowledge (ACK) signal, which is transmitted from a key-end communications unit 22 (to be described later) in response to the advertising signal. That is to say, the lock-end communications unit 13 has signal transmission and reception capabilities and is configured to communicate bidirectionally with the key-end communications unit 22. The lock-end communications unit 13 further has the capability of measuring the received signal strength indicator (RSSI) of the wireless signal (radio wave signal) Sig1 received. On receiving the wireless signal Sig1 from the key device 2, the lock-end communications unit 13 outputs information such as key information contained in the wireless signal Sig1 and the received signal strength indicator (measured value) of the wireless signal Sig1 (received signal) to the lock-end control unit 11.

[0029] The notification unit 14 includes a display unit, which may be implemented as an LED (light-emitting diode), for example, and a buzzer. The notification unit 14 has the capability of notifying the user 6 whether the opening/closing member 5 is locked or not. The notification unit 14 may make the display unit indicate the operating state of the electric lock 3, for example. Specifically, when the opening/closing member 5 is locked or unlocked by the electric lock 3, the notification unit 14 may turn the LED either ON or blinking. On the other hand, if the opening/closing member 5 is not locked by the electric lock 3, then the notification unit 14 may sound a buzzer. This allows the user 6 to learn, based on the information provided by the notification unit 14, whether the opening/closing member 5 is locked or not. Note that the notification unit 14 is not an essential constituent element for the electric lock control system 1 but may be omitted as appropriate.

[0030] The lock-end operating unit 15 has the capability of accepting commands entered by the user 6 (i.e., a human). The lock-end operating unit 15 may include a press button switch, for example, provided for the casing 17 so as to be exposed on the outside 42 of the building 4. Optionally, the lock-end operating unit 15 may also be provided for a door handle (lever) of the opening/closing member 5 (i.e., the main entrance door) or may also be implemented as a touchscreen sensor configured to sense the user 6 put his or her hand on the door handle. On accepting the commands entered by the user 6, the lock-end operating unit 15 outputs command signals representing his or her commands to the lock-end control unit 11.

[0031] The lock-end storage unit 16 includes an electrically programmable nonvolatile memory such as an electrically erasable programmable read-only memory (EEPROM). The lock-end storage unit 16 stores, as authentication information, key information about one or more key devices 2 which are authorized to control the electric lock 3. Multiple different pieces of key information are assigned to the plurality of key devices 2. Thus, the lock-end storage unit 16 stores the identification information of the key devices 2 and those pieces of key infor-

mation assigned to the key devices 2 in association with each other. The lock-end storage unit 16 also stores the decision condition before the second processing is performed, the decision condition after the second processing has been performed, and a cancellation condition for canceling the second processing.

[0032] The lock-end control unit 11 controls the electric lock 3 used to lock or unlock the opening/closing member 5. The lock-end control unit 11 is implemented as a microcomputer including a processor and a memory, for example. In other words, since the lock-end control unit 11 is configured as a computer system including a processor and a memory, the computer system performs various functions of the lock-end control unit 11 (such as the functions of an authentication unit 111 and a decision unit 112) by making the processor execute the program stored in the memory or the lock-end storage unit 16. The program may be stored in advance in either the memory of the microcomputer or the lock-end storage unit 16, or may also be downloaded via a telecommunications line such as the Internet or distributed after having been stored on a non-transitory storage medium such as a memory card.

[0033] The authentication unit 111 collates the key information that the lock-end communications unit 13 has received from the key device 2 with the authentication information that the lock-end storage unit 16 stores to determine whether or not the key device 2 that has transmitted the key information is one of the key devices 2 that are authorized to control the electric lock 3.

[0034] The decision unit 112 determines, based on the information that the lock-end communications unit 13 has received from the key device 2, whether or not to perform the first processing and the second processing. On receiving the wireless signal Sig1 from the key device 2, the lock-end communications unit 13 outputs the information contained in the wireless signal Sig1 received from the key device 2 and the received signal strength indicator (measured value) of the wireless signal Sig1 to the lock-end control unit 11. The decision unit 112 compares the received signal strength indicator provided by the lock-end communications unit 13 with the first threshold value. When finding the received signal strength indicator equal to or greater than the first threshold value, the decision unit 112 determines that the key device 2 should be present within the communication range A1 and makes the authentication unit 111 authenticate the key device 2.

[0035] When finding the decision condition satisfied while detecting the presence of the key device 2 within the communication range A1, the decision unit 112 performs the first processing. Specifically, when finding the decision condition satisfied before a predetermined wait time passes since a predetermined timing while the presence of the key device 2 is detected within the communication range A1, the decision unit 112 performs the first processing. As described above, when the key device 2 enters the communication range A1, the authentication

unit 111 performs the authentication processing of collating the key information of the key device 2 with the authentication information. As used herein, the "predetermined timing" refers to a timing when the key device 2, of which the key information has been successfully verified by the authentication unit 111, enters the authentication area A2. That is to say, the "predetermined timing" is a timing when the decision unit 112 determines the received signal strength indicator of the wireless signal received from the key device 2, of which the key information has been successfully verified by the authentication unit 111, should be equal to or greater than the second threshold value. If the key device 2 enters the authentication area A2 before the key information is successfully verified by the authentication unit 111, then the "predetermined timing" is a timing when the key information of the key device 2 that has entered the authentication area A2 is successfully verified by the authentication unit 111. In this embodiment, the "decision condition" is that the received signal strength indicator (measured value) of the wireless signal received from the key device 2 should be equal to or greater than the second threshold value and that a command should be entered into the lock-end operating unit 15 by a human. Therefore, when finding the lock-end operating unit 15 operated with the key device 2 present in the authentication area A2 before the wait time T1 passes since the predetermined timing, the decision unit 112 determines that the decision condition should be satisfied and performs the first processing.

[0036] On the other hand, when finding the lock-end operating unit 15 not operated yet even when the wait time T1 has passed since the predetermined timing, the decision unit 112 determines that the decision condition has been unsatisfied for the wait time or more and performs the second processing. The second processing is processing of changing the decision condition, and may be the processing of changing the second threshold value into a value larger than the one before the decision condition is changed. When the decision unit 112 performs the second processing, the authentication area A2 is changed into the authentication area A22, which is narrower than the authentication area A21 before the decision condition is changed.

(2.2) Key device

[0037] The key device 2 is implemented as a mobile telecommunications device such as a smartphone. As shown in FIG. 1, the key device 2 includes a key-end control unit 21, a key-end communications unit 22, a key-end operating unit 23, a key-end storage unit 24, and a display unit 25.

[0038] The key-end control unit 21 is implemented as a microcomputer including a processor and a memory, for example. In other words, since the key-end control unit 21 is configured as a computer system including a processor and a memory, the computer system functions

as the key-end control unit 21 by making the processor execute an appropriate program. The program may be stored in advance in the memory, or may also be downloaded via a telecommunications line such as the Internet or distributed after having been stored on a non-transitory storage medium such as a memory card.

[0039] The key-end communications unit 22 includes an antenna and a communications circuit, for example. The key-end communications unit 22 is configured to establish short-range wireless communication compliant with the BLE protocol, for example, with the lock-end communications unit 13. In addition, the key-end communications unit 22 transmits an acknowledge (ACK) signal in accordance with an instruction given by the key-end control unit 21. The key-end communications unit 22 also receives the advertising signal transmitted from the lock-end communications unit 13. On receiving the advertising signal, the key-end communications unit 22 transmits, to the electric lock control system 1, the ACK signal acknowledging a safe receipt of the advertising signal. That is to say, the key-end communications unit 22 has signal transmission function and signal reception function, and is configured to communicate bidirectionally with the lock-end communications unit 13. When the lock-end communications unit 13 of the electric lock control system 1 receives the ACK signal from the key device 2, the electric lock control system 1 and the key device 2 initiate communication to perform connection processing of confirming the state of the key device 2.

[0040] The key-end operating unit 23 has the capability of accepting commands entered by the user 6. The key-end operating unit 23 may be implemented as, for example, a press button switch (or lever) provided for the casing of the key device 2. In this embodiment, the key-end operating unit 23 includes a touchscreen panel provided for a display device serving as the display unit 25. The touchscreen panel includes a touchscreen sensor such as a capacitive touchscreen sensor or a pressure sensitive (or resistive) touchscreen sensor. When the user 6 performs some type of operation of touching the display device of the display unit 25 (such as tap operation or swipe operation), the key-end operating unit 23 outputs a signal indicating the type of operation performed to the key-end control unit 21.

[0041] The key-end storage unit 24 includes an electrically programmable nonvolatile memory such as an EEPROM. The key-end storage unit 24 stores identification information assigned individually to each key device 2 and key information given by the electric lock control system 1. The key-end storage unit 24 also stores a program to be executed by the computer of the key device 2. The program may be stored in advance in the memory. Alternatively, the program may also be downloaded via a telecommunications line such as the Internet or distributed after having been stored on a non-transitory storage medium such as a memory card. When the key device 2 is implemented as a smartphone as in this embodiment, the key-end storage unit 24 may store an application in-

stalled arbitrarily by the user 6.

[0042] The display unit 25 may be implemented as a thin display device such as a liquid crystal display (LCD) or an organic electroluminescent display (OLED). The display unit 25 has its content controlled by the key-end control unit 21.

