

TITLE OF THE INVENTION

ELEVATOR ROBOT CONTROL SYSTEM AND METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001]

The present invention relates to an elevator robot control system and method, and is suitably applied to, for example, a system in which a robot can control an elevator through various application programming interfaces (APIs).

2. Description of the Related Art

[0002]

In recent years, social implementation of robots that provide various services such as a cleaning robot that performs cleaning, a transport robot that transports a small package, and a guide robot that guides a visitor has been advanced. Among such robots, a robot that provides a service across a plurality of floors in an office building, a commercial building, an apartment, or the like moves to each floor using an elevator. At that time, this type of robot controls the elevator through an API to call a car, designate a destination floor, open and close the door, and the like.

[0003]

However, when an API of an elevator is disclosed,

since the elevator can be controlled remotely, unauthorized access by a malicious third party (hereinafter, this is referred to as a malicious person) is possible, and as a result, there is a possibility that a person or a robot who actually wants to use the elevator cannot use the elevator.

[0004]

Here, as an authentication method for preventing unauthorized access, an authentication method disclosed in JP 2014-21733 A is known. In this authentication method, first, a portable terminal device requests an authentication server device to issue a one-time password (hereinafter, referred to as an OTP), and transmits the issued OTP to a home appliance to be authenticated. Then, the home appliance transmits the received OTP to the authentication server device to request authentication. The authentication server device requests the portable terminal device to confirm whether to permit authentication of the home appliance, and authenticates the home appliance when the portable terminal device permits the authentication.

SUMMARY OF THE INVENTION

[0006]

In order for a robot to use the same elevator as that used by a person, it is required to have higher safety

and prevention capability against unauthorized operation and erroneous operation as compared with home appliances. However, the security measure using an OTP alone cannot completely prevent an unauthorized access to a system from a malicious person in a remote location or an erroneous operation of an elevator by a robot in a remote location. As a result, there has been a possibility that an unexpected situation occurs due to unauthorized access by a malicious person or an erroneous operation by a robot.

[0007]

The present invention is made in view of the above point, and an object of the present invention is to propose a highly reliable elevator robot control system and method capable of preventing occurrence of an unexpected situation caused by an unauthorized access by a malicious person in a remote location or erroneous operation by a robot device in a remote location.

[0008]

In order to achieve the object, according to the present invention, there is provided an elevator robot control system that manages elevator control by a robot when the robot moves in an elevator. The elevator robot control system is provided with an elevator gateway that performs communication between a robot that requests access to an elevator and the elevator. The elevator gateway is

provided with a one-time password issuance part that sends, to a robot, a one-time password that gives a control right of an elevator to the robot in proximity when the robot is in proximity to the elevator, and a control unit that enables control of an elevator in response to a control request for an elevator from a robot when receiving the one-time password and the control request from the robot.

[0009]

Further, in the present invention, there is provided an elevator robot control method that is executed in an elevator robot control system that manages elevator control by a robot when the robot moves in an elevator. The elevator robot control method is provided with, in the elevator robot control system, performing communication between a robot that requests access to an elevator and the elevator by an elevator gateway, a first step in which a one-time password issuance part sends a one-time password that gives a control right of an elevator to a robot in proximity when the robot is in proximity to the elevator, and a second step in which a control unit enables control of an elevator in response to a control request for an elevator from a robot when receiving the one-time password and the control request from the robot.

[0010]

According to the elevator robot control system and

method of the present invention, only a robot device in a state of being in physical proximity to an elevator device can control the elevator device via the elevator gateway.

[0011]

According to the present invention, it is possible to realize a highly reliable elevator robot control system and method capable of preventing occurrence of an unexpected situation caused by unauthorized access by a malicious person in a remote location or a malfunction of a robot device in a remote location.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 is a block diagram illustrating an overall configuration of an elevator robot interlocking system according to a first embodiment;

Fig. 2 is a block diagram illustrating a configuration of a robot device according to a first embodiment;

Fig. 3 is a block diagram illustrating a configuration of an elevator gateway of a second embodiment;

Fig. 4 is a table illustrating a configuration example of a robot management table;

Fig. 5 is a table illustrating a configuration

example of an elevator management table;

Fig. 6 is a table illustrating a configuration example of a login management table;

Fig. 7 is a table illustrating a configuration example of an elevator operation information table;

Fig. 8 is a table illustrating a configuration example of an elevator robot interlocking management table;

Fig. 9 is a sequence diagram illustrating a process of processing in a login phase of elevator robot interlocking processing in the first embodiment;

Fig. 10 is a sequence diagram illustrating a process of processing in an elevator operation mode switching phase of the elevator robot interlocking processing;

Fig. 11 is a sequence diagram illustrating a process of processing in a get-in phase of the elevator robot interlocking processing;

Fig. 12 is a sequence diagram illustrating a process of processing in a destination floor designation and door closing phase of the elevator robot interlocking processing;

Fig. 13 is a sequence diagram illustrating a process of processing in a get-off phase of the elevator robot interlocking processing;

Fig. 14 is a sequence diagram illustrating a process of processing in an interlocking stop phase of the elevator

robot interlocking processing;

Figs. 15A to 15E are diagrams for explaining various periods in the elevator robot interlocking system;

Fig. 16 is a table illustrating a configuration example of a priority management table;

Fig. 17 is a block diagram illustrating an overall configuration of the elevator robot interlocking system according to a second embodiment; and

Fig. 18 is a sequence diagram illustrating a process of processing in a login phase of the elevator robot interlocking processing in the second embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013]

Hereinafter, an embodiment of the present invention will be described in detail with reference to the drawings. Hereinafter, an elevator robot control system will be described as an elevator robot interlocking system that performs not only control such that a robot calls a car of an elevator and opens a door but also interlocking in a wider range.

[0014]

(1) First embodiment

(1-1) Configuration of elevator robot interlocking system according to present embodiment

In Fig. 1, reference numeral 1 indicates an elevator robot interlocking system according to the present embodiment as a whole. The elevator robot interlocking system 1 includes a robot device 2, an elevator gateway 3, and an elevator system 4. The elevator gateway 3 and the elevator system 4 are communicably connected to each other via a wired or wireless network 7 such as the Internet, a local area network (LAN), or a mobile phone line.

[0015]

The robot device 2 is a mobile robot that can move autonomously or along a predetermined route in a building such as an office building, a commercial building, or an apartment where an elevator device 5 is installed, and includes a control device 10, a moving mechanism 11, a short-range wireless communication device 12, a wireless communication device 13, and a self-position estimation sensor 14 as illustrated in Fig. 2.

[0016]

The control device 10 includes a computer device including an arithmetic device 15 and a memory 16. The arithmetic device 15 is a processor that controls the operation of the entire robot device 2, and includes a central processing unit (CPU), a graphics processing unit (GPU), and the like. The memory 16 is a storage device used as a work memory of the arithmetic device 15. Various

programs for causing the robot device 2 to provide a specific service, map information (not illustrated) showing a structure (including an installation position of an elevator device) of each floor in a building in which the host robot device 2 is arranged, and the like are stored in advance in the memory 16.

[0017]

The moving mechanism 11 is a mechanism unit that generates a propulsive force for the robot device 2 to move, and includes a propulsive force generation unit such as a leg mechanism, a wheel, or a crawler that mimics a human leg, and an actuator such as a motor that drives the propulsive force generation unit.

[0018]

The short-range wireless communication device 12 includes a communication device capable of performing radio wave communication of Wi-Fi, Bluetooth, ZigBee, a wireless LAN, or the like, infrared short-range communication of infrared data association (IrDA) or the like, ultrasonic communication, optical communication, or short-range wireless communication combining a plurality of these. The wireless communication device 13 includes a communication device conforming to a predetermined wireless communication standard such as Wi-Fi or a mobile phone line. The robot device 2 can be connected to a network 7 via the wireless

communication device 13.

[0019]

The self-position estimation sensor 14 includes various sensors such as a laser range finder (LRF), a light imaging detection and ranging (LiDAR), a camera, a global positioning system (GPS) receiver, an ultrasonic sensor, an infrared sensor, or a time of flight (ToF) sensor, or a combination of a plurality of these sensors. Based on a self-position estimation result of the self-position estimation sensor 14 and map information in a building in which the robot device 2 is arranged stored in the memory 16, the robot device 2 estimates the current position of the robot device 2 in the building and identifies the elevator device 5 located around the robot device 2 by the arithmetic device 15.

[0020]

The elevator system 4 includes one or a plurality of the elevator devices 5, an edge terminal 6, and an EV usage situation checking sensor 8. Each of the elevator devices 5 includes a car (not illustrated) which the user gets in, an elevating machine that raises and lowers the car in a hoistway, a door opening and closing mechanism that opens and closes a door of the car, a control panel 5A that controls the elevating machine and the door opening and closing mechanism, and the like, and provides a service as

an independent elevator to the user.

[0021]

The edge terminal 6 is a computer device having a function of acquiring operation information indicating an operation state of the elevator device 5 from the control panel 5A of the elevator device 5, transmitting the acquired operation information to the elevator gateway 3 via the network 7 in response to a request, and giving a necessary instruction to the control panel 5A of the corresponding elevator device 5 according to a request given from the elevator gateway 3 via the network 7. For this purpose, the edge terminal 6 includes a network interface (not illustrated) for communicating with the elevator gateway 3 via the network 7.

[0022]

The EV usage situation checking sensor 8 includes various sensors such as a camera, an ultrasonic sensor, an infrared sensor, or a ToF sensor, or a combination of a plurality of these sensors. As sensor information acquired by the EV usage situation checking sensor 8 is transmitted to the edge terminal 6, the edge terminal 6 can grasp the number of people and robots waiting for an elevator in an elevator hall which cannot be grasped only by operation information of the elevator device 5 based on the received sensor information. Note that the edge terminal 6 may

transmit the number of waiting people and robots to the elevator gateway 3 as one piece of operation information of the elevator device 5.

