

[Name of Document] DESCRIPTION

[Title of Invention] ELEVATOR APPARATUS AND METHOD FOR
CONTROLLING ELEVATOR APPARATUS

[Technical Field]

[0001]

The present invention relates to an elevator apparatus and a method for controlling the elevator apparatus, and particularly relates to a group-management elevator apparatus that collectively manages a plurality of elevators and to a method for controlling the group-management elevator apparatus.

[Background Art]

[0002]

Relatively large buildings adopt systems in which a plurality of elevators are installed to increase the user transport capacity of elevators and in which an optimum elevator is selected for providing a service from among the plurality of elevators in response to a hall call registration. As the scale of a building increases, the number of elevators installed therein increases, and thus the plurality of elevators are appropriately managed by a group-management system so as to improve service, for example, to reduce the waiting time of a user (see, for example, PTLs 1 to 3).

[0003]

PTL 1 describes the following. "A destination floor input through a hall destination floor registration device is registered as a hall call and a car is assigned to the hall call. For each car, a predicted value of the number of waiting users on a specific floor at the time point when the car reaches the specific floor in a predetermined direction is determined. If the predicted value of the number of waiting users determined for a certain car is larger than or equal to a predetermined value, the car is operated in an operation mode in which the car does not respond to a hall call made on a floor other than the specific floor."

[0004]

PTL 2 describes the following. "A service index value of each floor associated with a circumstantial change in the number of users in a hall or the number of users in a car from the time point of assignment of a hall call is calculated on the basis of hall information, in-car information, and assignment information. The assignment of the hall call is changed on the basis of the calculated service index value."

[0005]

PTL 3 describes the following. "Priority is given to the service for a user whose individual average waiting time is longer than a total average waiting time that is obtained by averaging the waiting times of all users."

[Citation List]

[Patent Literature]

[0006]

[PTL 1] Japanese Unexamined Patent Application
Publication No. 2015-67371

[PTL 2] Japanese Unexamined Patent Application
Publication No. 2015-67432

[PTL 3] Japanese Unexamined Patent Application
Publication No. 5-78045

[Summary of Invention]

[Technical Problem]

[0007]

In the related art described in PTL 1, a service on a specific floor is preferentially provided in accordance with the number of waiting users on the specific floor, but the waiting time of each waiting user is not considered and no consideration is given to a long wait from when a call is registered to when a car arrives. Thus, long-wait evaluation is performed on the basis of only the waiting time of a user who registers a call first, which may cause a situation where priority is given to a floor where a smaller number of users are waiting for long over a floor where a larger number of users are waiting for long in a case where a long wait occurs on a plurality of floors, for example, in a lunch hour. This may cause a problem that an average

waiting time in the entire building increases.

[0008]

In the related art described in PTL 2, assignment of a car is changed in consideration of a change in the number of users in a hall or in a car. Thus, for a user waiting for long, the car assigned to the user is changed after a long wait, which may increase impatience. The related art described in PTL 3 is a technique for preferentially providing a service to a user who is waiting for a longer time than a total average waiting time. In this technique, however, a priority service is provided to a plurality of floors, which may cause another long wait.

[0009]

An object of the present invention is to provide an elevator apparatus capable of suppressing the number of long-waiting users and improving service by evaluating an overall long-wait ratio on the basis of an excessively long waiting time beyond a long-wait judgment time and the number of long-waiting users, and a method for controlling the elevator apparatus.

[Solution to Problem]

[0010]

To solve the above-described problems, the configuration described in the claims is adopted, for example.

The present application includes a plurality of solutions to the above-described problems, one of which is an elevator apparatus that assigns one of in-service units providing a service to each of users, on the basis of an origin floor and a destination floor of the user and the number of users, the origin floor, the destination floor, and the number of users being registered before entering an elevator. The elevator apparatus includes a prediction section that predicts a distribution of waiting times of all the users on the basis of arrival-at-hall times of the users and predicted arrival times of the individual in-service units to be assigned, an evaluation section that evaluates a long-wait ratio by calculating, on the basis of the distribution of waiting times of all the users, the number of waiting users whose waiting time exceeds a long-wait judgment time and a long waiting time beyond the long-wait judgment time, for each of the in-service units to be assigned in each hall, and a to-be-assigned unit determination section that assigns one of the in-service units providing a service to each of the users, on the basis of an evaluation result generated by the evaluation section.