[0043] In the following description of this embodiment, the key device 2 is implemented as a mobile telecommunications device such as a smartphone. However, this is only an example and should not be construed as limiting. Rather, the key device 2 may be implemented as any other type of device. For example, the key device 2 may also be implemented as a tablet computer, for example, as long as the mobile telecommunications device is able to execute a program (application) that makes its computer serve as the key of the electric lock control system 1. Alternatively, the key device 2 may also be implemented as a dedicated remote controller for use in the electric lock control system 1 such as an electronic tag which may be contained in, or attached to, the user's 6 bag or any other personal belonging of his or hers. When the key device 2 is implemented as a dedicated remote controller such as an electronic tag, the key-end operating unit 23 may be implemented as a press button switch, for example, and the display unit 25 may be implemented as an LED, for example.

(2.3) Electric lock

[0044] The electric lock 3 locks and unlocks the opening/closing member 5 (e.g., a main entrance door in this embodiment). The electric lock 3 includes a deadbolt, a driving unit, and a driver circuit. The driver circuit generates a drive signal in accordance with a control signal (which may be either an unlock signal or a lock signal) supplied from the lock-end control unit 11, and outputs the drive signal to the driving unit. The driving unit includes an electric motor and a transmission mechanism for transmitting the driving force of the electric motor to the deadbolt. The driving unit drives a drive motor in accordance with the drive signal supplied from the driver circuit. Transmitting the driving force of the drive motor to the deadbolt via the transmission mechanism causes the deadbolt to move to either a locked position or an unlocked position. In this case, when the deadbolt moves to the locked position, the deadbolt is at least partially inserted into a bolt hole cut in a door frame that supports the opening/closing member 5. In this state, the opening/closing member 5 is kept closed. That is to say, the opening/closing member 5 is locked. On the other hand, when the deadbolt moves to the unlocked position, the deadbolt is entirely out of the bolt hole. In this state, the opening/closing member 5 is ready to be opened or closed. That is to say, the opening/closing member 5 is unlocked.

(3) Operation

[0045] First of all, it will be described with reference to FIG. 4 how the electric lock control system 1 performs the first processing.

[0046] In the electric lock control system 1, the lock-end communications unit 13 transmits the advertising signal at regular intervals (e.g., every second) (in Step S1).

[0047] Suppose the user 6 who carries the key device 2 with him or her has approached the opening 40 of the building 4 to enter the inside 41 from the outside 42. When the user 6 who carries the key device 2 with him or her and who still stays outdoors (in the outside 42) has come close enough to the opening 40 of the building 4 for the key device 2 to receive the advertising signal from the lock-end communications unit 13, the key device 2 transmits, in response to the advertising signal, an acknowledge signal to the lock-end communications unit 13 (in Step S2).

[0048] The lock-end control unit 11 compares the received signal strength indicator (measured value) of the signal received at the lock-end communications unit 13 with the first threshold value. When finding the received signal strength indicator equal to or greater than the first threshold value, the lock-end control unit 11 determines that the key device 2 should be present within the communication range A1 (i.e., detects the key device 2 within the communication range A1) (in Step S3).

[0049] On detecting the presence of the key device 2 within the communication range A1, the lock-end control unit 11 makes the lock-end communications unit 13 and the key device 2 establish communication between them at regular intervals (e.g., every 0.1 second) in order to monitor the state of the key device 2 (in Step S4: monitoring processing).

[0050] Once the lock-end communications unit 13 has initiated communication with the key device 2, the lock-end control unit 11 performs authentication processing on the key device 2 (in Step S5). The lock-end control unit 11 instructs the lock-end communications unit 13 to request the key device 2 to provide key information. When the lock-end communications unit 13 receives the key information transmitted from the key device 2, the lock-end control unit 11 collates the key information with the authentication information that the lock-end storage unit 16 stores. When finding the key information matching up with the authentication information (i.e., when the key information is successfully verified), the lock-end control unit 11 determines that the key device 2 should be a device authorized to control the electric lock 3. On the other hand, when finding the key information not matching up with the authentication information, the lock-end control unit 11 determines that the key device 2 should be a device prohibited from controlling the electric lock 3.

[0051] When the key information is verified successfully, the lock-end control unit 11 makes the lock-end communications unit 13 and the key device 2 communi-

cate with each other on a regular basis. Subsequently, when finding the received signal strength indicator of the wireless signal received from the key device 2 equal to or greater than the second threshold value, the lock-end control unit 11 determines that the key device 2 should now be present within the authentication area A2 (in Step S6).

[0052] Thereafter, if the user 6 enters a command through the lock-end operating unit 15 before the predetermined wait time T1 passes since the lock-end control unit 11 determined that the key device 2 should be present within the authentication area A2, a command signal is output from the lock-end operating unit 15 to the lock-end control unit 11 (in Step S7). When receiving the command signal from the lock-end operating unit 15 before the wait time T1 passes, the lock-end control unit 11 determines that the decision condition should be satisfied (in Step S8) and outputs the unlock signal to the electric lock 3 (in Step S9). On receiving the unlock signal from the lock-end control unit 11, the electric lock 3 unlocks the opening/closing member 5 (in Step S10). That is to say, the lock-end control unit 11 performs the first processing of unlocking the opening/closing member 5. This allows the user 6 who carries the key device 2 with him or her to open the opening/closing member 5 and enter the inside 41. Note that when a certain amount of time passes since the electric lock 3 has been unlocked, the lock-end control unit 11 may output the lock signal to the electric lock 3 to have the electric lock 3 locked.

[0053] Next, it will be described with reference to FIG. 5 how the electric lock control system 1 performs the second processing.

[0054] In the electric lock control system 1, the lock-end communications unit 13 transmits the advertising signal at regular intervals (in Step S11).

[0055] Suppose the user 6 who carries the key device 2 with him or her has approached the opening 40 of the building 4 to enter the inside 41 from the outside 42. When the user 6 who carries the key device 2 with him or her and who still stays outdoors (in the outside 42) has come close enough to the opening 40 of the building 4 for the key device 2 to receive the advertising signal from the lock-end communications unit 13, the key device 2 transmits, in response to the advertising signal, an acknowledge signal to the lock-end communications unit 13 (in Step S12).

[0056] The lock-end control unit 11 compares the received signal strength indicator of the signal received at the lock-end communications unit 13 with the first threshold value. When finding the received signal strength indicator equal to or greater than the first threshold value, the lock-end control unit 11 determines that the key device 2 should be present within the communication range A1 (i.e., detects the key device 2 within the communication range A1) (in Step S13).

[0057] On detecting the presence of the key device 2 within the communication range A1, the lock-end control unit 11 makes the lock-end communications unit 13 and

the key device 2 establish communication between them at regular intervals in order to monitor the state of the key device 2 (in Step S14: monitoring processing).

[0058] Once the lock-end communications unit 13 has initiated communication with the key device 2, the lock-end control unit 11 performs authentication processing on the key device 2 (in Step S15). The lock-end control unit 11 instructs the lock-end communications unit 13 to request the key device 2 to provide key information. When the lock-end communications unit 13 receives the key information transmitted from the key device 2, the lock-end control unit 11 collates the key information with the authentication information that the lock-end storage unit 16 stores.

[0059] When the key information is verified successfully, the lock-end control unit 11 makes the lock-end communications unit 13 and the key device 2 communicate with each other on a regular basis. Subsequently, when finding the received signal strength indicator of the wireless signal received from the key device 2 equal to or greater than the second threshold value, the lock-end control unit 11 determines that the key device 2 should now be present within the authentication area A2 (A21) (in Step S16).

[0060] At this time, if the lock-end operating unit 15 is not operated yet even when the wait time T1 has passed since the key device 2 was determined to be present within the authentication area A21 (i.e., when finding the decision condition unsatisfied for the wait time T1 or more), the lock-end control unit 11 performs the second processing (in Step S17). In this case, the second processing is the processing of changing the decision condition, more specifically, changing the second threshold value into a value larger than the value before the decision condition is changed to turn the authentication area A2 into an authentication area A22, which is narrower than the authentication area A21 before the decision condition was changed. The lock-end control unit 11, which has performed the second processing, determines, based on the decision condition that has been changed, whether the opening/closing member 5 should be locked or unlocked.

[0061] For example, if the user 6 who carries the key device 2 with him or her is at a stop inside the authentication area A21 but outside the authentication area A22, then the user 6 is located outside the authentication area A22 after the decision condition has been changed. In that case, even if the lock-end operating unit 15 is operated by a third party, the decision condition is not satisfied. This reduces the chances of a third party who is not authorized to open the electric lock 3 opening the electric lock 3, thus improving security performance.

[0062] Thereafter, when the user 6 who carries the key device 2 with him or her moves to the authentication area A22, the lock-end control unit 11 determines, based on the received signal strength indicator of the wireless signal received from the key device 2, that the key device 2 authorized to shut or open the electric lock 3 should

now be present within the authentication area A22 (in Step S18). If the user 6 enters a command through the lock-end operating unit 15 in this state (in Step S19), a command signal is output from the lock-end operating unit 15 to the lock-end control unit 11. When receiving the command signal from the lock-end operating unit 15, the lock-end control unit 11 determines that the decision condition should be satisfied (in Step S20) and outputs the unlock signal to the electric lock 3 (in Step S21). On receiving the unlock signal from the lock-end control unit 11, the electric lock 3 unlocks the opening/closing member 5 (in Step S22). That is to say, the lock-end control unit 11 performs the first processing of unlocking the opening/closing member 5. This allows the user 6 who carries the key device 2 with him or her to open the opening/closing member 5 and enter the inside 41. Note that when a certain amount of time passes since the electric lock 3 has been unlocked, the lock-end control unit 11 may output the lock signal to the electric lock 3 to have the electric lock 3 locked.