[0023]

The elevator gateway 3 is a relay server that relays communication between the robot device 2 and the elevator system 4 performed via the network 7. As illustrated in Fig. 3, the elevator gateway 3 includes a general-purpose server device including an arithmetic device 20, a storage device 21, a short-range wireless communication device 22, and a network interface 23. Note that the elevator gateway 3 may be installed in the same building as a building in which the elevator device 5 is installed, or may be installed at a distant place like a cloud server.

[0024]

The arithmetic device 20 is a processor that controls the entire operation of the elevator gateway 3, and includes a CPU, a GPU, and the like. Further, the storage device 21 includes, for example, a nonvolatile large-capacity storage device such as a hard disk device or a solid state drive (SSD), a volatile semiconductor memory, and the like. A part of a storage area provided by the storage device 21 is used as a work memory of the arithmetic device 20, and the remaining storage area is used to hold various programs and various pieces of control

information for a long period of time.

[0025]

The short-range wireless communication device 22 is a communication device similar to the short-range wireless communication device 12 (Fig. 2) of the robot device 2, and an antenna (not illustrated) of the short-range wireless communication device 22 is installed in the vicinity of each of the elevator devices 5 or in an elevator hall of each floor. In this manner, the elevator gateway 3 can communicate with the robot device 2 using the short-range wireless communication device 22 only when the robot device 2 is physically in proximity to the elevator device 5. The network interface 23 is a communication device conforming to a communication standard of the network 7. The elevator gateway 3 can communicate with the robot device 2 and the edge terminal 6 of the elevator system 4 via the network 7 via the network interface 23.

[0026]

(1-2) Elevator robot interlocking function

Next, an elevator robot interlocking function mounted on the present elevator robot interlocking system 1 will be described. This elevator robot interlocking function is a function in which the robot device 2 interlocks with the desired elevator devices 5 of the elevator system 4 via the elevator gateway 3 in order to

move to another floor in a building where the robot device 2 is arranged, and controls the elevator device 5 via the elevator gateway 3.

[0027]

In practice, in a case of the present elevator and robot interlocking system 1, the elevator gateway 3 provides an API for controlling the elevator device 5 to the robot device 2. In a case of the present embodiment, such APIs include an OTP issue request API, a login request API, an elevator state acquisition API, an elevator interlocking request API, an elevator control request API, a door control request API, and an elevator interlocking stop API.

[0028]

The OTP issue request API is an API for the robot device 2 to request the elevator gateway 3 to issue an OTP. Note that the OTP issue request API is an API used by the robot device 2 only at the time of communication with the elevator gateway 3 using the short-range wireless communication device 12 (Fig. 2). The other APIs described below are used for communication with the elevator gateway 3 via the network 7 using the wireless communication device 13 (Fig. 2).

[0029]

The login request API is an API for the robot device

2 to request login to the elevator gateway 3 using a robot ID and a password registered in advance in the elevator gateway 3. Further, the elevator state acquisition API is an API for the robot device 2 to request the elevator gateway 3 to provide current operation information of the desired elevator device 5, and the elevator interlocking request API is an API for the robot device 2 to request the elevator gateway 3 to achieve interlocking with the desired elevator device 5.

[0030]

Furthermore, the elevator control request API is an API for the robot device 2 to perform control such as calling a car or designating a destination floor with respect to the desired elevator device 5, and the door control request API is an API for the robot device 2 to control opening and closing of a door of the elevator device 5. Furthermore, the elevator interlocking stop API is an API for the robot device 2 to request the elevator gateway 3 to stop interlocking with the elevator device 5 that is interlocked.

[0031]

Then, the robot device 2 logs in to the elevator gateway 3 using these APIs and controls operation of the desired elevator device 5 by interlocking with the desired elevator device 5 via the elevator gateway 3, so as to move

to a desired floor using the elevator device.

[0032]

As a means for realizing such an elevator robot interlocking function, as illustrated in Fig. 3, the storage device 21 of the elevator gateway 3 stores an elevator robot interlocking (control) program 24, a robot management table 25, an elevator management table 26, a login management table 27, an elevator operation information table 28, an elevator robot interlocking management table 29, and a priority management table 30.

[0033]

The elevator robot interlocking (control) program 24 is a series of programs including a login management part 24A that performs login management of the robot device 2, a one-time password issuance part 24B that issues a one-time password and performs authentication when the robot device 2 requests interlocking with the elevator device 5, and an elevator robot interlocking part 24C that causes the elevator gateway 3 to execute various types of processing for controlling the elevator device 5 in response to a request from the authenticated robot device 2. When the arithmetic device 20 of the elevator gateway 3 executes the elevator robot interlocking (control) program 24, various types of processing as described later are executed as the entire elevator gateway 3.

[0034]

Further, the robot management table 25 is a table used by the elevator gateway 3 to manage the robot device 2 for which control of the elevator device 5 is permitted in advance (registered in advance), and to reject access from a malicious person or the unregistered robot device 2. As illustrated in Fig. 4, the robot management table 25 includes a robot ID field 25A, a robot class field 25B, an ID expiration date field 25C, and a password field 25D. One record (one row in Fig. 4) in the robot management table 25 corresponds to one of the robot devices 2 registered in advance.

[0035]

An identifier (robot ID) unique to the corresponding robot device 2 assigned to the corresponding robot device 2 is stored in the robot ID field 25A, and an expiration date of the robot ID is stored in the ID expiration date field 25C. The robot ID is valid only within an expiration date of the robot ID, and the elevator gateway 3 rejects access from the robot device 2 to which a robot ID whose expiration date has expired is assigned.

[0036]

A class of the robot device 2 is stored in the robot class field 25B. Here, the "class" means a working range of a service provided by the robot device 2. Details of

the "class" will be described later. In a case of the present embodiment, such "classes" include, for example, "cleaning" for cleaning the inside of a building, "transport" for transporting an article in a building, "security" for performing security in a building, and "fire fighting" for performing fire extinguishing work or the like when a fire or the like occurs in a building.

[0037]

In the password field 25D, a password unique to the corresponding robot device 2 set to the corresponding robot device 2 in advance is stored.

[0038]

Therefore, in the case of the example in Fig. 4, for example, it is indicated that, for the robot device 2 to which a robot ID "A1001" is assigned, the class is "transport", the expiration date of the robot ID is "2022/07/27 12:34:56", and the password set for the robot device 2 is "AAAAA".

[0039]

The elevator management table 26 is a table used to manage each of the elevator devices 5 installed in a target building (hereinafter, referred to as a target building), and includes an elevator ID field 26A, an installation place ID field 26B, and a unit number field 26C as illustrated in Fig. 3. One record (one row in Fig. 5) of

the elevator management table 26 corresponds to one of the elevator devices 5 installed in a target building registered in advance.

[0040]

In the elevator ID field 26A, an identifier (elevator ID) unique to the corresponding elevator device 5 assigned to the corresponding elevator device 5 is stored. Further, the installation place ID field 26B stores an identifier (installation place ID) of a place where the elevator device 5 is installed among identifiers indicating places assigned to parts of floors of a target building.

[0041]

Furthermore, in a case where a plurality of the elevator devices 5 are installed at corresponding places in a target building to which corresponding installation place IDs are assigned, a unit number unique to the elevator device 5 assigned to the corresponding elevator device 5 is stored in the unit number field 26C. As the unit number of the elevator device 5, a serial number starting from one is used.

[0042]

Therefore, in the case of the example of Fig. 5, the elevator device 5 to which the elevator ID "A1001" is assigned is the elevator device 5 of which the unit number is "1" among a plurality of the elevator devices 5

installed in a place to which an installation place ID "P3001" is assigned in a target building.

[0043]

The login management table 27 is a table used by the elevator gateway 3 to manage the robot device 2 that logs in to the elevator gateway 3. As illustrated in Fig. 6, the login management table 27 includes a robot ID field 27A, an OTP field 27B, an OTP issue time field 27C, an OTP expiration date field 27D, a final login time field 27E, a login frequency field 27F, and a final interlocking time field 27G. One record (one row in the diagram) of the login management table 27 corresponds to one of the robot devices 2 that logs in at that time.

[0044]

Then, a robot ID of the robot device 2 corresponding to the record is stored in the robot ID field 27A, and an OTP issued last to the robot device 2 is stored in the OTP field 27B. An OTP includes a character string in which an alphanumeric character and a symbol are combined.

[0045]

Further, the date and time when the elevator gateway 3 issues the OTP is stored in the OTP issue time field 27C, and an expiration date of the OTP is stored in the OTP expiration date field 27D. Further, the final login time field 27E stores the date and time when the robot device 2

last logs in to the elevator gateway 3, and the login frequency field 27F stores the total number of times that the robot device 2 has logged in to the elevator gateway 3 up to that point. Furthermore, the final interlocking time field 27G stores the date and time when the robot device 2 is last interlocked with the elevator device 5.

[0046]

Therefore, in the case of the example in Fig. 6, for example, it is indicated that an OTP issued most recently to the robot device 2 with the robot ID of "A1001" is "xxxxxx", issuance date and time of the OTP is "2021/07/27 12:34:00", and expiration date is of the OTP is "2021/07/27 12:35:00", the date and time when the robot device 2 last logs in to the elevator gateway 3 using the OTP is "2021/07/27 12:34:21", the total number of times the robot device 2 logs in up to that point is "11", and the date and time when the robot device 2 is last interlocked with the elevator device 5 is "2021/07/26 18:57:04".

[0047]

In the login management table 27, a record may be prepared (for example, a robot ID of the corresponding robot device 2 already registered is stored in the robot ID field 27A of each record, and the OTP field 27B, the OTP issue time field 27C, the OTP expiration date field 27D, the final login time field 27E, the login frequency field

27F, and the final interlocking time field 27G are blank) in advance corresponding to each of the registered robot devices 2. In this case, after the robot device 2 logs in, necessary information only needs to be appropriately stored in the OTP field 27B, the OTP issue time field 27C, the OTP expiration date field 27D, the final login time field 27E, the login frequency field 27F, and the final interlocking time field 27G of a record corresponding to the robot device 2.