[Advantageous Effects of Invention]

[0011]

According to the present invention, a distribution of waiting times of all users is predicted on the basis of

arrival-at-hall times of the users and predicted arrival times of individual in-service units to be assigned, and an overall long-wait ratio is evaluated on the basis of the distribution of waiting times of all users, and thereby the number of long-waiting users can be suppressed and service can be improved.

The problems, configurations, and advantages other than those described above will become apparent from the following description of embodiments.

[Brief Description of Drawings]

[0012]

[Fig. 1] Fig. 1 is an example of a configuration diagram schematically illustrating the system configuration of a group-management elevator apparatus according to a first embodiment of the present invention.

[Fig. 2] Fig. 2 is an example of a configuration diagram schematically illustrating the system configuration of a group-management elevator apparatus according to a second embodiment of the present invention.

[Fig. 3] Fig. 3 is an example of a flowchart illustrating a flow of operation of a hall call duration measurement timer according to Example 1.

[Fig. 4] Fig. 4 is an example of a flowchart illustrating a flow of a process of predicting the waiting times of individual users according to Example 2.

[Fig. 5] Fig. 5 is an example of a diagram illustrating a number of long-waiting users recording time table (N).

[Fig. 6] Fig. 6 is an example of a diagram illustrating a cumulative number of long-waiting users table (K, J, I).

[Fig. 7] Fig. 7 is an example of a diagram illustrating a number of long-waiting users by time table (K, J, I, N).

[Fig. 8] Fig. 8 is an example of a flowchart illustrating a flow of a process of performing long-wait evaluation on each floor according to Example 3.

[Fig. 9] Fig. 9 is an example of a diagram illustrating a long-wait judgment time by traffic demand table (N).

[Fig. 10] Fig. 10 is an example of a flowchart illustrating a flow of a process of performing long-wait evaluation on each floor according to Example 4.

[Fig. 11] Fig. 11 is an example of a flowchart illustrating a flow of a process of performing long-wait evaluation on each floor according to Example 5.

[Fig. 12] Fig. 12 is an example of an explanatory diagram illustrating display of a predicted number of long-waiting users according to Example 6.

[Fig. 13] Fig. 13 is an example of an explanatory diagram illustrating display of a predicted number of long-waiting users according to Example 7.

[Fig. 14] Fig. 14 is an example of an explanatory diagram illustrating display of the number of long-waiting users and

the degree of fatigue caused by long wait in the past according to Example 8.

[Fig. 15] Fig. 15 is an example of an explanatory diagram illustrating display of past impatience indexes according to Example 9.

[Fig. 16] Fig. 16 is an example of an explanatory diagram illustrating display of a long-wait status at registration according to Example 10.

[Fig. 17] Fig. 17 is an example of an explanatory diagram illustrating display of a long-wait status before registration according to Example 11.

[Fig. 18] Fig. 18 is an example of an explanatory diagram illustrating a long-wait judgment time setting according to Example 12.

[Description of Embodiments]

[0013]

Hereinafter, modes for carrying out the present invention (hereinafter referred to as "embodiments") will be described in detail with reference to the drawings. The present invention is not limited to the embodiments. Various numeric values and so forth according to the embodiments are merely examples, and various modification examples and application examples within the technical concept of the present invention are also included in the scope of the present invention.

[0014]

<Elevator Apparatus According to First Embodiment of Invention>

An elevator apparatus according to a first embodiment of the present invention is a group-management elevator apparatus having a configuration of a group-management system that collectively manages a plurality of elevators.