[0063] As can be seen from the foregoing description, even after having changed the decision condition by performing the second processing, the electric lock control system 1 also determines, based on the decision condition that has been updated, whether or not to perform the first processing. Thus, even after the decision condition has been changed through the second processing, the electric lock 3 may still be unlocked or controlled using the key device 2. This improves security performance while keeping the electric lock control system 1 sufficiently handy to use.

[0064] Also, when the authentication processing is done successfully based on the key information of the key device 2 and the electric lock 3 is unlocked after the second processing has been performed, the lock-end control unit 11 determines that a predetermined cancellation condition should be satisfied, and cancels the second processing to restore an original state (specifically, original parameters) before the second processing was performed (in Step S23). Specifically, the lock-end control unit 11 restores the decision condition into the original one that was not changed through the second processing and also restores the second threshold value into the original value. As a result, the authentication area A2 is restored from the authentication area A22 after the decision condition has been changed into the authentication area A21. That is to say, the state where the authentication area A2 is restricted does not last long, thus making the electric lock control system 1 even handier to use.

(4) Variations

[0065] Note that the exemplary embodiment described above is only one of various embodiments of the present disclosure and should not be construed as limiting. Rather, the exemplary embodiment may be readily modified in various manners depending on a design choice or any other factor without departing from a true spirit and scope

of the present disclosure. The functions of the electric lock control system 1 may also be implemented as a method for controlling the electric lock control system 1, a computer program, or a non-transitory storage medium that stores the computer program thereon.

[0066] A control method according to an aspect includes performing first processing and performing second processing. A program according to another aspect is designed to make a computer system execute the first processing and the second processing. The first processing includes shutting or opening an electric lock 3 when a decision condition is satisfied while the presence of any key device 2 is detected, according to quality of communication with the key device 2, within a predetermined communication range A1 (the processing step S8 shown in FIG. 4). The second processing is different from the first processing, and is performed if the decision condition is still unsatisfied even when the wait time T1 has passed since the presence of the key device 2 was detected within the communication range A1 (the processing step S17 shown in FIG. 5).

[0067] Next, variations of the exemplary embodiment will be enumerated one after another. Note that the variations to be described below may be adopted in combination as appropriate.

(4.1) First variation

[0068] In the exemplary embodiment described above, the received signal strength indicator for use in the decision processing by the decision unit 112 is the received signal strength indicator of the wireless signal Sig1 received from the key device 2. However, this is only an example and should not be construed as limiting. Alternatively, the received signal strength indicator may also be the received signal strength indicator of a wireless signal received from the electric lock control system 1. In that case, the received signal strength indicator of the wireless signal received from the electric lock control system 1 is measured by the key device 2 and the result of measurement is transmitted from the key device 2 to the electric lock control system 1. In response, the decision unit 112 of the electric lock control system 1 performs the decision processing based on the received signal strength indicator (measured value) of the signal received at the key device 2.

[0069] Optionally, a decision unit may be provided for the key device 2. In that case, the received signal strength indicator for use in the decision processing by the decision unit may be the received signal strength indicator of the wireless signal Sig1 transmitted from the key device 2 to the electric lock control system 1 or the received signal strength indicator of a wireless signal transmitted from the electric lock control system 1 to the key device 2, whichever is appropriate. In the former case, the received signal strength indicator of the wireless signal Sig1 transmitted from the key device 2 to the electric lock control system 1 is measured by the electric lock control

system 1 and the result of measurement is transmitted from the electric lock control system 1 to the key device 2. In the latter case, the received signal strength indicator of the wireless signal transmitted from the electric lock control system 1 to the key device 2 is measured by the key device 2. Then, the decision unit of the key device 2 may perform the decision processing based on the received signal strength indicator thus acquired.

(4.2) Second variation

[0070] In the exemplary embodiment described above, the second processing is the processing of changing the second threshold value that is a threshold value of the received signal strength indicator. However, this is only an example and should not be construed as limiting. Alternatively, the second processing may also be the processing of changing the authentication area A2 by changing the sensitivity of either the lock-end communications unit 13 or the key-end communications unit 22. When the lock-end control unit 11 changes the sensitivity of the key-end communications unit 22 of the key device 2, a control signal for decreasing the sensitivity may be transmitted from the lock-end communications unit 13 to the key device 2 and the reception sensitivity may be changed at the key device 2.

[0071] Still alternatively, the second processing may also be the processing of changing the detection condition for determining whether or not there are any key devices 2. For example, the second processing may be the processing of narrowing the communication range A1 (i.e., a range where a decision should be made whether or not any key device 2 is present) from the original range before the detection condition is changed by either increasing the first threshold value or decreasing the transmission output of the advertising signal, for example.

[0072] Yet alternatively, the second processing may also be the processing of changing the time interval at which the lock-end communications unit 13 communicates with the key device 2 present within the communication range A1. For example, the second processing may include changing the communication time interval into a longer time interval (of one second, for example) than the original interval. In that case, the number of times (frequency of occurrence) of communications per unit time decreases. This causes a decrease in the number of times of communications between the lock-end communications unit 13 and the key device 2, thus cutting down the power consumption of the electric lock control system 1 and the key device 2.

(4.3) Third variation

[0073] In the exemplary embodiment described above, the cancellation condition for canceling the second processing is that the authentication processing should be done successfully based on the key information of the

key device 2 to have the electric lock 3 unlocked. However, this is only an example and should not be construed as limiting. Alternatively, the cancellation condition for canceling the second processing may also be that the authentication processing should be done successfully based on the key information of the key device 2 to have the electric lock 3 locked.

[0074] In this case, if the electric lock control system 1 includes a plurality of key devices 2, the cancellation condition for canceling the second processing may be that the key device 2 in question that has caused the second processing to be performed should be used to have the electric lock 3 either locked or unlocked. This prevents any other key device 2 from canceling the second processing, thus improving security performance.

[0075] Still alternatively, the cancellation condition for canceling the second processing may also be that the electric lock 3 should be locked or unlocked successfully in any of the plurality of key devices 2. This allows any of the plurality of key devices 2 to cancel the second processing, thus making this electric lock system 10 even handier to use.

[0076] Yet alternatively, the cancellation condition for canceling the second processing may also be that the quality of communication between the key device 2 and the lock-end communications unit 13 should vary. For example, the cancellation condition may be that the received signal strength indicator of the signal received by the lock-end communications unit 13 from the key device 2 should be less than the first threshold value, i.e., that the key device 2 should go out of the communication range A1.

[0077] Yet alternatively, the cancellation condition may also be that the lock-end communications unit 13 should be unable to communicate with the key device 2, e.g., that the key device 2 should have moved to a location that is too distant from the lock-end communications unit 13 to receive the advertising signal from the lock-end communications unit 13.

[0078] Furthermore, the cancellation condition may specify that the second processing should be canceled for either all key devices 2 or only a particular key device 2. For example, if the cancellation condition specifies that the electric lock 3 should be locked or unlocked successfully, then the lock-end control unit 11 cancels the second processing for all key devices 2 present within the authentication area A2. On the other hand, if the cancellation condition specifies that the key device 2 should go out of the communication range A1, then the lock-end control unit 11 cancels the second processing for only key devices 2 that have gone out of the communication range A1. In that case, if any other key devices 2 are still present within the communication range A1, the lock-end control unit 11 does not cancel the second processing for those key devices 2 present within the communication range A1.

(4.4) Fourth variation

[0079] In the exemplary embodiment described above, the decision condition before the second processing is performed, the decision condition after the second processing has been performed, and the cancellation condition are stored in advance in the lock-end storage unit 16 of the electric lock system 10. However, this is only an example and should not be construed as limiting. Alternatively, the decision condition and the cancellation condition may be set by the key device 2.

[0080] In the following example, it will be described with reference to FIG. 6 how the user 6 who carries the key device 2 with him or her and who still stays outdoors (the outside 42) moves to the site of installation of the electric lock control system 1 and sets the decision condition using the key device 2.

[0081] In the electric lock control system 1, the lock-end communications unit 13 transmits the advertising signal at regular intervals (in Step S31). When receiving the advertising signal from the lock-end communications unit 13, the key device 2 transmits, in response to the advertising signal, an acknowledge signal to the lock-end communications unit 13 (in Step S32).

[0082] The lock-end control unit 11 compares the received signal strength indicator (measured value) of the signal received at the lock-end communications unit 13 with the first threshold value. When finding the received signal strength indicator equal to or greater than the first threshold value, the lock-end control unit 11 determines that the key device 2 should be present within the communication range A1 (i.e., detects the key device 2 within the communication range A1).

[0083] On detecting the presence of the key device 2 within the communication range A1, the lock-end control unit 11 makes the lock-end communications unit 13 and the key device 2 establish communication between them at regular intervals in order to monitor the state of the key device 2 (in Step S33: monitoring processing).

[0084] Once the lock-end communications unit 13 has initiated communication with the key device 2, the lock-end control unit 11 performs authentication processing on the key device 2 (in Step S34). The lock-end control unit 11 instructs the lock-end communications unit 13 to request the key device 2 to provide key information. When the lock-end communications unit 13 receives the key information transmitted from the key device 2, the lock-end control unit 11 collates the key information with the authentication information that the lock-end storage unit 16 stores. At this time, if the key information of the key device 2 is successfully verified, then the user 6 may set the decision condition and cancellation condition using the key device 2.