[0048]

The elevator operation information table 28 is a table used for managing and holding operation information which is information on an operation state of each of the elevator devices 5 acquired last by the elevator gateway 3 from the edge terminal 6 of the elevator system 4. As illustrated in Fig. 7, the elevator operation information table 28 includes an elevator ID field 28A, a current floor field 28B, a destination floor field 28C, a moving direction field 28D, a door open and close state field 28E, a robot interlocking state field 28F, and an operation mode field 28G. In the elevator operation information table 28, one record (one row in Fig. 7) corresponds to one of the elevator devices 5 installed in a building.

[0049]

Then, an elevator ID of the corresponding elevator

device 5 is stored in the elevator ID field 28A, and a floor where a car of the elevator device 5 is currently located is stored in the current floor field 28B. In the destination floor field 28C, a destination floor of the car is stored. However, in a case where the car is stopped (in a case where the car is not used at that time), the destination floor field 28C is blank.

[0050]

Furthermore, information ("up" if ascending, "down" if descending, "stopping" if stopped) indicating a moving direction of the car is stored in the moving direction field 28D, and information ("open" if open, "closed" if closed) indicating whether a door of the car is open or closed at that time is stored in the door open and close state field 28E.

[0051]

Furthermore, the robot interlocking state field 28F stores information indicating whether or not the corresponding elevator device 5 interlocks with any one of the robot devices 2 at that time ("interlocking" if interlocking, or blank if not interlocking), and the operation mode field 28G stores an operation mode of the elevator device 5 at that time. There are two operation modes of the elevator device 5: a robot dedicated mode ("dedicated to robot") in which only the interlocking robot

device 2 can be used; and a normal operation mode ("not dedicated to robot") which is not the robot dedicated mode.
[0052]

Therefore, in the case of the example of Fig. 7, for example, for the elevator device 5 to which an elevator ID "E2001" is assigned, the operation mode "dedicated to robot" is set for the operation mode, a current position of a car is the "third" floor, the elevator device 5 moves in the "down" direction toward the "first" floor as a destination floor, a door is in a "closed" state, and the elevator device 5 interlocks with the robot device 2 ("interlocking").

[0053]

The elevator robot interlocking management table 29 is a table used to manage a pair (hereinafter, referred to as an interlocking pair) of the elevator device 5 and the robot device 2 interlocked at that time, and includes an elevator ID field 29A, an interlocking robot ID field 29B, an access token field 29C, and an elevator interlocking request approval time field 29D as illustrated in Fig. 8. In the elevator robot interlocking management table 29, one record (one row in Fig. 8) corresponds to one interlocking pair.

[0054]

An elevator ID of the elevator device 5 constituting

a corresponding interlocking pair is stored in the elevator ID field 29A, and a robot ID of the robot device 2 constituting the interlocking pair is stored in the interlocking robot ID field 29B.

[0055]

Further, as will be described later, an access token for using various APIs notified by the elevator gateway 3 to the robot device 2 at that time is stored in the access token field 29C, and the date and time when the elevator gateway 3 approves interlocking between the robot device 2 and the elevator device 5 in response to an interlocking request through short-range wireless communication from the robot device 2 are stored in the elevator interlocking request approval time field 29D.

[0056]

The access token is a character string in which an alphanumeric character and a symbol are combined and which is notified to the robot device 2 that has authenticated by the elevator gateway 3 to log in. While logging in to the elevator gateway 3, the robot device 2 adds the access token to a request or the like when transmitting the request or the like to the elevator gateway 3. In this manner, the elevator gateway 3 can confirm that the request or the like is from the authenticated robot device 2 on the basis of the access token.

[0057]

Therefore, in the case of the example in Fig. 8, it is indicated that the elevator device 5 with an elevator ID "E2001" interlocks with the robot device 2 with a robot ID "A1001", an access token at the login at that time is "xxxxx", and the elevator gateway 3 approves interlocking between the elevator device 5 and the robot device 2 at "2021/07/27 12:34:31".

[0058]

Note that details of the priority management table 30 will be described later.

[0059]

(1-3) Elevator robot interlocking processing

Next, a process of a series of processing (hereinafter, referred to as elevator robot interlocking processing) performed in the robot device 2, the elevator gateway 3, and the elevator system 4 in order for the robot device 2 to move to another floor of a target building using the elevator device 5 will be described.

[0060]

Note that, hereinafter, a processing subject of various types of processing performed by the robot device 2 will be described as the robot device 2. However, in practice, as a matter of fact, the arithmetic device 15 of the robot device 2 described above with reference to Fig. 2

executes the processing on the basis of a corresponding program stored in the memory 16. Similarly, hereinafter, a processing subject of various types of processing performed by the elevator gateway 3 will be described as the elevator gateway 3. However, in practice, as a matter of fact, the arithmetic device 20 of the elevator gateway 3 described above with reference to Fig. 3 executes the processing based on the elevator robot interlocking (control) program 24 stored in the storage device 21.

[0061]

(1-3-1) Process of processing in login phase

Fig. 9 illustrates a process of a phase (hereinafter, referred to as a login phase) until the robot device 2 is notified of an OTP from the elevator gateway 3 in the elevator robot interlocking processing.

[0062]

First, the elevator gateway 3 periodically acquires operation information of each of the elevator devices 5 from the edge terminal 6 of the elevator system 4 asynchronously with a response to various requests transmitted from the robot device 2 using an API, and stores the acquired operation information in the elevator operation information table 28 (Fig. 7) (S1). A cycle at which the elevator gateway 3 acquires the operation information of each of the elevator devices 5 may be a

fixed value such as a cycle of 20 milliseconds, or may be dynamically changed according to a situation of the robot device 2 or the elevator device 5.

[0063]

The robot device 2 transmits a login request to the elevator gateway 3 via the network 7 using the login request API (S2). At this time, the robot device 2 includes information such as a robot ID, a password, and a class of the robot device 2 in the login request and transmits the login request to the elevator gateway 3 via the network 7. Note that the login request can be transmitted from any place, and can be transmitted even if the robot device 2 is not in a target building. This is to enable the robot device 2 to perform at least acquisition of a state of an elevator described later in an optional place even if the robot device 2 is not in proximity to the target elevator device 5.

[0064]

Upon receiving the login request, the elevator gateway 3 performs login authentication of the robot device 2 based on the robot ID and the class of the robot device 2 and the password included in the login request (S3). Specifically, the elevator gateway 3 refers to the robot management table 25 (Fig. 4) based on the robot ID, the class, and the password included in the login request, and

determines whether or not the robot device 2 is a registered robot device and whether or not the robot ID is within the expiration date.

[0065]

Then, in a case where final determination that the robot device 2 is a robot device that can log in cannot be obtained by the above determination (in a case where the login authentication cannot be performed), the elevator gateway 3 notifies the robot device 2 of the fact.

[0066]

In contrast, in a case where final determination that the robot device 2 is a robot device that can log in is obtained in Step S3 (in a case where the login authentication can be performed), the elevator gateway 3 notifies the robot device 2 of an access token (S4). The access token is a character string for identifying the robot device 2 that has been authenticated, and the robot device 2 then transmits various API requests to the elevator gateway 3 by adding the access token.

[0067]

Further, in a case where the login authentication of the robot device 2 can be performed in Step S3, the elevator gateway 3 stores the current time as a final login time in the final login time field 27E of a record corresponding to the robot device 2 in the login management

table 27, and updates the login frequency field 27F (S5).

[0068]

Further, in a case where the robot device 2 needs to move to a floor above or below the current floor according to service content provided at that time, the robot device 2 moves to in front of the desired elevator device (hereinafter, referred to as the target elevator device) 5 (S6).

[0069]

Then, when the robot device 2 approaches the target elevator device to a distance at which the robot device 2 can communicate with the elevator gateway 3 by short-range wireless communication, the robot device 2 is connected to the elevator gateway 3 by short-range wireless communication via the short-range wireless communication device 12 (Fig. 2) (S7), and transmits an issue request for an OTP (OTP issue request) to the elevator gateway 3 via the short-range wireless communication (S8). At this time, the robot device 2 includes a robot ID and a password of the robot device 2 set in advance and stored in the memory 16 (Fig. 2) and the access token notified from the elevator gateway 3 in Step S4 in the OTP issue request, and transmits the OTP issue request to the elevator gateway 3.

[0070]

Upon receiving such an OTP issue request, the

elevator gateway 3 determines whether or not the robot ID and the password included in the OTP issue request are records stored in the robot ID field 25A and the password field 25D, respectively, among records of the robot management table 25 (Fig. 4), and determines whether or not the access token included in the OTP issue request is a stored access token among records of the elevator robot interlocking management table 29 (Fig. 8). Then, in a case where it can be determined that the record has been registered, the elevator gateway 3 determines that the robot device 2 is a registered robot device, issues an OTP (S9), and notifies the robot device 2 of the issued OTP by short-range wireless communication via the short-range wireless communication device 12 (S10).

[0071]

Note that the OTP issued in Step S9 dynamically changes according to a time at which the OTP issue request from the robot device 2 is received, the number of times of the OTP issue request given up to that point from the robot device 2, and the like, and an expiration date by which the OTP becomes invalid in a certain period of time is set. In a case where the elevator gateway 3 issues an OTP in Step S9, the elevator gateway 3 registers the OTP issued at this time and the issue time and the expiration date of the OTP in the login management table 27 (Fig. 6).

[0072]

Specifically, in a case where the robot device 2 that transmits the OTP issue request has transmitted the OTP issue request in the past, since a record in which the robot ID of the robot device 2 is already stored in the robot ID field 27A exists in the login management table 27, the elevator gateway 3 stores the OTP issued at that time, the issue time of the OTP, and the expiration date of the OTP in each of the OTP field 27B, the OTP issue time field 27C, and the OTP expiration date field 27D of the record.

[0073]

Further, in a case where the robot device 2 that transmits the OTP issue request has not transmitted the OTP issue request in the past, the elevator gateway 3 creates a new record on the login management table 27, stores the robot ID of the robot device 2 in the robot ID field 27A of the record, and stores the OTP issued at that time, the issue time of the OTP, and the expiration date of the OTP in each of the OTP field 27B, the OTP issue time field 27C, and the OTP expiration date field 27D of the record.