[0015]

[System Configuration]

Fig. 1 is an example of a configuration diagram schematically illustrating the system configuration of a group-management elevator apparatus according to a first embodiment of the present invention. As illustrated in Fig. 1, a group-management elevator apparatus 10 according to this embodiment has a system configuration including an elevator part 1, a group-management control part (group-management control device) 2, a hall call registration part (hall call registration device) 3, and an operation information display part (operation information display device) 4.

[0016]

(Elevator Part)

The elevator part 1 includes n (an integer of 2 or more) elevators 11_1, 11_2, ..., and 11_n and unit controllers 12_1, 12_2, ..., and 12_n that control the

elevators 11_1, 11_2, ..., and 11_n, respectively.

Hereinafter, the individual elevators 11_1, 11_2, ..., and 11_n of the elevator part 1 may be referred to as in-service units or simply units. The n elevators 11_1, 11_2, ..., and 11_n (the first unit 11_1, the second unit 11_2, ..., and the n-th unit 11_n) are collectively managed under the control of the group-management control part 2, and a unit (elevator) for a user which is optimum from the viewpoint of waiting time and so forth is assigned via the unit controller 12_1, 12_2, ..., or 12_n.

[0017]

Each of the elevators 11_1, 11_2, ..., and 11_n of the elevator part 1 has a known configuration in which, for example, a car 111 and a counter weight 112 that are installed in a hoistway are connected to both ends of a main rope 113. In each of the elevators 11_1, 11_2, ..., and 11_n, the main rope 113 is wound around a sheave 114 and a pulley 115 of a hoisting machine (not illustrated).

[0018]

(Group-Management Control Part)

The group-management control part 2 includes a usage information acquisition section 20, a usage information prediction section 21, a waiting time evaluation section 22, an interval evaluation section 23, a long-wait evaluation section 24, an overall evaluation section 25, a to-be-

assigned unit determination section 26, and an operation information management section 27. The group-management control part 2 including these functional sections (20 to 27) collectively manages the n elevators 11_1, 11_2, ..., and 11_n so as to assign a unit (elevator) for a user which is optimum from the viewpoint of waiting time and so forth.

[0019]

The usage information acquisition section 20 acquires elevator usage information (described below) that is registered with the hall call registration part 3 by a user before entering an elevator, and provides the acquired elevator usage information to the usage information prediction section 21. The usage information prediction section 21 predicts a waiting time from when each user arrives at a hall to when an in-service unit arrives and the number of waiting users on each floor on the basis of the elevator usage information provided from the usage information acquisition section 20 and operation information on each in-service unit provided from the operation information management section 27.

[0020]

The waiting time evaluation section 22 evaluates a waiting time on each floor on the basis of the waiting time of each user and the number of waiting users on each floor predicted by the usage information prediction section 21 and

the operation information on each in-service unit. The interval evaluation section 23 evaluates the equality of time intervals of each in-service unit in the future, on the basis of the waiting time of each user and the number of waiting users on each floor predicted by the usage information prediction section 21 and the operation information on each in-service unit. The long-wait evaluation section 24 calculates a long waiting time and the number of long-waiting users on each floor on the basis of the waiting time of each user and the number of waiting users on each floor predicted by the usage information prediction section 21 and the operation information on each in-service unit, and evaluates a long-wait ratio. Here, the long-wait ratio is the ratio of elevator users whose waiting time exceeds a predetermined long-wait judgment time.

[0021]

The overall evaluation section 25 performs overall evaluation to determine which in-service unit is optimum to be assigned from the viewpoint of waiting time and so forth, on the basis of the various evaluation values obtained from the waiting time evaluation section 22, the interval evaluation section 23, the long-wait evaluation section 24, and so forth. The to-be-assigned unit determination section 26 assigns an in-service unit having the best (highest) overall evaluation value generated by the overall evaluation

section 25. The operation information management section 27 creates operation information on the basis of the in-service unit to be assigned (hereinafter referred to as a "unit to be assigned") determined by the to-be-assigned unit determination section 26 and the elevator usage information predicted by the usage information prediction section 21, and outputs the operation information to a mobile terminal or the operation information display part 4 installed in a hall, a monitoring room, or the like.