[0085] If the user 6 who carries the key device 2 with him or her is going to set the decision condition and cancellation condition using the key device 2, then the user 6 may, for example, start an application installed in the key device 2 to control the electric lock 3. When the user

6 performs the operation of setting the decision condition using the key-end operating unit 23, the decision condition setting information is transmitted from the key device 2 to the electric lock control system 1 (in Step S35). In this case, the timing to start the application installed in the key device 2 to control the electric lock 3 does not have to be the timing when the user 6 performs the operation of setting the decision condition. Alternatively, the application to control the electric lock 3 may be started automatically before the user 6 performs the operation of setting the decision condition or may also run on the background. Note that if the verification of the key information fails, then the key device 2 posts, on the display unit 25, an error message that the verification of the key information has failed to disable the user to set the decision condition, and does not transmit the decision condition setting information.

[0086] When receiving the decision condition setting information transmitted from the key device 2, the lock-end communications unit 13 outputs the decision condition setting information to the lock-end control unit 11. On receiving the decision condition setting information from the key device 2, of which the key information has been successfully verified, the lock-end control unit 11 makes the lock-end storage unit 16 store the specific settings of the decision condition in accordance with the decision condition setting information (in Step S36).

[0087] This allows the user 6 to set the decision condition using the key device 2. In other words, the user 6 may set the decision condition according to his or her preference, which makes this electric lock system 10 even more user-friendly. Likewise, this also allows the user 6 to set the cancellation condition using the key device 2. In other words, the user 6 may set the cancellation condition according to his or her preference.

[0088] Optionally, if the electric lock control system 1 includes a plurality of key devices 2, then the user 6 may set mutually different decision conditions and cancellation conditions for those key devices 2 on an individual basis.

[0089] As an example, it will be described with reference to FIG. 7 how the user 6 may set the decision conditions using two key devices 2 (2A, 2B).

[0090] If the user 6 who carries the key device 2A with him or her is going to set a decision condition or cancellation condition for the electric lock control system 1 using the key device 2A, then he or she approaches the electric lock control system 1 while carrying the key device 2A with him or her. When the user 6 who carries the key device 2A with him or her enters the communication range A1, the key device 2A receives the advertising signal transmitted from the electric lock control system 1 (in Step S41). In response to the advertising signal, the key device 2A transmits an acknowledge signal to the lock-end communications unit 13 (in Step S42).

[0091] When receiving the acknowledge signal from the key device 2A, the lock-end control unit 11 performs monitoring processing to communicate at regular inter-

vals with the key device 2A present within the communication range A1 (in Step S43).

[0092] The lock-end control unit 11, which has initiated communication with the key device 2A, performs authentication processing on the key device 2A (in Step S44). The lock-end control unit 11 instructs the lock-end communications unit 13 to request the key device 2A to provide key information. When the lock-end communications unit 13 receives the key information transmitted from the key device 2A, the lock-end control unit 11 collates the key information with the authentication information that the lock-end storage unit 16 stores. At this time, if the key information of the key device 2A is successfully verified, then the user 6 may set the decision condition and cancellation condition using the key device 2A.

[0093] If the user 6 who carries the key device 2A with him or her is going to set the decision condition and cancellation condition using the key device 2A, then the user 6 may start an application installed in the key device 2A to control the electric lock 3. When the user 6 performs the operation of setting the decision condition using the key-end operating unit 23 (in Step S45), the decision condition setting information is transmitted from the key device 2 to the electric lock control system 1 (in Step S46). In this case, the timing to start the application installed in the key device 2A to control the electric lock 3 does not have to be the timing when the user 6 performs the operation of setting the decision condition. Alternatively, the application to control the electric lock 3 may be started automatically before the user 6 performs the operation of setting the decision condition or may also run on the background. Note that if the verification of the key information fails, then the key device 2A posts, on the display unit 25, an error message that the verification of the key information has failed to disable the user to set the decision condition, and does not transmit the decision condition setting information.

[0094] When the lock-end communications unit 13 receives the decision condition setting information transmitted from the key device 2A, the lock-end communications unit 13 outputs decision condition setting information to the lock-end control unit 11. On receiving the decision condition setting information from the key device 2A, of which the key information has been successfully verified, the lock-end control unit 11 makes the lock-end storage unit 16 store the specific settings of the decision condition in accordance with the decision condition setting information (in Step S47).

[0095] Next, if the user 6 who carries the key device 2B with him or her is going to set a decision condition or cancellation condition for the electric lock control system 1 using the key device 2B, then he or she approaches the electric lock control system 1 while carrying the key device 2B with him or her. When the user 6 who carries the key device 2B with him or her enters the communication range A1, the key device 2B receives the advertising signal transmitted from the electric lock control system 1 (in Step S48). In response to the advertising signal,

the key device 2B transmits an acknowledge signal to the lock-end communications unit 13 (in Step S49).

[0096] When receiving the acknowledge signal from the key device 2B, the lock-end control unit 11 performs monitoring processing to communicate at regular intervals with the key device 2B present within the communication range A1 (in Step S50).

[0097] The lock-end control unit 11, which has initiated communication with the key device 2B, performs authentication processing on the key device 2B (in Step S51). The lock-end control unit 11 instructs the lock-end communications unit 13 to request the key device 2B to provide key information. When the lock-end communications unit 13 receives the key information transmitted from the key device 2B, the lock-end control unit 11 collates the key information with the authentication information that the lock-end storage unit 16 stores. At this time, if the key information of the key device 2B is successfully verified, then the user 6 may set the decision condition and cancellation condition using the key device 2B.

[0098] If the user 6 who carries the key device 2B with him or her is going to set the decision condition and cancellation condition using the key device 2B, then the user 6 may start an application installed in the key device 2B to control the electric lock 3. When the user 6 performs the operation of setting the decision condition using the key-end operating unit 23 (in Step S52), the decision condition setting information is transmitted from the key device 2B to the electric lock control system 1 (in Step S53). In this case, the timing to start the application installed in the key device 2 to control the electric lock 3 does not have to be the timing when the user 6 performs the operation of setting the decision condition. Alternatively, the application to control the electric lock 3 may be started automatically before the user 6 performs the operation of setting the decision condition or may also run on the background. Note that if the verification of the key information fails, then the key device 2B posts, on the display unit 25, an error message that the verification of the key information has failed to disable the user to set the decision condition, and does not transmit the decision condition setting information.

[0099] When receiving the decision condition setting information transmitted from the key device 2B, the lock-end communications unit 13 outputs the decision condition setting information to the lock-end control unit 11. On receiving the decision condition setting information from the key device 2B, of which the key information has been successfully verified, the lock-end control unit 11 makes the lock-end storage unit 16 store the specific settings of the decision condition in accordance with the decision condition setting information (in Step S54).

[0100] This allows respective decision conditions to be set, and stored in the lock-end storage unit 16 of the electric lock control system 1, for the two key devices 2A and 2B, thus enabling the lock-end control unit 11 to determine, based on the decision conditions that have been set using the key devices 2A and 2B, whether or not to

perform the first processing and the second processing. This allows the user 6 to set, using the key devices 2A and 2B, appropriate decision conditions for the respective key devices 2A and 2B. Thus, the user 6 may set the decision conditions according to his or her preference, which makes this electric lock system 10 even more user-friendly. Likewise, this also allows the user 6 to set, using the key devices 2A and 2B, appropriate cancellation conditions for the respective key devices 2A and 2B. Thus, the user 6 may set the cancellation conditions according to his or her preference, which makes this electric lock system 10 even more user-friendly.

[0101] Also, if the single building 4 has a plurality of openings 40, each of which is provided with the electric lock control system 1, then the user may set decision conditions for the respective electric lock control systems 1 using the key device 2. In that case, the user may set the same decision condition for the plurality of electric lock control systems 1 or mutually different decision conditions for the respective electric lock control systems 1, whichever is appropriate.

[0102] Optionally, only at least one key device 2, selected from the plurality of key devices 2, may be authorized to set the decision condition, and only the authorized key device(s) 2 may set the decision condition for the electric lock control system 1.

(4.5) Other variations

[0103] Next, other variations will be enumerated one after another.

[0104] The agent that performs the functions of the electric lock control system 1 according to the present disclosure includes a computer system. In that case, the computer system may include, as principal hardware components, a processor and a memory. The functions of the electric lock control system 1 according to the present disclosure or the functions of the agent that performs the control method may be performed by making the processor execute a program stored in the memory of the computer system. The program may be stored in advance in the memory of the computer system. Alternatively, the program may also be downloaded through a telecommunications line or be distributed after having been recorded in some non-transitory storage medium such as a memory card, an optical disc, or a hard disk drive, any of which is readable for the computer system. The processor of the computer system may be made up of a single or a plurality of electronic circuits including a semiconductor integrated circuit (IC) or a largescale integrated circuit (LSI). Those electronic circuits may be either integrated together on a single chip or distributed on multiple chips, whichever is appropriate. Those multiple chips may be integrated together in a single device or distributed in multiple devices without limitation.

[0105] Also, in the embodiment described above, the lock-end control unit 11 is implemented as a single circuit. However, this is only an example and should not be con-

strued as limiting. Alternatively, the lock-end control unit 11 may also be implemented as two or more circuits. For example, the functions of the lock-end control unit 11 may be distributed in two or more circuits. Furthermore, the functions of the lock-end control unit 11 may be performed by either constituent elements of a single device housed in a single casing or constituent elements distributed in multiple devices, whichever is appropriate. Still alternatively, at least some functions of the lock-end control unit 11 may be implemented as a cloud computing system as well.