[0074]

In contrast, in a case where the record as described above cannot be detected from among records of the robot management table 25 in Step S9, the elevator gateway 3 does not issue an OTP, and notifies the robot device 2 that an

OTP cannot be issued in Step S10 that follows.

[0075]

On the other hand, when the robot device 2 is notified of an OTP from the elevator gateway 3 in Step S10, the robot device 2 accesses the elevator gateway 3 via the network 7 via the wireless communication device 13 (Fig. 2) after the notification.

[0076]

Note that, in the present embodiment, the robot device 2 connected to short-range wireless communication requests the elevator gateway 3 to issue an OTP in Step S8. However, as another embodiment, the elevator gateway 3 may continue to transmit an OTP that changes in a certain period of time through short-range wireless communication (between S9 and S10), so that the robot device 2 that moves to in front of an elevator and is connected to the short-range wireless communication receives the OTP without requesting issuance of the OTP.

[0077]

(1-3-2) Process of processing in elevator operation mode switching phase

In contrast, Fig. 10 illustrates a process of phases (hereinafter, referred to as an elevator operation mode switching phase) in the elevator robot interlocking processing until the robot device 2 that acquires an OTP

from the elevator gateway 3 as described above starts interlocking with the target elevator device 5 and switches an operation mode of the target elevator device 5 to the robot dedicated mode.

[0078]

The robot device 2 transmits an elevator state acquisition request for requesting provision of operation information of the target elevator device 5 to the elevator gateway 3 using the elevator state acquisition API in a state of logging in to the elevator gateway 3 as described above (S11).

[0079]

Note that, unlike other APIs, the elevator state acquisition API can be executed asynchronously with other APIs from the robot device 2 at an optional timing, and does not require interlocking with an elevator by an OTP. In the elevator state acquisition request using the elevator state acquisition API, information (hereinafter, referred to as target elevator device identification information) for identifying the target elevator device 5 such as an access token notified from the elevator gateway 3 in Step S4 of Fig. 9, an installation place ID of the target elevator device 5, and a unit number of the target elevator device 5 is transmitted to the elevator gateway 3.

[0080]

Upon receiving the elevator state acquisition request, the elevator gateway 3 reads operation information of the target elevator device 5 from the elevator operation information table 28 (Fig. 7) and transmits the operation information to the robot device which is the transmission source of the elevator state acquisition request (S12). Specifically, the elevator gateway 3 first identifies a target elevator device with reference to the elevator management table 26 (Fig. 5) based on the installation place ID and the unit number of the target elevator device 5 transmitted from the robot device 2. Further, the elevator gateway reads operation information of the target elevator device 5 from the elevator operation information table 28 using the elevator ID of the identified target elevator device 5, and transmits the read operation information to the robot device 2.

[0081]

Further, the robot device 2 that receives the operation information transmits a request (hereinafter, referred to as the elevator interlocking request) to interlock with the target elevator device 5 to the elevator gateway 3 using the elevator interlocking request API (S13). At this time, the robot device 2 includes the access token acquired in Step S4, the OTP acquired in Step S10, and the target elevator device identification

information described above with respect to Step S11 in the elevator interlocking request, and transmits the request to the elevator gateway 3.

[0082]

Then, when receiving the elevator interlocking request, the elevator gateway 3 identifies the target elevator device 5 based on the target elevator device identification information included in the elevator interlocking request. Further, the elevator gateway 3 refers to the login management table 27 (Fig. 6), determines whether or not the robot device 2 is a robot device that can be interlocked with an elevator since a re-interlocking impossible period to be described later elapses based on the OTP, the expiration date of the OTP, and the final interlocking time included in the elevator link request, and records an elevator interlocking request approval time in a record corresponding to an elevator ID and an interlocked robot ID in the elevator robot interlocking management table 29 (Fig. 8) in a case where the robot device 2 is a robot device that can be interlocked with an elevator. After the above, the elevator gateway 3 refers to the elevator operation information table 28 to determine whether or not the target elevator device 5 is being interlocked with another one of the robot device 2, and if not, transmits an elevator mode

switching request for requesting switching of an operation mode of the target elevator device 5 to the robot dedicated mode to the edge terminal 6 of the elevator system 4 (S14).
[0083]

Thus, when receiving the elevator mode switching request, the edge terminal 6 gives an instruction to switch the operation mode to the robot dedicated mode to the control panel 5A (Fig. 1) of the target elevator device 5. In accordance with this instruction, the control panel 5A of the target elevator device 5 switches the operation mode of the host elevator device 5 to the robot dedicated mode (S15).
[0084]

Then, after giving the instruction to switch the operation mode of the target elevator device 5 to the robot dedicated mode, the edge terminal 6 notifies the elevator gateway 3 that the instruction has been given as a mode switching result (S16). In a case where the operation mode of the target elevator device 5 cannot be switched to the robot dedicated mode due to a failure, maintenance, or the like, the edge terminal 6 notifies the elevator gateway 3 of a mode switching result indicating the fact.
[0085]

After receiving the mode switching result, the elevator gateway 3 transmits a result of the elevator

interlocking request in Step S13 to the robot device 2 as a transmission source (S17). When the elevator gateway 3 confirms that the operation mode of the target elevator device 5 has changed due to periodic information acquisition of the target elevator device 5 in Step 1, the elevator gateway 3 updates operation information of the target elevator device 5 stored in the elevator operation information table 28 together with this (S18).

Specifically, the elevator gateway 3 rewrites a value stored in the robot interlocking state field 28F (Fig. 7) of a record corresponding to the target elevator device 5 in the elevator operation information table 28 to "interlocking" which means that the target elevator device 5 is being interlocked with the robot device 2. Further, the elevator gateway 3 rewrites a value stored in the operation mode field 28G (Fig. 7) of the record to "dedicated to robot" indicating that the operation mode of the target elevator device 5 is the robot dedicated mode.

[0086]

(1-3-3) Process of processing in get-in phase

Fig. 11 illustrates a process of a phase (hereinafter, referred to as the get-in phase) until the robot device 2 calls a car by controlling the target elevator device 5 and gets in the car after the end of the elevator operation mode switching phase described above

with reference to Fig. 10 in the elevator robot interlocking processing.

[0087]

After the end of the elevator operation mode switching phase described above with reference to Fig. 10, the robot device 2 transmits, to the elevator gateway 3, an elevator control request (hereinafter, referred to as an elevator car call control request) requesting that a car of the target elevator device 5 be called up to the floor where the robot device 2 is located using the elevator control request API (S19). At this time, the robot device 2 includes the robot ID of the robot device 2, the access token acquired in Step S9 of Fig. 9, and the target elevator identification information in the elevator car call control request, and transmits the elevator car call control request to the elevator gateway 3.

[0088]

The elevator gateway 3 that receives the elevator car call control request first refers to the elevator robot interlocking management table 29, determines whether or not the target elevator identification information, the robot ID, and the access token included in the elevator car call control request are valid. In a case where it is determined that the target elevator identification information, the robot ID, and the access token are valid,

the elevator gateway 3 identifies the target elevator device 5 on the basis of the target elevator device identification information, and transmits a car call request indicating that a car of the identified target elevator device 5 is to be moved to the floor designated in the elevator car call control request to the edge terminal 6 of the elevator system 4 (S20).

[0089]

Then, the edge terminal 6 that receives the car call request gives an instruction to move the car to the floor designated in the car call request (the floor where the target robot device 2 is located) to the control panel 5A of the target elevator device 5. Thus, the control panel 5A of the target elevator device 5 moves the car to the designated floor by controlling an elevating machine of the host elevator device 5 (S21).

[0090]

When the edge terminal 6 gives an instruction to move the car to the control panel 5A of the target elevator device 5, the edge terminal 6 returns the fact that the instruction has been given to the elevator gateway 3 as a result of the car call request in Step S20 (hereinafter, referred to as a car call result) (S22).

[0091]

Then, the elevator gateway 3 that receives the car

call result transmits the fact that the car call result has been received to the robot device 2 that is the transmission source of the elevator car call control request as a result of the elevator car call control request in Step S19 (hereinafter, referred to as an elevator car call control request result) (S23).

[0092]

The robot device 2 that receives the elevator car call control request result transmits an elevator state acquisition request for requesting provision of operation information of the target elevator device 5 to the elevator gateway 3 using the elevator state acquisition API. Then, the robot device 2 checks whether or not a car of the target elevator device 5 has actually arrived at the floor where the host robot device 2 is located and stopped based on operation information of the target elevator device 5 transmitted from the elevator gateway 3 as a result of the elevator state acquisition request (S24).

[0093]

Further, when the robot device 2 recognizes that the car of the target elevator device 5 is stopped on the floor where the host robot device 2 is located as a result of Step S24, the robot device 2 transmits a door control request (hereinafter, referred to as a door opening control request) for requesting the elevator gateway 3 to open a

door of the target elevator device 5 to the elevator gateway 3 by using the door control request API (S25). At this time, the robot device 2 includes the access token acquired in Step S9 of Fig. 9, the target elevator device identification information, the robot ID of the robot device 2, and a requested door state (open state) in the door opening control request, and transmits the door opening control request to the elevator gateway 3. Note that the door opening control request continues until the robot device 2 gets in the car.

[0094]

When the elevator gateway 3 receives this door control opening request, the elevator gateway 3 first refers to the elevator robot interlocking management table 29, determines whether or not the target elevator identification information, the robot ID, and the access token included in the elevator car call control request are valid. In a case where it is determined that the target elevator identification information, the robot ID, and the access token are valid, the elevator gateway 3 identifies the target elevator device 5 based on the target elevator device identification information included in the door control opening request, and transmits a door opening request for requesting to open the door of the identified target elevator device 5 to the edge terminal 6 of the

elevator system 4 (S26).