[0022]

The above-described functional sections (20 to 27) of the group-management control part 2 can be implemented by software when a processor interprets and executes a program for implementing the individual functions. In this case, information including the program that implements the individual functions of the functional sections (20 to 27), a table, and a file can be recorded in a recording device such as a memory, a hard disk, or an SSD, or on a recording medium such as an IC card, an SD card, or a DVD.

Furthermore, some or all of the individual functional sections (20 to 27) of the group-management control part 2 can be implemented by hardware, for example, by designing them on an integrated circuit.

[0023]

(Hall Call Registration Part/Operation Information Display

Part)

The hall call registration part 3 includes an operation section including a numeric keypad and a display section and is installed in an elevator hall. With the hall call registration part 3, elevator usage information including at least the origin floor and destination floor of each user is registered through an operation by the user. For example, if the user registers a fifth floor as a destination floor by using the hall call registration part 3 installed in a hall on a first floor, the first floor is registered as an origin floor and the fifth floor is registered as a destination floor.

[0024]

The operation information display part 4 is a display part of a mobile terminal owned by a user of an elevator or a display device installed in a hall, a monitoring room, or the like. The operation information display part 4 presents (provides) operation information to a user in response to output of the operation information, which is created on the basis of an assigned unit and elevator usage information, from the operation information management section 27. The details of the operation information presented to the user will be described below.

[0025]

In the above-described group-management elevator

apparatus 10 according to the first embodiment, attention is focused on a long wait, which is a major cause of dissatisfaction of elevator users, and a fact that the dissatisfaction is proportional to a long waiting time and the number of long-waiting users, and a long-wait ratio is evaluated by predicting a long waiting time beyond a long-wait judgment time and the number of long-waiting users.

[0026]

Specifically, a distribution of waiting times of all users is predicted on the basis of arrival-at-hall times (registration times) of the users and predicted arrival times of individual units to be assigned. The distribution of waiting times represents the waiting times of all users in individual halls and can be calculated from registration times of destination floors of the individual users, hall call durations (waiting times) on individual floors, and predicted arrival times of individual in-service units at the individual floors. On the basis of the distribution of waiting times of all users, the number of long-waiting users whose waiting time exceeds a long-wait judgment time and the long waiting time beyond the long-wait judgment time are calculated for each unit to be assigned in each hall, so as to evaluate a long-wait ratio.

[0027]

Accordingly, even if a long wait frequently occurs on a

plurality of floors, service can be preferentially provided to a floor where the waiting time is long and there are many long-waiting users. Thus, dissatisfaction of elevator users caused by long waits can be reduced and service can be improved. In other words, the waiting times of individual users are considered and thus higher priority is given to a floor where it is predicted that there are more long-waiting users among floors where a long wait occurs. Accordingly, an increase in waiting time of more long-waiting users can be suppressed.

[0028]

For easy understanding, more specific description will be given with numeric values. For example, it is assumed that ten users are waiting for the arrival of an in-service unit on the first floor and that one user among the ten users is waiting for about 180 seconds whereas the nine other users arrive at the hall within about 15 seconds before the estimated arrival time of the in-service unit. That is, in the distribution of waiting times on the first floor, the waiting time of one user among the ten users is long and the waiting times of the nine other users are short. On the other hand, it is assumed that ten users are waiting for the arrival of an in-service unit on the third floor and that the distribution of waiting times there is that all the ten users or nearly ten users are waiting for about 180

seconds.

[0029]

In the case of such a distribution of waiting times on the individual floors, according to the group-management elevator apparatus 10 according to the first embodiment, the waiting times of individual users are considered, and thereby high priority is given to the third floor over the first floor and accordingly an increase in the waiting times of more long-waiting users can be suppressed. Accordingly, service for more users can be improved and also the average waiting time and long-wait ratio of the entire building can be reduced.

[0030]

Furthermore, according to the group-management elevator apparatus 10 according to the first embodiment, the arrival-at-hall times (registration times) of the individual users are stored/saved and learned. Thus, learning and simulation can be performed more accurately, and an accurate value of long-wait judgment time can be calculated for each traffic flow.