[0106] In the exemplary embodiment described above, the lock-end control unit 11, the lock-end communications unit 13, and the lock-end operating unit 15 are housed in the single casing 17. However, this is only an example and should not be construed as limiting. Alternatively, the lock-end control unit 11, the lock-end communications unit 13, and the lock-end operating unit 15 may also be distributed in two or more casings 17.

[0107] Also, in the exemplary embodiment described above, the electric lock control system 1 includes the notification unit 14. However, this is only an example and should not be construed as limiting. Alternatively, the key device 2 may include a notification unit. In that case, even though the user 6 is supposed to carry the key device 2 with him or her, the user 6 may be notified by the notification unit of the key device 2 that opening/closing member 5 is locked by the electric lock 3. Notification by the notification unit may be made by posting, on the display unit 25 of the key device 2, a message that the opening/closing member 5 is locked or by having a verbal message that the opening/closing member 5 is locked emitted through a loudspeaker of the key device 2, for example. Naturally, a buzzer or any other alarm of the key device 2 may also be sounded to notify the user 6 that the opening/closing member 5 is locked.

[0108] In the exemplary embodiment described above, the key device 2 is able to perform both the operation of unlocking the opening/closing member 5 and the operation of locking the opening/closing member 5. However, this is only an example and should not be construed as limiting. Alternatively, the key device 2 may also be configured to perform only the operation of unlocking the opening/closing member 5. In other words, the key device 2 may be configured to perform at least the unlocking operation, out of the operation of locking the opening/closing member 5 and the operation of unlocking the opening/closing member 5.

[0109] Furthermore, in the embodiment described above, the opening/closing member 5 is implemented as a door (which may be a hinged door or a sliding door) or window that separates the inside 41 and outside 42 of the building 4 from each other. However, this is only an example and should not be construed as limiting. Alternatively, the opening/closing member 5 may also be a door that separates the inside and outside of some unit of the building 4. For example, if the building 4 is implemented as a multi-family dwelling house with a plurality

of dwelling units, a multi-tenant building with a plurality of tenant stores, or an office building with a plurality of offices, the opening/closing member 5 may be the door that separates the inside and outside of each unit (which may be a dwelling unit, a tenant store, or an office) from each other.

[0110] In the embodiment described above, the electric lock system 10 is applied to a single-family dwelling house. However, this is only an example and should not be construed as limiting. Alternatively, the electric lock system 10 is also applicable to each dwelling unit of a multi-family dwelling house, for example. Still alternatively, the electric lock system 10 is also applicable to the main entrance door of a common area of a multi-family dwelling house or to a non-dwelling building 4 such as an office, a store, or a factory.

(Resume)

[0111] As can be seen from the foregoing description, an electric lock control system (1) according to a first aspect includes a lock-end communications unit (13) and a lock-end control unit (11). The lock-end communications unit (13) communicates wirelessly with a key device (2). The lock-end control unit (11) controls an electric lock (3) in accordance with information that the lock-end communications unit (13) has received from the key device (2). The electric lock (3) is used to lock or unlock an opening/closing member (5) provided at an opening (40) of a building (4). When finding a decision condition satisfied while presence of any key device (2) is detected, according to quality of communication between the lock-end communications unit (13) and the key device (2), within a predetermined communication range (A1), the lock-end control unit (11) performs first processing of shutting or opening the electric lock (3). On the other hand, when finding the decision condition unsatisfied for a predetermined wait time (T1) or more while the key device (2) is present within the communication range (A1), the lock-end control unit (11) performs predetermined, second processing, which is different from the first processing.

[0112] This prevents, if the decision condition is still unsatisfied even when the wait time (T1) has passed since the presence of the key device (2) was detected, the first processing of shutting or opening the electric lock (3) from being performed, thus improving security performance.

[0113] In an electric lock control system (1) according to a second aspect, which may be implemented in conjunction with the first aspect, the decision condition includes that a received signal strength indicator is equal to or greater than a predetermined threshold value. The received signal strength indicator is at least one of a received signal strength indicator of a signal that the lock-end communications unit (13) receives from the key device (2) or a received signal strength indicator of a signal that the key device (2) receives from the lock-end communications unit (13).

[0114] This makes the decision condition unsatisfied when the key device (2) is present outside of the range where the received signal strength indicator is equal to or greater than the threshold value, thus improving security performance.

[0115] In an electric lock control system (1) according to a third aspect, which may be implemented in conjunction with the first or second aspect, the second processing includes change processing of changing the decision condition.

[0116] This allows, if the decision condition is still unsatisfied even when the wait time (T1) has passed since the presence of the key device (2) was detected, the decision condition for determining whether or not to perform the first processing to be changed, thus improving security performance by changing the decision condition. In addition, when finding the decision condition thus changed satisfied, the lock-end control unit (11) performs the first processing of shutting or opening the electric lock (3). This contributes to improving security performance without decreasing, but while maintaining, the degree of handiness of the electric lock control system (1).

[0117] In an electric lock control system (1) according to a fourth aspect, which may be implemented in conjunction with any one of the first to third aspects, the second processing includes processing of changing a detection condition to determine whether the key device (2) is present or not.

[0118] This allows, if the decision condition is still unsatisfied even when the wait time (T1) has passed since the presence of the key device (2) was detected, the detection condition to be changed, thus making the communication range (A1) adjustable by changing the detection condition.

[0119] In an electric lock control system (1) according to a fifth aspect, which may be implemented in conjunction with any one of the first to fourth aspects, the second processing includes processing of changing a time interval at which the lock-end communications unit (13) communicates with the key device (2) present within the communication range (A1).

[0120] This allows, if the decision condition is still unsatisfied even when the wait time (T1) has passed since the presence of the key device (2) was detected, the time interval at which the lock-end communications unit (13) communicates with the key device (2) present within the communication range (A1) to be changed. For example, as the time interval of communications is lengthened, the number of times of communications per unit time between the lock-end communications unit (13) and the key device (2) decreases, thus cutting down the power consumption of the lock-end communications unit (13) and the key device (2).

[0121] In an electric lock control system (1) according to a sixth aspect, which may be implemented in conjunction with any one of the first to fifth aspects, the lock-end control unit (11) restores, when finding a predetermined cancellation condition satisfied, an original state before

the second processing is performed.

[0122] This allows, when the cancellation condition is satisfied, the lock-end control unit (11) to restore the original state before the second processing is performed, thus making the electric lock control system (1) even

[0123] In an electric lock control system (1) according to a seventh aspect, which may be implemented in conjunction with the sixth aspect, the cancellation condition includes that the electric lock (3) be shut or opened completely and/or that the quality of communication between the key device (2) and the lock-end communications unit (13) vary.

[0124] This allows the lock-end control unit (11) to restore the original state before the second processing is performed when the electric lock (3) is completely shut or opened or when the quality of communication between the key device (2) and the lock-end communications unit (13) varies. This makes the electric lock control system (1) even handier to use.

[0125] In an electric lock control system (1) according to an eighth aspect, which may be implemented in conjunction with any one of the first to seventh aspects, the lock-end control unit (11) sets the decision condition based on setting information that the lock-end communications unit (13) has received from the key device (2).

[0126] This allows the user (6) to set the decision condition using the key device (2).

[0127] In an electric lock control system (1) according to a ninth aspect, which may be implemented in conjunction with the eighth aspect, the key device (2) includes a plurality of key devices (2), and the lock-end control unit (11) sets the decision condition for each of the plurality of key devices (2).

[0128] This allows, when the electric lock control system (1) is used with a plurality of key devices (2), the decision condition to be set for each of the plurality of key devices (2), thus making the electric lock control system (1) even handier to use.

[0129] An electric lock system (10) according to a tenth aspect includes: the electric lock control system (1) according to any one of the first to ninth aspects; and an electric lock (3) to be controlled by the lock-end control unit (11).

[0130] This provides an electric lock system (10) contributing to improving security performance.

[0131] An electric lock system (10) according to an eleventh aspect, which may be implemented in conjunction with the tenth aspect, further includes a key device (2) used to shut or open the electric lock (3).

[0132] This provides an electric lock system (10) contributing to improving security performance.

[0133] A method for controlling an electric lock control system (1) according to a twelfth aspect includes performing first processing and performing predetermined, second processing. The first processing includes shutting or opening an electric lock (3) when a decision condition is satisfied while presence of any key device (2) is

detected, according to quality of communication with the key device (2), within a predetermined communication range (A1). The second processing is different from the first processing and performed when the decision condition is unsatisfied for a predetermined wait time (T1) or more while the key device (2) is present within the communication range (A1).

[0134] This contributes to improving security performance.

[0135] A program according to a thirteenth aspect is designed to make a computer system execute first processing and predetermined, second processing. The first processing includes shutting or opening an electric lock (3) when a decision condition is satisfied while presence of any key device (2) is detected, according to quality of communication with the key device (2), within a predetermined communication range (A1). The second processing is different from the first processing and performed when the decision condition is unsatisfied for a predetermined wait time (T1) or more while the key device (2) is present within the communication range (A1).

[0136] This contributes to improving security performance.

[0137] Note that the constituent elements according to the second to ninth aspects are not essential elements for the electric lock control system (1) but may be omitted as appropriate. The constituent element according to the eleventh aspect is not an essential element for the electric lock system (10) but may be omitted as appropriate.