[0095]

Then, the edge terminal 6 that receives the door opening request gives an instruction to open the door to the control panel 5A of the target elevator device 5. Thus, the control panel 5A of the target elevator device 5 controls the door opening and closing mechanism of the host elevator device 5 to control the doors of the target elevator device 5 (both the door on the car side and the door on the elevator hall side, which applies similarly hereinafter) (S27).

[0096]

When the edge terminal 6 instructs the control panel 5A to open the door in Step S27, the edge terminal 6 returns the fact to the elevator gateway 3 as a result (hereinafter, referred to as a door opening result) of the door opening request in Step S26 (S28).

[0097]

After receiving the door opening result, the elevator gateway 3 transmits the fact of receiving the door opening result to the robot device 2 as a transmission source as a result (hereinafter, referred to as a door opening control request result) of the door opening control request in Step S25 (S29). After that, the robot device 2 that receives the door opening control request result

acquires operation information of the target elevator device 5 from the elevator gateway 3 in the same manner as in Step S24 (S30), and when confirming that the door of the target elevator device 5 is opened based on the acquired operation information, the robot device 2 moves into the car of the target elevator device 5 (S31).

[0098]

(1-3-4) Process of processing in destination floor designation and door closing phase

Fig. 12 illustrates a process of a phase (hereinafter, referred to as a destination floor designation and door closing phase) until the robot device 2 designates a destination floor of the car and further closes the door of the target elevator device 5 after the end of the get-in phase described above with reference to Fig. 11 in the elevator robot interlocking processing.

[0099]

When the robot device 2 gets in the car of the target elevator device 5 as described above, the robot device 2 first transmits an elevator control request (hereinafter, referred to as an elevator destination floor designation control request) for designating a destination floor to the elevator gateway 3 using the elevator control request API (S32). At this time, the robot device 2 includes the access token acquired in Step S9 of Fig. 9,

the robot ID of the robot device 2, the target elevator device identification information, and information such as a destination floor of the target elevator device 5 in the elevator destination floor designation control request, and transmits the elevator destination floor designation control request to the elevator gateway 3.

[0100]

The elevator gateway 3 that receives the elevator destination floor designation control request refers to the elevator robot interlocking management table 29, determines whether or not the target elevator identification information, the robot ID, and the access token included in the elevator car call control request are valid. In a case where it is determined that the target elevator identification information, the robot ID, and the access token are valid, the elevator gateway 3 identifies the target elevator device 5 on the basis of the target elevator device identification information included in the elevator destination floor designation control request, and transmits a destination floor setting request for requesting to set the destination floor of the car of the identified target elevator device 5 as the destination floor to the edge terminal 6 of the elevator system 4 (S33).

[0101]

Then, the edge terminal 6 that receives the destination floor setting request gives an instruction to set the destination floor designated in the destination floor setting request as the destination floor of the car to the control panel 5A of the target elevator device 5. Thus, the control panel 5A of the target elevator device 5 sets the floor instructed by the edge terminal 6 at that time as the destination floor of the car of the host elevator device 5 (S34).

[0102]

When notifying the control panel 5A of the target elevator device 5 of the destination floor, the edge terminal 6 returns the fact of notification to the elevator gateway 3 as a result (hereinafter, referred to as a destination floor setting result) of the destination floor setting request in Step S33 (S35).

[0103]

Then, the elevator gateway 3 that receives the destination floor setting result transmits the fact of receiving the destination floor setting result as a result (hereinafter, referred to as an elevator destination floor designation control request result) of the elevator destination floor designation control request in Step S32 to the robot device 2 that is a transmission source of the elevator destination floor designation control request

(S36).

[0104]

The robot device 2 that receives the elevator destination floor designation control request result transmits a door control request (hereinafter, referred to as a door closing control request) to release the door opening request of the target elevator device 5 to the elevator gateway 3 using the door control request API (S37). At this time, the robot device 2 includes the access token acquired in Step S9 of Fig. 9, the robot ID of the robot device 2, the target elevator device identification information, and a requested door state (closed state) in the door closing control request, and transmits the door closing control request to the elevator gateway 3. Even if the robot device 2 does not notify the door closing control request, in a case where the control panel 5A of the elevator device 5 determines that it is safe to close the door with a sensor mounted on the elevator device 5, the door is automatically closed by the control panel 5A.

[0105]

The elevator gateway 3 that receives the door closing control request refers to the elevator robot interlocking management table 29, determines whether or not the target elevator identification information, the robot

ID, and the access token included in the elevator car call control request are valid. In a case where it is determined that the target elevator identification information, the robot ID, and the access token are valid, the elevator gateway 3 identifies the target elevator device 5 based on the target elevator device identification information included in the door closing control request, and transmits a door control request for notifying to stop the door opening request of the identified target elevator device 5 to the edge terminal 6 of the elevator system 4 (S38).

[0106]

Then, the edge terminal 6 that receives the door closing request gives an instruction to stop continuing opening of the door to the control panel 5A of the target elevator device 5. The control panel 5A of the target elevator device 5 closes the door of the target elevator device 5 by, for example, controlling the door opening and closing mechanism after determining that it is safe without any problem to close the door by various sensors of the host elevator device 5 (S39).

[0107]

When notifying the control panel 5A of the target elevator device 5 of the door closing control request, the edge terminal 6 transmits the fact of notification to the

elevator gateway 3 as a result (hereinafter, referred to as a door closing result) of the door closing request in Step S38 (S40). After that, the control panel 5A of the target elevator device 5 controls an elevating machine or the like to move the car of the host elevator device 5 to the floor set in Step S34 (S42).

[0108]

Meanwhile, the elevator gateway 3 that receives the door closing result transmits a result (hereinafter, referred to as a door closing control request result) of the door closing control request in Step S37 to the robot device 2 as a transmission source (S41).

[0109]

(1-3-5) Process of processing in get-off phase

Fig. 13 illustrates a process of a phase (hereinafter, referred to as a get-off phase) until the robot device 2 gets off the car of the target elevator device 5 after the end of the destination floor designation and door closing phase described above with reference to Fig. 12 and then closes the door of the target elevator device 5 in the elevator robot interlocking processing.

[0110]

After getting on the car of the target elevator device 5 as described above, the robot device 2 acquires operation information of the target elevator device 5 at

regular intervals by a method similar to that Step S11 in Fig. 10 (S43).

[0111]

Then, when recognizing that the car of the target elevator device 5 has arrived at the destination floor on the basis of the acquired operation information, the robot device 2 transmits a door opening control request for requesting opening of the door of the target elevator device 5 to the elevator gateway 3 using the door control request API (S44). At this time, the robot device 2 includes the access token acquired in Step S9 of Fig. 9, the robot ID of the robot device 2, the target elevator device identification information, and a requested door state (open state) in the door opening control request, and transmits the door opening control request to the elevator gateway 3. The door opening control request continues until the robot device 2 gets off the car.

[0112]

As a result, after the above, processes similar to that in Steps S26 to S30 in Fig. 11 are executed between the elevator gateway 3, the edge terminal 6 of the elevator system 4, and the robot device 2 (S45 to S49). Then, when the robot device 2 confirms that the door of the target elevator device 5 is opened based on the operation information of the target elevator device 5 acquired in

Step S49, the robot device 2 moves out of the car of the target elevator device 5 (gets off the car of the target elevator device 5) (S50).

[0113]

After the above, the robot device 2 transmits a door closing control request for releasing the door opening request of the target elevator device 5 to the elevator gateway 3 using the door control request API (S51). At this time, the robot device 2 includes the access token acquired in Step S9 of Fig. 9, the robot ID of the robot device 2, the target elevator device identification information, and a requested door state (closed) in the door closing control request, and transmits the door closing control request to the elevator gateway 3. Even if the robot device 2 does not notify the door closing control request, in a case where the control panel 5A of the elevator device 5 determines that it is safe to close the door with a sensor mounted on the elevator device 5, the door is automatically closed by the control panel 5A.

[0114]

As a result, after the above, processing similar to that in Steps S38 to S40 in Fig. 12 is executed between the elevator gateway 3, the edge terminal 6 of the elevator system 4, and the robot device 2 (S52 to S54). In this manner, the door of the target elevator device 5 is closed,

and the door closing control request result indicating that the door closing control request has been notified to the target elevator device 5 is transmitted from the elevator gateway 3 to the robot device 2 (S55).

[0115]

(1-3-6) Process of processing in interlocking stop phase

Fig. 14 illustrates a process of a phase (hereinafter, referred to as an interlocking stop phase) until the robot device 2 stops the interlocking with the target elevator device 5 after the end of the get-off phase described above with reference to Fig. 13 in the elevator robot interlocking processing.

[0116]

After the robot device 2 gets off the target elevator device 5 and notifies the door closing request as described above, the robot device 2 transmits an interlocking stop request for requesting to stop interlocking with the target elevator device 5 to the elevator gateway 3 using an elevator interlocking stop request API (S56). At this time, the robot device 2 includes the access token acquired in Step S9 of Fig. 9, the robot ID of the robot device 2, and the target elevator device identification information in the interlocking stop request, and transmits the interlocking stop request to the

elevator gateway 3.

[0117]

Upon receiving the interlocking stop request, the elevator gateway 3 identifies the target elevator device 5 based on the target elevator device identification information included in the interlocking stop request, refers to the elevator robot interlocking management table 29, determines whether or not the target elevator identification information, the robot ID, and the access token included in the elevator car call control request are valid. In a case where it is determined that the target elevator identification information, the robot ID, and the access token are valid, the elevator gateway 3 refers to the elevator operation information table 28 (Fig. 7), and determines whether or not the identified target elevator device 5 is being interlocked with the robot device 2. Then, in a case where the target elevator device 5 is being interlocked with the robot device 2, the elevator gateway 3 transmits an elevator mode switching request for requesting switching of the operation mode of the target elevator device 5 to a non-robot dedicated mode to the edge terminal 6 of the elevator system 4 (S57).

[0118]

Thus, when receiving the elevator mode switching request, the edge terminal 6 gives an instruction to switch

the operation mode to the non-robot dedicated mode from the robot dedicated mode to the control panel 5A of the target elevator device 5. In accordance with this instruction, the control panel 5A of the target elevator device 5 switches the operation mode of the host elevator device 5 to the non-robot dedicated mode (S58).