[0031]

In the group-management elevator apparatus 10 according to the first embodiment, elevator usage information that is registered before entering an elevator is acquired from the hall call registration part 3, but the embodiment is not

limited thereto. For example, the elevator usage information can be acquired via ID authentication at a security gate installed away from a hall, detection information generated by an arrival-at-building detector or arrival-at-hall detector such as a sensor installed in a building, or an information terminal carried by each user.

[0032]

Hereinafter, a description will be given of a group-management elevator apparatus according to a second embodiment, which is an elevator apparatus having a configuration for acquiring elevator usage information from detection information generated by a device for specifying each individual at the entrance or hall of a building.

[0033]

<Elevator Apparatus According to Second Embodiment of Invention>

The elevator apparatus according to the second embodiment of the present invention is a group-management elevator apparatus that acquires elevator usage information from detection information generated by a device that specifies each individual at the entrance or hall of a building under the control of a group-management system that collectively manages a plurality of elevators. As a result of acquiring elevator usage information at the entrance or hall of the building, the elevator usage information can be

detected earlier than in the case of the group-management elevator apparatus 10 according to the first embodiment, and thus the accuracy of various evaluations described below can be enhanced.

[0034]

[System Configuration]

Fig. 2 is an example of a configuration diagram schematically illustrating the system configuration of the group-management elevator apparatus according to the second embodiment of the present invention. As illustrated in Fig. 2, a group-management elevator apparatus 50 according to this embodiment has a system configuration including an elevator part 1, a group-management control part (device) 2, a user management part (device) 5, an arrival-at-building detection part (device) 6, an arrival-at-hall detection part (device) 7, and a display part (device) 8.

[0035]

(Elevator Part/Group-Management Control Part)

The elevator part 1 has the same configuration as that of the group-management elevator apparatus 10 according to the first embodiment. The group-management control part 2 includes a waiting time evaluation section 22, an interval evaluation section 23, a long-wait evaluation section 24, an overall evaluation section 25, a to-be-assigned unit determination section 26, an operation information

management section 27, and a usage information management section 28. The usage information management section 28 manages predicted data about the waiting times of individual users and the number of waiting users on individual floors, received from the user management part 5.

[0036]

The waiting time evaluation section 22 evaluates the waiting times on individual floors on the basis of the waiting times of individual users and the number of waiting users on individual floors managed by the usage information management section 28, and operation information on the individual in-service units. The interval evaluation section 23 evaluates the equality of time intervals at which the individual in-service units in the future are operated, on the basis of the waiting times of individual users and the number of waiting users on individual floors managed by the usage information management section 28, and operation information on the individual in-service units. The long-wait evaluation section 24 calculates the long waiting times and the numbers of long-waiting users on individual floors on the basis of the waiting times of individual users and the number of waiting users on individual floors managed by the usage information management section 28, and operation information on the individual in-service units, and evaluates a long-wait load.

[0037]

The overall evaluation section 25 performs overall evaluation to determine which in-service unit is the optimum unit to be assigned from the viewpoint of waiting time and so forth, on the basis of the various evaluation values obtained from the waiting time evaluation section 22, the interval evaluation section 23, the long-wait evaluation section 24, and so forth. The to-be-assigned unit determination section 26 assigns an in-service unit having the best (largest) overall evaluation value generated by the overall evaluation section 25. The operation information management section 27 creates operation information on the basis of the unit to be assigned determined by the to-be-assigned unit determination section 26 and the elevator usage information predicted by the usage information prediction section 21 and transmits the operation information to the user management part 5.

[0038]

The above-described functional sections (22 to 28) of the group-management control part 2 can be implemented by software when a processor interprets and executes a program for implementing the individual functions. Furthermore, some or all of the individual functional sections (22 to 28) of the group-management control part 2 can be implemented by hardware, for example, by designing them on an integrated

circuit.