Reference Signs List

[0138]

1	Electric Lock Control System
2, 2A, 2B	Key Device
3	Electric Lock
4	Building
5	Opening/Closing Member
10	Electric Lock System
11	Lock-End Control Unit
13	Lock-End Communications Unit
40	Opening
A1	Communication Range
A2, A21, A22	Authentication Area

Claims

1. An electric lock control system comprising:

a lock-end communications unit configured to communicate wirelessly with a key device; and
a lock-end control unit configured to control an electric lock in accordance with information that the lock-end communications unit has received from the key device, the electric lock being used to lock or unlock an opening/closing member

provided at an opening of a building,
the lock-end control unit being configured to:

when finding a decision condition satisfied while presence of any key device is detected, according to quality of communication between the lock-end communications unit and the key device, within a predetermined communication range, perform first processing of shutting or opening the electric lock; and
when finding the decision condition unsatisfied for a predetermined wait time or more while the key device is present within the communication range, perform predetermined, second processing, which is different from the first processing.

2. The electric lock control system of claim 1, wherein the decision condition includes that at least one of a received signal strength indicator of a signal that the lock-end communications unit receives from the key device or a received signal strength indicator of a signal that the key device receives from the lock-end communications unit is equal to or greater than a predetermined threshold value.
3. The electric lock control system of claim 1 or 2, wherein the second processing includes change processing of changing the decision condition.
4. The electric lock control system of any one of claims 1 to 3, wherein the second processing includes processing of changing a detection condition to determine whether the key device is present or not.
5. The electric lock control system of any one of claims 1 to 4, wherein the second processing includes processing of changing a time interval at which the lock-end communications unit communicates with the key device present within the communication range.
6. The electric lock control system of any one of claims 1 to 5, wherein the lock-end control unit is configured to, when finding a predetermined cancellation condition satisfied, restore an original state before the second processing is performed.
7. The electric lock control system of claim 6, wherein the cancellation condition includes that the electric lock be shut or opened completely and/or that the quality of communication between the key device and the lock-end communications unit vary.

8. The electric lock control system of any one of claims 1 to 7, wherein the lock-end control unit is configured to set the decision condition based on setting information that the lock-end communications unit has received from the key device.

9. The electric lock control system of claim 8, wherein the key device includes a plurality of key devices, and the lock-end control unit is configured to set the decision condition for each of the plurality of key devices.

10. An electric lock system comprising:

the electric lock control system of any one of claims 1 to 9; and
an electric lock configured to be controlled by the lock-end control unit.

11. The electric lock system of claim 10, further comprising a key device used to shut or open the electric lock.

12. A method for controlling an electric lock control system, the method comprising:

performing first processing of shutting or opening an electric lock when a decision condition is satisfied while presence of any key device is detected, according to quality of communication with the key device, within a predetermined communication range; and
performing predetermined, second processing, the second processing being different from the first processing and performed when the decision condition is unsatisfied for a predetermined wait time or more while the key device is present within the communication range.

13. A program designed to make a computer system execute:

first processing of shutting or opening an electric lock when a decision condition is satisfied while presence of any key device is detected, according to quality of communication with the key device, within a predetermined communication range; and
predetermined, second processing, the second processing being different from the first processing and performed when the decision condition is unsatisfied for a predetermined wait time or more while the key device is present within the communication range.