[0119]

Then, when the edge terminal 6 gives an instruction to switch the operation mode of the target elevator device 5 to the non-robot dedicated mode to the control panel 5A of the target elevator device 5, the edge terminal 6 notifies the elevator gateway 3 of a mode switching result indicating that the instruction has been given (S59).

[0120]

Upon receiving the mode switching result, the elevator gateway 3 transmits the mode switching result as a result of the elevator interlocking stop request in Step S56 to the robot device 2 as a transmission source (S60).

[0121]

Together with the above, the elevator gateway 3 updates operating information of the target elevator device 5 stored in the elevator operation information table 28 and updates the elevator robot interlocking management table 29 (Fig. 8) (S61).

[0122]

Specifically, the elevator gateway 3 rewrites a value stored in the operation mode field 28G of a record corresponding to the target elevator device 5 in the elevator operation information table 28 to "non-robot dedicated" indicating that the operation mode of the target elevator device 5 is the non-robot dedicated mode.

Further, the elevator gateway 3 deletes a value ("interlocking") stored in the robot interlocking state field 28F of the record. The elevator gateway 3 deletes a record corresponding to the robot device 2 in the elevator robot interlocking management table 29 (Fig. 8).

[0123]

Furthermore, in the case of the present embodiment, in a case where the robot device 2 stops interlocking with the elevator device 5, the robot device 2 is assumed to have logged out of the elevator gateway 3. Therefore, the elevator gateway 3 updates a record corresponding to the robot device 2 in the login management table 27 (Fig. 6) assuming that the robot device has logged out (S62). Specifically, the elevator gateway 3 deletes all pieces of information stored in the OTP field 27B (Fig. 6) and the OTP issue time field 27C (Fig. 6) of a record corresponding to the robot device 2 in the login management table 27, and updates the final login time field 27E (Fig. 6) and the final interlocking time field 27G (Fig. 6).

[0124]

The above completes the elevator robot interlocking processing.

[0125]

(1-4) Various periods in present elevator robot interlocking system

Fig. 15 illustrates various valid periods in the elevator robot interlocking system 1 of the present embodiment. As illustrated in Fig. 15, in the present elevator robot interlocking system 1, an OTP, a login state, an access token, a period in which the robot device 2 can control the elevator device 5 after approval of an elevator interlocking request, and an elevator interlocking state are provided with valid periods.

[0126]

Further, in the elevator robot interlocking system 1, a period (hereinafter, referred to as a re-interlocking impossible period) in which the robot device 2 cannot interlock with the elevator device 5 again is set with respect to a period from when the robot device 2 stops interlocking with the elevator device 5 to when the robot device 2 interlocks with the elevator device 5 again. Hereinafter, the valid period and the re-interlocking impossible period will be described.

[0127]

(1-4-1) Access token valid period

Fig. 15A illustrates a valid period (hereinafter, referred to as an access token valid period) P1 of an access token. The access token valid period P1 is provided for the purpose of preventing a state in which the robot device 2 logs in the elevator gateway 3 for a long time from being maintained, and preventing the target elevator device 5 from becoming unavailable as the robot device 2 becomes uncontrollable in a car of the target elevator device 5 due to communication abnormality, abnormality of the robot device 2, or the like. When the access token valid period P1 elapses, the valid period is extended or the interlocking state is forcibly disconnected according to an interlocking state of the robot device 2 and the elevator device 5 at an elapsed time point.

[0128]

For example, when the access token valid period P1 elapses in a state where the robot device 2 is not in a car of the target elevator device 5, the access token becomes invalid, and login of the robot device 2 to the elevator gateway 3 also becomes invalid.

[0129]

Meanwhile, when the access token valid period P1 elapses in a state where the robot device 2 is in a car of the target elevator device 5, the elevator gateway 3

extends the access token valid period. This is to prevent a situation in which the robot device 2 cannot perform door control of the target elevator device 5 and is left in the car when the access token becomes invalid.

[0130]

Note that extension time of the access token valid period P1 may be a certain period such as five minutes, for example, or may be dynamically switched according to a usage situation of the elevator device 5 and a situation of the robot device 2 in the car. Even when the access token valid period P1 elapses, a login state of the robot device 2 to the elevator gateway 3 is maintained within an elevator control valid period P4 to be described later.

[0131]

(1-4-2) OTP valid period

Fig. 15B illustrates a valid period (hereinafter, referred to as an OTP valid period) P2 of an OTP. The OTP valid period P2 is a period in which the robot device 2 can be interlocked with the elevator device 5 for which the robot device 2 desires a control request using an OTP issued by the elevator gateway 3 in response to the OTP issue request from the robot device 2.

[0132]

The OTP valid period P2 may be a certain period such as one minute, or may be dynamically changed by the

elevator gateway 3 according to an environment. Even within the OTP valid period P2, an OTP is invalidated when the robot device 2 finishes interlocking with the target elevator device 5 using the OTP.

[0133]

(1-4-3) Timer until car call after approval of elevator interlocking request

Fig. 15D illustrates a period (hereinafter, referred to as a timer until a car call after approval of the elevator interlocking request) P3 during which the robot device 2 can be controlled to call a car of the elevator device 5 after approval of the elevator interlocking request. The timer P3 until a car call after approval of the elevator interlocking request is set for the purpose of prompting immediate control of the target elevator device 5 when the robot device 2 is interlocked with the elevator device 5.

[0134]

When the elevator control request from the robot device 2 is not received within the timer P3 until a car call after approval of the elevator interlocking request, the elevator gateway 3 cancels an interlocking state between the robot device 2 and the corresponding elevator device 5 and releases the elevator device 5.

[0135]

(1-4-4) Elevator control valid period

In Fig. 15D, the valid period (hereinafter, referred to as an elevator controllable valid period) P4 of a state of being interlocked with and able to control an elevator is a period in which an interlocking state of the robot device 2 and the elevator device 5 can be maintained, and is set in order to avoid the interlocking state of the robot device 2 and the elevator device 5 from being maintained for a long time due to communication abnormality, abnormality of the robot device 2, or the like.

[0136]

In a case where, after approval of interlocking of the robot device 2 and the elevator device 5, the interlocking is not stopped within certain time (an interlocking stop request is not given from the robot device 2), the elevator gateway 3 forcibly cancels the interlocking state of the robot device 2 and the elevator device 5 and releases the elevator device 5.

[0137]

(1-4-5) Re-interlocking impossible period

Fig. 15F illustrates a re-interlocking impossible period P5. The re-interlocking impossible period P5 is a period in which the elevator gateway 3 rejects an elevator interlocking request for the elevator device 5 even if the

robot device 2 transmits the elevator interlocking request to the elevator gateway 3 within certain time after transmitting an interlocking stop request. However, even within the re-interlocking impossible period P5, the robot device 2 can log in to the elevator gateway 3, acquire an OTP from the elevator gateway 3, and acquire operating information of the elevator device 5 from the elevator gateway 3.

[0138]

The re-interlocking impossible period P5 is set for the purpose of preventing the robot device 2 from repeatedly requesting to be interlocked with the same elevator device 5 which causes a person or another robot device 2 to be unable to use the elevator device 5. The re-interlocking impossible period P5 may be certain time such as one minute, and may be dynamically changed according to a usage situation of the elevator device 5 or another elevator device 5 requested to be re-interlocked, the number of the robot devices 2 operating in the same building, and the like.

[0139]

As an example of the usage situation of the elevator device 5, continuous stop time of the elevator device 5, the number of people staying in an elevator hall in contact with the elevator device 5 acquired by the EV usage

situation checking sensor 8 mounted on the elevator system 4, and the like can be considered. In a case where continuous stop time of the elevator device 5 is short or in a case where the number of people staying in an elevator hall in contact with the elevator device 5 is large, it is conceivable that the elevator gateway 3 makes the re-interlocking impossible period P5 longer by certain time, and conversely, in a case where the continuous stop time of the elevator device 5 is long or in a case where the number of people staying in the elevator hall in contact with the elevator device 5 is small, the elevator gateway 3 makes the re-interlocking impossible period P5 shorter by certain time.

[0140]

(1-5) Priority processing of elevator interlocking request

In the present elevator robot interlocking system 1, in a case where a plurality of the robot devices 2 are arranged in the same building, priority is set in advance for each of the robot devices 2 according to a class of the robot device 2 and a usage situation of the elevator device 5.

[0141]

Here, the "class" means a working range of a service provided by the robot device 2 as described above, and

includes "cleaning", "transport", "security", "guidance", "fire fighting", and the like. Further, the "usage situation" of the elevator device 5 here is a combination of a type of a building in which the elevator device 5 is arranged (office building, commercial building, apartment, or the like) and division between day and night (daytime or nighttime), and examples of the usage situation include "daytime in an office building", "nighttime in an office building", "daytime in a commercial building", "nighttime in a commercial building", "daytime in an apartment", and "nighttime in an apartment". Other than the above, the usage situation may be dynamically changed using a usage situation acquired by the EV usage situation checking sensor 8 included in the elevator system 4.

[0142]

The elevator gateway 3 stores and manages the priority according to the usage situation of the elevator device 5 for each class of the robot device 2 in the priority management table 30 illustrated in Fig. 16.

[0143]

In practice, as illustrated in Fig. 16, the priority management table 30 includes a plurality of records (rows in Fig. 16) corresponding to different usage situations. Each record is classified into a plurality of service fields 30A corresponding to each class of the robot device

2, and the priority of a service corresponding to each of the service fields 30A is stored.

[0144]

Therefore, in the case of the example of Fig. 16, for example, with respect to "office building" with a normal degree of congestion, the priorities in "daytime" of a "cleaning" robot, a "transport" robot, a "security" robot, a "guidance" robot, and a "fire fighting" robot are set to "4", "2", "4", "3", and "1", respectively, and the priorities in "nighttime" are set to "3", "4", "2", "2", and "1", respectively. This indicates that the priority of the "transport" robot is set to be higher than that of the "cleaning" robot and the "security" robot during the daytime, and the priorities of the "cleaning" robot and the "security" robot are set to be higher than that of the "transport" robot during the nighttime.