[0039]

(Arrival-At-Building Detection Part/Arrival-At-Hall
Detection Part/Display Part)

The arrival-at-building detection part 6 is formed of a sensor, such as a camera installed in the entrance of the building, and detects the arrival of a user at the building. The arrival-at-hall detection part 7 is formed of a sensor, such as a camera installed in an elevator hall, and detects the arrival of a user at the hall. The arrival-at-building detection part 6 and the arrival-at-hall detection part 7 each detect the arrival of a user and at the same time acquire elevator usage information such as a destination floor of the user and usage information about the user. The usage information about the user can be acquired from various types of information terminals such as an ID card or a mobile terminal. The display part 8 is a display part of a mobile terminal owned by a user or a display device installed in a hall, a monitoring room, or the like, and presents (provides) operation information about an elevator to the user.

[0040]

(User Management Part)

The user management part 5 includes a usage information acquisition section 51, a usage information prediction

section 52, a usage information management section 53, an operation information acquisition section 54, a usage information transmission section 55, and a display information notification section 56. The usage information acquisition section 51 acquires elevator usage information, such as a destination floor of a user, from the arrival-at-building detection part 6 or the arrival-at-hall detection part 7. The usage information prediction section 52 predicts the waiting times of individual users and the number of waiting users in individual floors on the basis of the elevator usage information acquired by the usage information acquisition section 51 and the elevator operation information acquired by the operation information acquisition section 54 from the group-management control part 2.

[0041]

The usage information management section 53 records and manages current elevator usage information and the elevator usage information predicted by the usage information prediction section 52. The operation information acquisition section 54 receives the operation information transmitted from the operation information management section 27 of the group-management control part 2. The usage information transmission section 55 transmits the elevator usage information predicted by the usage

information prediction section 52 to the group-management control part 2. The display information notification section 56 outputs elevator operation information and elevator usage information to the display part 8 installed in a hall, a monitoring room, or the like.

[0042]

The above-described functional sections (51 to 56) of the user management part 5 can be implemented by software when a processor interprets and executes a program for implementing the individual functions. Furthermore, some or all of the individual functional sections (51 to 56) of the user management part 5 can be implemented by hardware, for example, by designing them on an integrated circuit.

[0043]

As described above, the group-management elevator apparatus 50 according to the second embodiment is configured to manage, with the user management part 5, user information and elevator usage information acquired from various information terminals such as an ID card and a mobile terminal and a sensor such as a camera. That is, part of the function of the group-management control part 2 is executed by the user management part 5. Accordingly, change in the system of the group-management control part 2 can be minimized. Furthermore, elevator usage information and elevator operation information can be displayed on a

mobile terminal owned by each user or on a digital signage under the management of the user management part 5 on the basis of the elevator usage information and the elevator operation information acquired from the group-management control part 2.

[0044]

Next, a description will be given of specific examples of a method for controlling the group-management elevator apparatus 10 according to the first embodiment or the group-management elevator apparatus 50 according to the second embodiment having the above-described configuration. In the following examples, it is assumed that the individual functional sections (20 to 28) of the group-management control part 2 and the individual functional sections (51 to 56) of the user management part 5 are implemented by software and that the individual functions of the functional sections (20 to 28 and 51 to 56) are executed under the control of a central processing unit (CPU). Note that the control is not limited to that of the CPU.

[0045]

[Example 1]

Example 1 is an example of the operation of a hall call duration measurement timer in the usage information prediction section 21 in Fig. 1 and the usage information prediction section 52 in Fig. 2. The hall call duration

measurement timer is a timer for measuring a waiting time of a user in an elevator hall. The hall call duration measurement timer is provided on each floor for each service direction. If there are sufficient system resources, the timer may be provided for each in-service unit.

[0046]

Here, if timers are provided for individual users to measure their waiting times, the waiting times of the individual users can be easily measured. However, this will cause a problem of enormous system resources. For example, if there are 1000 users, 1000 timers need to be provided. Thus, the waiting times of individual users are measured by using a hall call duration measurement timer that has conventionally been adopted.

[0047]

Fig. 3 is an example of a flowchart illustrating a flow of operation of the hall call duration measurement timer according to Example 1.