FIG. 1

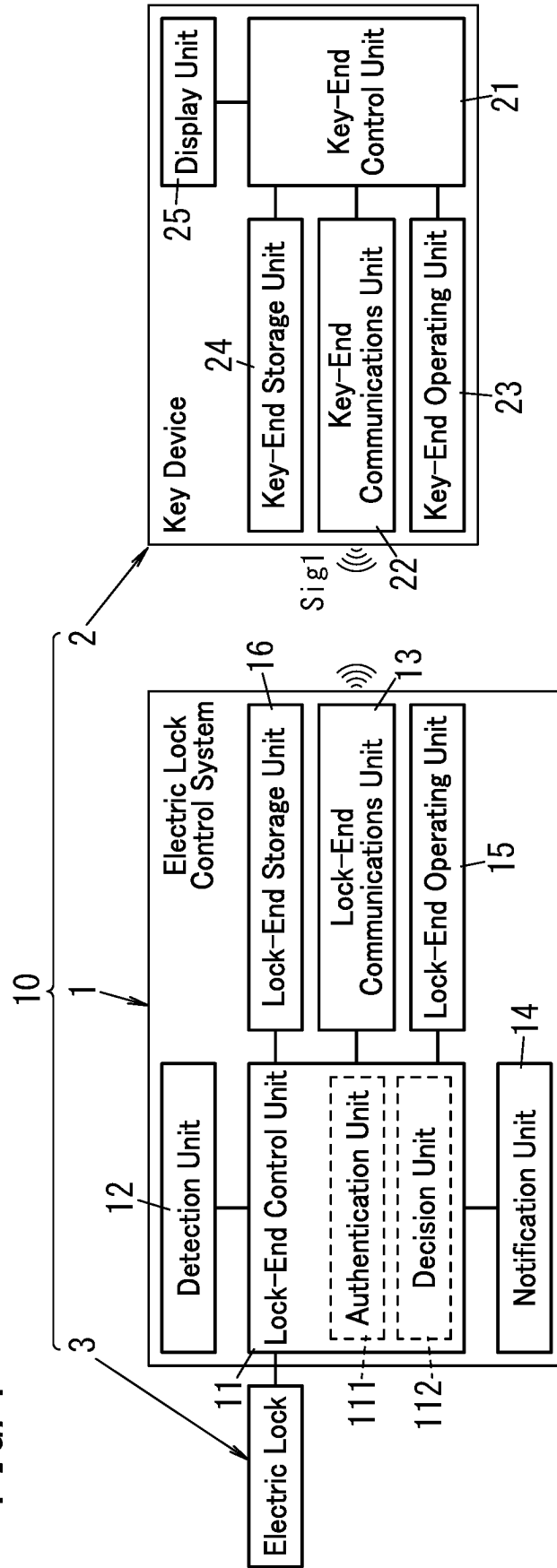


FIG. 2

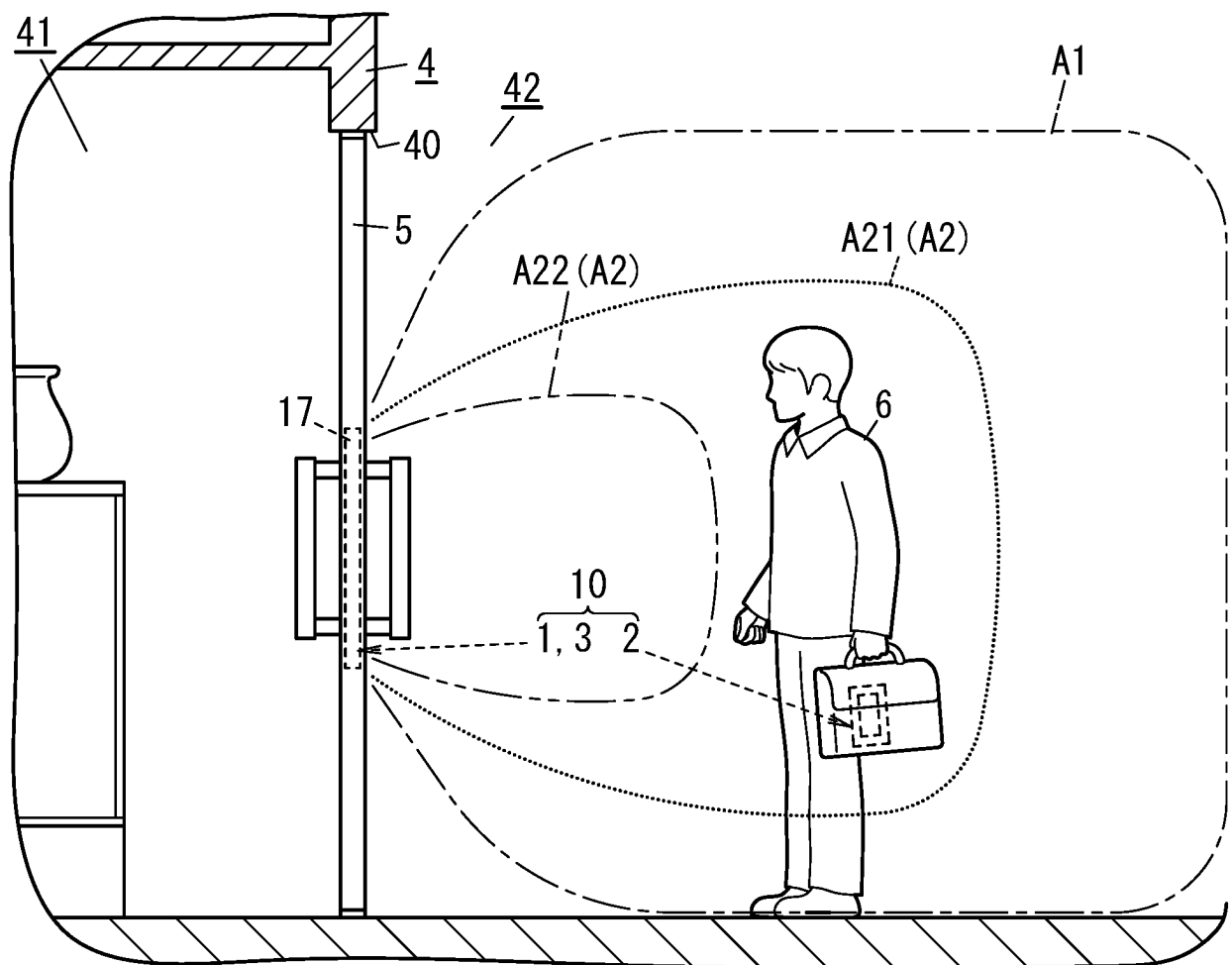


FIG. 3

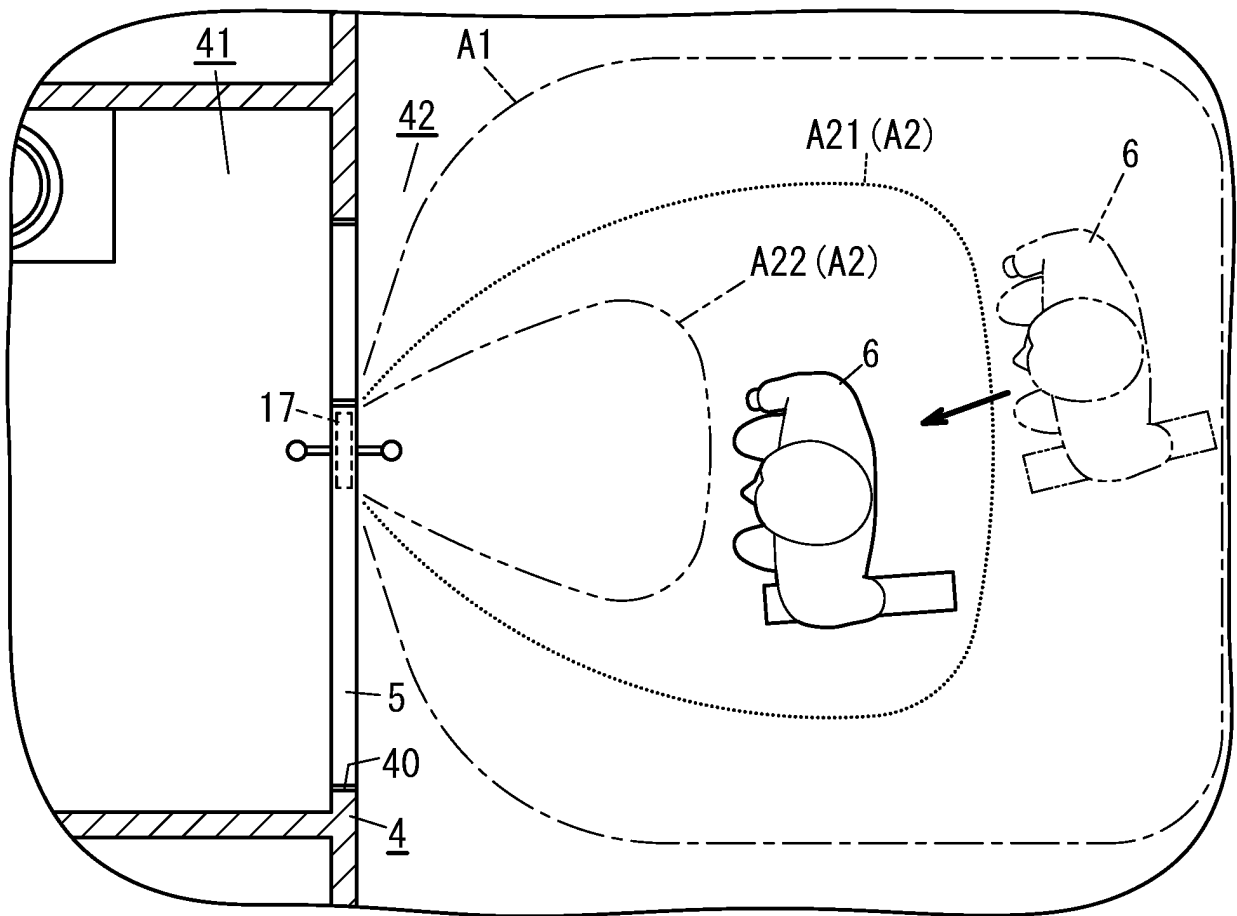


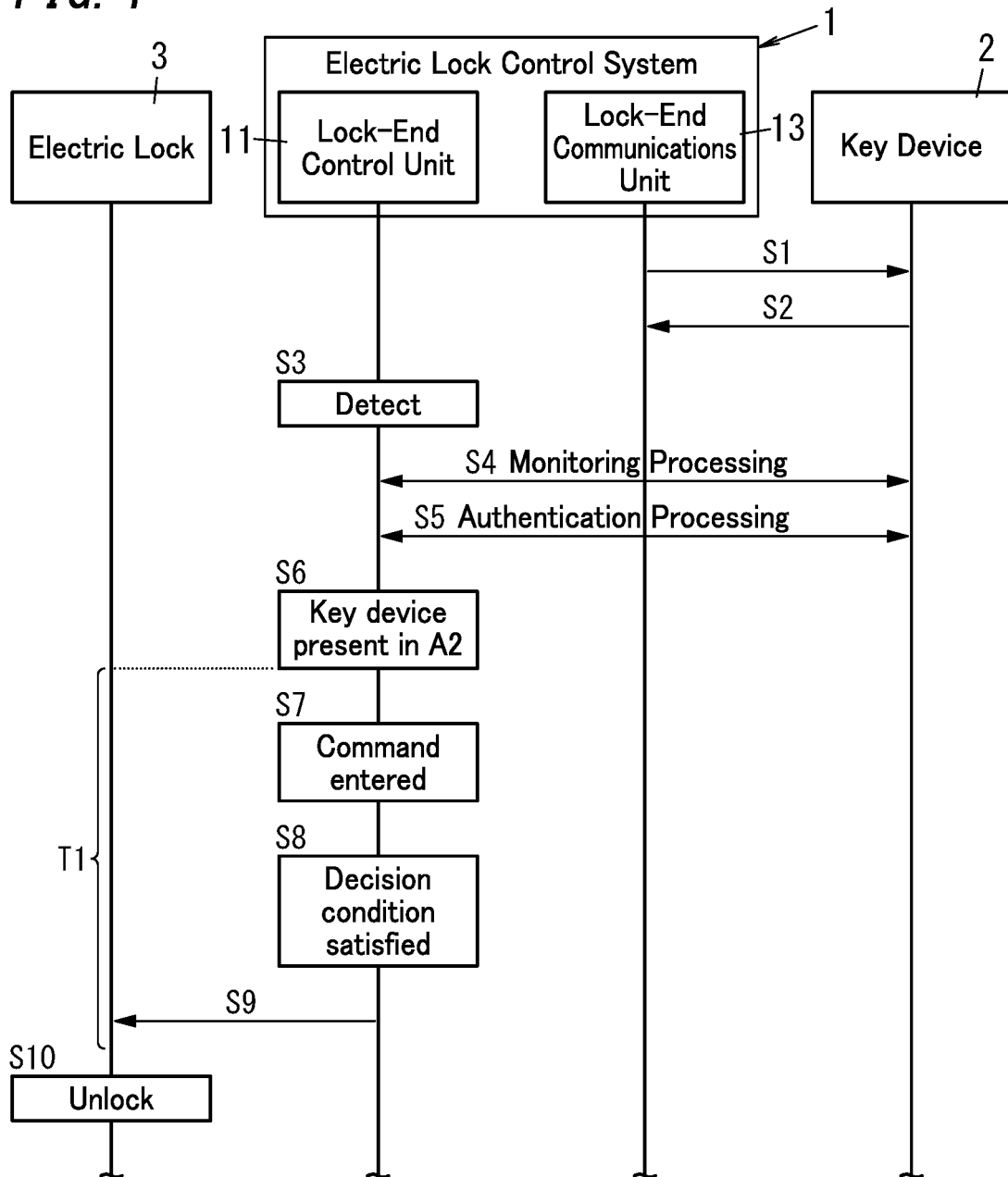
FIG. 4

FIG. 5

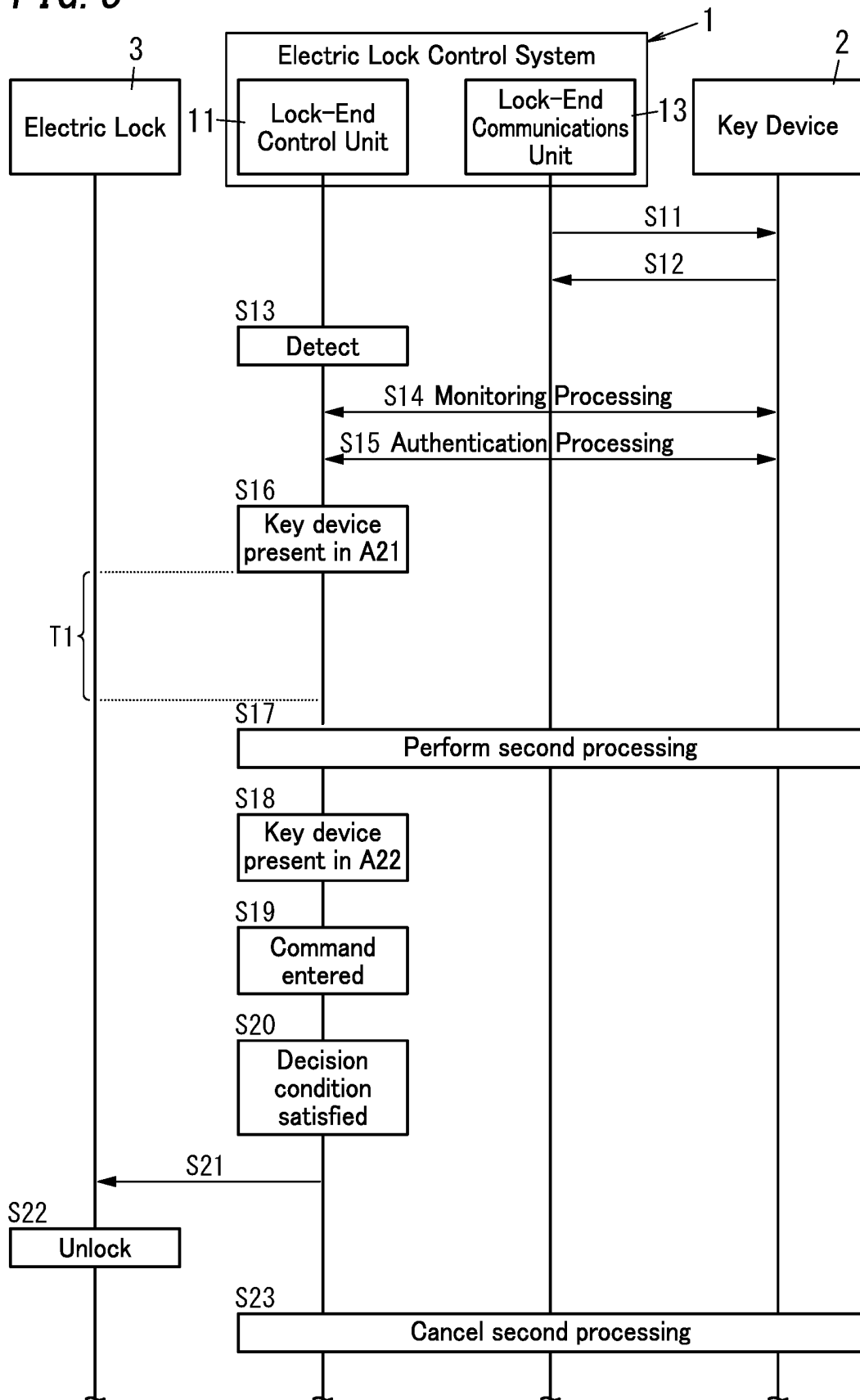


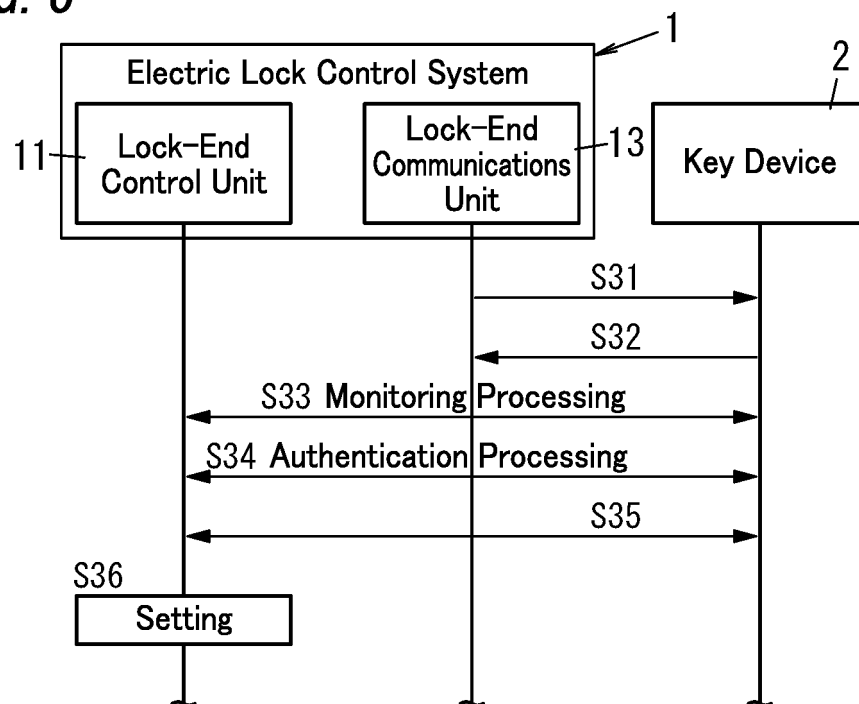
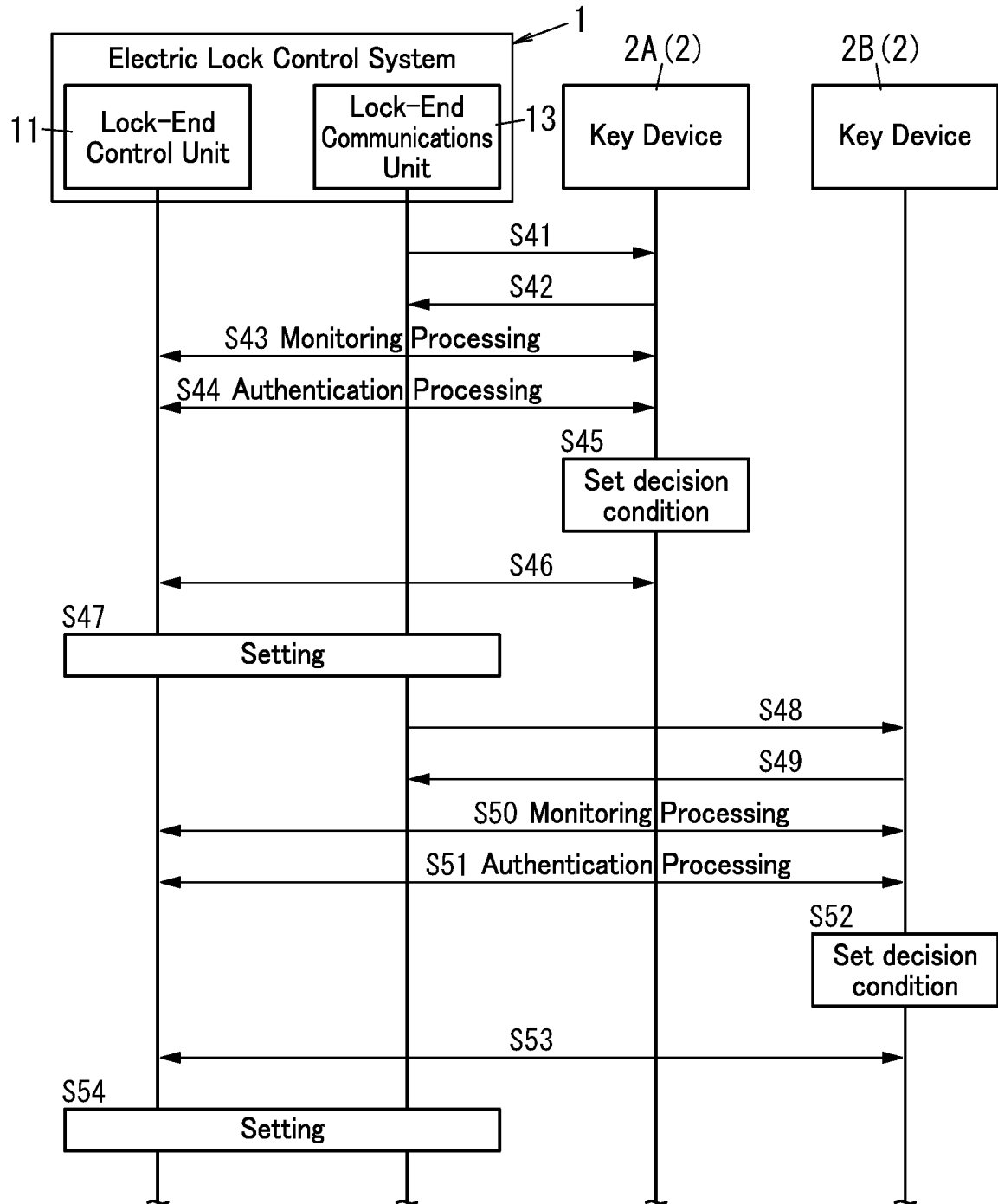
FIG. 6

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/032093

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. E05B49/00 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. E05B49/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2015-137493 A (DENSO CORP.) 30 July 2015,	12-13
Y	paragraphs [0013]-[0072], fig. 1-5 (Family: none)	1-11
Y	JP 2014-205978 A (TOYOTA MOTOR CORP.) 30 October 2014, paragraphs [0099], [0124], [0125] & US 2016/0063784 A1, paragraphs [0109], [0134], [0135] & WO 2014/167403 A1 & CN 105103200 A & RU 2015143222 A & BR 112015025586 A2	1-11
Y	JP 2001-336321 A (OMRON CORP.) 07 December 2001, paragraph [0032] (Family: none)	5-11



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See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/032093

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2017-141639 A (OMRON AUTOMOTIVE ELECTRONICS CO., LTD.) 17 August 2017, paragraphs [0022]-[0086], fig. 1-9 & US 2017/0232933 A1, paragraphs [0035]-[0100], fig. 1-9 & DE 102017202126 A1 & KR 10-2017-0095124 A	8-11
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REFERENCES CITED IN THE DESCRIPTION

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