[0145]

Further, regarding the "office building" in crowded time, the priorities of "daytime" of the "cleaning" robot, the "transport" robot, the "security" robot, the "guidance" robot, and the "fire fighting" robot are set to "4", "3", "4", "3", and "1", respectively, and the priorities of "nighttime" is set to "4", "4", "4", "3", and "1", respectively. In general, the priority of the robot can be lowered to prioritize human use.

[0146]

Other than the above, a template of the priority management table 30 for an apartment or a commercial building may be prepared, and a priority order corresponding to a use situation of a building to be actually used may be designated.

[0147]

In the present embodiment, the priorities are classified according to "daytime", "at work", "lunch break", "at leaving work", and "nighttime". However, in order to operate the robot according to a use situation of a specific building, a time zone may be specified and set more precisely.

[0148]

Further, the elevator gateway may be provided with a priority update unit that temporarily lowers the priority of a specific robot and lowers an elevator use frequency by the specific robot in a case where the specific robot uses an elevator a predetermined number of times that is determined so that the specific robot frequently using the elevator does not disturb the use by a person or another robot.

[0149]

Furthermore, in the present embodiment, the degrees of congestion are classified into "normal" and "crowded

time" to determine the priority. However, more degrees of congestion may be defined to determine appropriate priorities according to the degree of congestion. The priority update unit may receive event information such as congestion of an elevator hall obtained from a sensor such as a security camera, congestion of an elevator obtained from a control panel, holiday information obtained from schedule information, and an event schedule performed on a specific floor, and change the priority of a robot that identifies a floor on which an event has occurred in real time.

[0150]

In the case of the present embodiment, in a case where a plurality of the robot devices 2 are arranged in the same building, the elevator gateway 3 that receives the elevator interlocking request from a first one of the robot devices 2 and then is given the elevator interlocking request from a second one of the robot devices 2 within a certain time range before the start of interlocking between the elevator device 5 and the first one of the robot devices 2 refers to the priority management table 30 and preferentially processes the elevator interlocking request from the robot device 2 having the highest priority.

[0151]

This means that in a case where no priority is set

to the robot device 2, the elevator gateway 3 always approves interlocking of the robot device 2 and the elevator device 5 in order of reception of the elevator interlocking requests. However, in such specifications, depending on the content of a service provided by the interlocking robot device 2 and the usage situation of the interlocking elevator device 5, the degree of satisfaction of a person who desires to use the elevator device 5 or a person who expects a service provided by another robot device 2 may not be increased. Therefore, the above processing is to avoid this. Hereinafter, such a function of the elevator gateway 3 will be described more specifically.

[0152]

As described above with reference to Fig. 10, in a case where the elevator interlocking request is received from the robot device 2 (Step S13), the elevator gateway 3 requests the edge terminal 6 (Fig. 1) of the elevator system 4 (Fig. 1) to switch the operation mode of the target elevator device 5 (Step S14). After that, when a mode switching result indicating that the operation mode of the target elevator device 5 has been switched to the robot dedicated mode is given from the edge terminal 6 (Step S16), the elevator gateway 3 notifies the robot device 2 as a transmission source of a result of the elevator

interlocking request (Step S17).

[0153]

During the above processing, another one of the robot devices 2 can acquire a state of the elevator device (the target elevator device described above) 5 from the elevator gateway 3. At this time, the status representing an interlocking state of the elevator device 5 with the robot device 2 acquired from the elevator gateway 3 by the another robot device 2 is any one of "blank" indicating that the elevator device 5 is not in interlocked, "in interlocking operation with other robot devices", "(after elevator interlocking request) in interlocking operation standby", "(after elevator control request) interlocking", and "(in case of re-interlocking impossible period) in interlocking temporary stop".

[0154]

Here, "(after elevator interlocking request) in interlocking operation standby" represents a state in which, after a certain one of the robot devices 2 transmits the elevator interlocking request for requesting interlocking with the elevator device 5 in the elevator gateway 3, the robot device 2 is not yet interlocked with the elevator device 5. In the case of the present embodiment, in a case where a desired state of the elevator device 5 acquired from the elevator gateway 3 is "(after

elevator interlocking request) in interlocking operation standby", the robot device 2 can transmit an elevator interlocking request for requesting interlocking with the elevator device 5 to the elevator gateway 3.

[0155]

Then, in a case where, after the elevator interlocking request for requesting interlocking with a certain one of the elevator devices 5 is received from a certain one of the robot devices 2, the elevator interlocking request for the elevator device 5 is given from another one of the robot devices 2 having a higher priority than the certain one of the robot devices 2 before the mode switching result from the edge terminal 6 of the elevator system 4 is received, the elevator gateway 3 gives priority to the elevator interlocking request from the robot device 2 having a higher priority, and transmits the operation mode switching result transmitted from the edge terminal 6 of the elevator system 4 to the robot device 2 having a higher priority.

[0156]

In this way, the robot device 2 with a high priority can transmit the elevator control request to the target elevator device 5 before the robot device 2 with a low priority, which has previously transmitted the elevator interlocking request to the elevator gateway 3, and can be

interlocked with the elevator device 5.

[0157]

(1-6) Effect of present embodiment

As described above, in the elevator robot interlocking system 1 of the present embodiment, when the OTP issue request is given from the robot device 2 by using short-range wireless communication, the elevator gateway 3 transmits an OTP to the robot device 2 by using short-range wireless communication in response to the OTP issue request, and the robot device 2 is interlocked with an elevator that the robot device 2 desires to control via the network 7 by using the OTP.

[0158]

Therefore, in the elevator robot interlocking system 1, only when the robot device 2 is in a state of being physically in proximity to the elevator device 5, the robot device 2 acquires an OTP, becomes in an interlocking state with and can control the elevator device 5 by using the acquired OTP. Therefore, it is possible to prevent unauthorized access from a malicious person in a remote location and erroneous operation of the elevator device 5 by the robot device 2 in a remote location. In this manner, according to the present embodiment, it is possible to prevent occurrence of an unexpected situation caused by unauthorized access by a malicious person in a remote

location or erroneous operation by the robot device 2 in a remote location, and it is possible to construct the highly reliable elevator robot interlocking system 1. Further, since it is possible to prevent erroneous operation of the elevator device 5 by the robot device 2 in a remote location in this manner, it is also possible to reduce the influence on the use by a person when the robot device 2 uses the elevator device 5 used by the person.

[0159]

Furthermore, in the present elevator robot interlocking system 1, priority is set for each class of the robot device 2, and login of the robot device 2 of a class with a high priority is prioritized. Therefore, it is possible to allow the robot device 2 of an appropriate class to preferentially use the elevator device 5 according to a time zone and a situation. Therefore, it is possible to prioritize a service by the robot device 2 of an optimum class for the time zone and the situation.

[0160]

(2) Second embodiment

As a second embodiment, the elevator gateway 3 may change the re-interlocking impossible period P5 in Fig. 15 based on the priority management table 30 in Fig. 16 illustrated in the first embodiment.

[0161]

For example, the re-interlocking impossible period P5 is set so as to be inversely proportional to the priority set in the priority management table 30. When the re-interlocking impossible period P5 is one minute under the condition where the priority is set to "1" in the priority management table 30, the re-interlocking impossible period P5 is set to be 1/4 of the condition where the priority is "1", that is, 15 seconds under the condition where the priority is set to "4".

[0162]

Further, the re-interlocking impossible period P5 may be dynamically changed according to a usage situation of the elevator device 5 or another elevator device 5 requested to be re-interlocked, the number of the robot devices 2 operating in the same building, and the like. As an example of the usage situation of the elevator device 5, continuous stop time of the elevator device 5, the number of people staying in an elevator hall in contact with the elevator device 5, and the like can be considered. In a case where continuous stop time of the elevator device 5 is short or in a case where the number of people staying in an elevator hall in contact with the elevator device 5 is large, it is conceivable that the elevator gateway 3 makes the re-interlocking impossible period P5 longer by certain

time, and conversely, in a case where the continuous stop time of the elevator device 5 is long or in a case where the number of people staying in the elevator hall in contact with the elevator device 5 is small, the elevator gateway 3 makes the re-interlocking impossible period P5 shorter by certain time. As a means for grasping a usage situation of the elevator device 5, a security camera or the like may be used as the EV usage situation checking sensor 8. It is conceivable that the edge terminal 6 installed in the same elevator system 4 analyzes an image of the security camera to grasp the number of people staying in the elevator hall.

[0163]

(3) Third embodiment

Fig. 17 illustrates an elevator robot interlocking system 40 according to a third embodiment in which the same reference numerals are assigned to portions corresponding to those in Fig. 1. The elevator robot interlocking system 40 includes a robot device 41, an elevator gateway 42, a proximity detector 43, and the elevator system 4, which are communicably connected via the network 7.

[0164]

The robot device 41 is configured similarly to the robot device 2 of the first embodiment or the second

embodiment except that the short-range wireless communication device 12 described above with reference to Fig. 2 is not included and that, accordingly, the elevator gateway 42 is logged in by a different method.

[0165]

The elevator gateway 42 is configured similarly to the elevator gateway 3 of the first embodiment or the second embodiment except that the elevator gateway 3 does not have the short-range wireless communication device 22 described above with reference to Fig. 3 and that, accordingly, an OTP is notified to the robot device 41 by a different method.

[0166]

The proximity detector 43 is a detector that detects the robot device 41 approaching the elevator device 5, and is installed corresponding to each of the elevator devices 5 or installed for each elevator hall. The proximity detector 43 detects the proximity of the robot device 41 to the corresponding elevator device 5 (including the elevator device 5 installed in an elevator hall at an installation destination) by, for example, photographing with a camera, a beacon using Bluetooth, Wi-Fi positioning, positioning by a radio frequency identification (RFID) tag, sound wave positioning, radar positioning, ultra wide band (UWB) positioning, or a positioning method combining these.

However, the proximity detector 43 may detect the proximity of the robot device 41 to the elevator device 5 by a method other than the above.

[0167]

Fig. 18 illustrates a process of an OTP issue phase until the elevator gateway 42 issues an OTP in proximity to the elevator device 5 with which the robot device 41 desires to be interlocked in the elevator robot interlocking processing executed in the elevator robot interlocking system 40 of the present embodiment.

[0168]

Although not illustrated in Fig. 18, the elevator gateway 42 periodically acquires operation information of each of the elevator devices 5 from the edge terminal 6 of the elevator system 4 asynchronously with a response to various requests transmitted from the robot device 41 using an API, and stores and manages the acquired operation information in the elevator operation information table 28 (Fig. 7) (see the description of Step S1 in Fig. 9), which is similar to the first embodiment or the second embodiment.

[0169]

In the elevator robot interlocking system 40 of the present embodiment, first, the robot device 41 transmits a login request to the elevator gateway 42 via the network 7

using the login request API (S70). At this time, the robot device 41 includes information such as a robot ID, a password, and a class of the robot device 41 in the login request and transmits the login request to the elevator gateway 42 via the network 7. Note that the login request can be transmitted from any place, and can be transmitted even if the robot device 41 is not in a target building. This is to enable the robot device 41 to perform at least acquisition of a state of an elevator in an optional place even if the robot device 41 is not close to the target elevator device 5.

[0170]

After the above, similarly to the first embodiment or the second embodiment, the elevator gateway 42 performs login authentication of the robot device 41 (S71), notifies the robot device 41 of an access token (S72), and updates an access state (S73).

[0171]

Subsequently, the robot device 41 that is going to move to another floor moves to the front of the elevator device 5 that is going to be used for the floor movement based on a positioning result of the self-position estimation sensor 14 (see Fig. 2) and map information of each floor in a building in which the robot device 41 is arranged stored in the memory 16 (Fig. 2) (S74).

[0172]

At this time, when detecting the proximity of the robot device 41 to the corresponding elevator device 5 (S75), the proximity detector 43 transmits a notification (hereinafter, referred to as a proximity detection notification) indicating that the proximity of the robot device 41 is detected to the elevator gateway 42 via the network 7 (Fig. 17) (S76). Then, when the above-described proximity detection notification is given from the proximity detector 43, the elevator gateway 42 internally sets a proximity status flag indicating that the robot device 41 is in proximity (S77).

[0173]

After the above, in a case where the robot device 41 moves away from the elevator device 5 without transmitting the OTP issue request to the elevator gateway 42 as described later, the proximity detector 43 transmits a notification indicating that the robot device 41 is not in proximity to the corresponding elevator device 5 to the elevator gateway 42. Then, in this case, the elevator gateway 42 clears the proximity status flag.

[0174]

When being in proximity to the desired elevator device 5 within a predetermined distance, the robot device 41 transmits the OTP issue request to the elevator gateway

42 via the network 7 via the wireless communication device 13 (see Fig. 2) using the OTP request API (S78). At this time, the robot device 41 includes the robot ID of the robot device 41 itself and a predetermined password set in advance and stored in the memory 16 (see Fig. 2) of the control device 10 (see Fig. 2) in the OTP issue request, and transmits the OTP issue request to the elevator gateway 42.

[0175]

Upon receiving the OTP issue request, the elevator gateway 42 refers to the proximity status flag, and rejects the issuance of an OTP and notifies the robot device 41 of the rejection in a case where the proximity status flag is not set.

[0176]

In contrast, in a case where the proximity status flag is set, the elevator gateway 42 searches for a record in which the robot ID and the password included in the OTP issue request are stored in the robot ID field 25A and the password field 25D from records of the robot management table 25 (Fig. 4). Then, in a case where such a record can be detected, the elevator gateway 42 determines that the robot device 41 is a registered robot device, issues an OTP (S79), and notifies the robot device 41 of the issued OTP via the network interface 23 (see Fig. 3) via the network 7

(S80).

[0177]

After the above, the robot device 41 notifies the elevator gateway 42 of the interlocking request with the elevator device 5 that the robot device 41 desires to control together with the acquired OTP in the same manner as Steps S13 to S18 in Fig. 10 using the OTP. When receiving the elevator interlocking request, the elevator gateway 42 sets the robot device 41 that is a transmission source of the interlocking request and the target elevator device 5 to be in an interlocking state if there is no problem in the same manner as Step S14 in Fig. 10.

[0178]

After the above, the processing performed between the robot device 41, the elevator gateway 42, and the elevator system 4 is similar to that in the process described above with reference to Figs. 10 to 14, and thus the description of the processing will be omitted.

[0179]

As described above, in the elevator robot interlocking system 40 of the present embodiment, only when the proximity detector 43 detects the proximity of the robot device 41 to the elevator device 5, the elevator gateway 42 issues an OTP to the robot device 41 in response to the OTP issue request from the robot device 41.

[0180]

Therefore, in the elevator robot interlocking system 40, only when the robot device 2 is in a state of being physically in proximity to the elevator device 5, the robot device 2 acquires an OTP, is interlocked with and can control the elevator device 5 by using the acquired OTP. Therefore, it is possible to prevent unauthorized access from a malicious person in a remote location and erroneous operation of the elevator device 5 by the robot device 2 in a remote location. In this manner, even in the present embodiment, as in the first embodiment or the second embodiment, it is possible to prevent occurrence of an unexpected situation caused by unauthorized access by a malicious person in a remote location or erroneous operation by the robot device in a remote location, and it is possible to construct the highly reliable elevator robot interlocking system 40.

[0181]

(4) Other embodiments

In the first and third embodiments described above, the case where the priority of the robot device is set as described above with reference to Fig. 16 is described, but the present invention is not limited to this, and various other settings can be applied. For example, the priority

may be set depending on whether or not a person and a robot device can get in the same car, whether or not a plurality of robot devices can get in the same car, and the like.

[0182]

For example, in a case where a robot device that is not allowed to get in the same car with a person or another robot device and a robot device that is allowed to get in the same car with a person or another robot device coexist even if the service contents to be provided are the same "transport", the priority of the robot device that is allowed to get in the same car with a person or another robot device may be set higher than that of the robot device that is not allowed to get in the same car. In this way, transportation efficiency by the robot device can be improved.

[0183]

Further, for example, in a case where a security guard in a security room in an office building finds a suspicious person and wants to cause a security robot device to go to a site as soon as possible, the security guard sets the priority of the security robot device to be high, so that it is possible to cause the security robot device to be interlocked with an elevator device more preferentially than other robot devices. Similarly, in a commercial building, in a case where an external image

analysis system detects stagnation of flow of people with a security camera or the like, an external system may automatically raise the priority of a security robot device temporarily in order to prompt staying people to move or promptly dispatch the security robot device to the site for the purpose of prompting people to line up.

[0184]

In the first and third embodiments describe the case where the priority is set to the robot device 2 in advance according to a class of the robot device 2 and a usage situation of the elevator device 5, and the elevator gateway 3 prioritizes the elevator interlocking request from the robot device 2 having a higher priority. However, the present invention is not limited to this. The configuration may be such that, for example, when a disaster such as a fire occurs, the elevator interlocking request from the robot device 2 that provides general services such as "cleaning" and "transport" is not accepted, and the elevator interlocking request only from the "fire fighting" robot device 2 is accepted. In this manner, in the event of a disaster, it is possible to allow only the "fire fighting" robot device 2 to use the elevator device 5 regardless of the priority of the robot device 2.

[0185]

Furthermore, the first and third embodiments

describe the case where various periods (various valid periods and re-interlocking impossible period) described above with respect to Fig. 15 are uniform regardless of the priority or the class. However, the present invention is not limited to this. The configuration may be such that, for example, a part or all of the various periods are changed according to the priority or the class by lengthening the re-interlocking impossible period of the "guidance" robot during daytime while shortening the re-interlocking impossible period of the "guidance" robot during nighttime.

INDUSTRIAL APPLICABILITY

[0186]

The present invention can be widely applied to elevator robot interlocking systems having various configurations in which a robot device controls an elevator device by being interlocked with the elevator device.

What is claimed is:

1. An elevator robot control system that manages elevator control by a robot when the robot moves in an elevator, the elevator robot control system comprising an elevator gateway that performs communication between a robot that requests access to an elevator and the elevator, wherein

the elevator gateway includes

a one-time password issuance part that sends, to a robot, a one-time password that gives a control right of an elevator to the robot in proximity when the robot is in proximity to the elevator, and

a control unit that enables control of an elevator in response to a control request for an elevator from a robot when receiving the one-time password and the control request from the robot.

2. The elevator robot control system according to claim 1, wherein

the elevator gateway includes a priority table that stores movement priority information of a robot, and

the control unit refers to the priority table and permits elevator control based on priority of a robot that makes a control request.

3. The elevator robot control system according to

claim 2, wherein the movement priority information is determined based on a service type provided by a robot.

4. The elevator robot control system according to claim 2, wherein the movement priority information is determined based on a time at which a robot moves in an elevator.

5. The elevator robot control system according to claim 2, further comprising a priority update unit that receives detection of an event when the event is detected from a sensor that detects security information, and raises a priority order of a robot that provides a service associated with the event in the priority table.

6. The elevator robot control system according to claims 2 to 5, wherein the priority information is a re-interlocking impossible period indicating time until an access request can be accepted next after an access request is once accepted from a robot.

7. The elevator robot control system according to claim 2, wherein the one-time password is valid until the control unit enables interlocking with the elevator.

8. An elevator robot control method that is executed in an elevator robot control system that manages elevator control by a robot when the robot moves in an elevator, the elevator robot control method comprising, in the elevator robot control system:

performing communication between a robot that requests access to an elevator and the elevator by an elevator gateway;

a first step in which a one-time password issuance part sends a one-time password that gives a control right of an elevator to a robot in proximity when the robot is in proximity to the elevator; and

a second step in which a control unit enables control of an elevator in response to a control request for an elevator from a robot when receiving the one-time password and the control request from the robot.