[0048]

First, the CPU judges whether or not the hall call duration measurement timer on each floor is in operation (step S1). If the timer is not in operation (inactivated) on a certain floor (YES in S1), the CPU judges whether or not there is a new hall call on the certain floor (step S2). If there is a new hall call (YES in S2), the CPU activates

the hall call duration measurement timer on the target floor where the timer is to be activated (step S3). If there are no new hall calls (NO in S2), the process returns to step S1.

[0049]

If the CPU judges in step S1 that the timer is already operating on a certain floor (NO in S1), the CPU judges whether or not all the in-service units assigned to the certain floor have completed the services on the floor (step S4). If the services have been completed (YES in S4), there are no waiting users and thus the CPU stops the timer that is in operation (step S5). If the services have not been completed (NO in S4), there is a waiting user and thus the process returns to step S1 and the timer continues operating.

[0050]

Here, if the hall call duration measurement timer is stopped when there are no more assigned units and if there are waiting users beyond the transport capacity, the users who are not able to take an elevator are counted again starting from zero seconds. Thus, the number of users who are not able to take an elevator is predicted in advance so that the hall call duration measurement timer does not count from zero seconds when those users perform reregistration again with the hall call registration part 3 illustrated in Fig. 1. The number of users who are not able to take an elevator may be estimated on the basis of the number of

users who exit/enter each in-service unit on each floor or may be estimated on the basis of a detection result generated by a sensor provided in each hall.

[0051]

[Example 2]

Example 2 is an example of predicting the waiting times of individual users by using a hall call duration measurement timer. Fig. 4 is an example of a flowchart illustrating a flow of a process of predicting the waiting times of individual users according to Example 2.

[0052]

First, the CPU judges whether or not the hall call duration measurement timer on the floor I in the direction J is in operation (step S11). If the hall call duration measurement timer is not in operation on the floor (NO in S11), the CPU resets a number of long-waiting users by time table (see Fig. 7) and a cumulative number of long-waiting users table (see Fig. 6) of the floor described below (step S12) and the process returns to step S11. The cumulative number of long-waiting users table stores the total number of users on the floor.

[0053]

If the hall call duration measurement timer is in operation (YES in S11), the CPU judges whether or not a hall call has occurred on the floor I in the direction J and

whether or not the unit K has been assigned (step S13). If a new hall call has not occurred (NO in S13), the process returns to step S11.

[0054]

If a new hall call has occurred (YES in S13), the CPU adds the number of new users to the cumulative number of long-waiting users table (K, J, I) on the floor where the new hall call has occurred of the in-service unit assigned by the to-be-assigned unit determination section 26 (step S14). Here, the number of new users is normally one, but may be two or more if usage in a group is designated or the number of users in a group is input.

[0055]

Subsequently, the CPU judges whether or not the hall call duration on the floor where the new hall call has occurred is equal to or less than the time indicated in the number of long-waiting users recording time table (N) in Fig. 5 (step S15), and repeats the judgment until the duration becomes equal to or less than the time indicated in the table (N) (NO in S15). Fig. 5 is an example of a diagram illustrating the number of long-waiting users recording time table (N). N represents the number of users per unit time. In the number of long-waiting users recording time table (N), the hall call duration in which the number of long-waiting users is to be recorded is set in units of ten seconds, for

example, 10 seconds when $N = 0$ whereas 20 seconds when $N = 1$.

[0056]

As an example, if a new hall call of one user in the up direction on the first floor is input at the time point of hall call duration of 15 seconds and if the first unit is assigned, the following process is performed in steps S14 and S15. That is, in step S14, one user is added to the cumulative number of long-waiting users table (0, 0, 0) in Fig. 6. Fig. 6 is an example of a diagram illustrating the cumulative number of long-waiting users table (K, J, I).

[0057]

In step S15, the number of long-waiting users recording time table (1) in Fig. 5 is selected, and the total number of users is recorded in the number of long-waiting users by time table (0, 0, 0, 1) in Fig. 7. That is, in the number of long-waiting users by time table (0, 0, 0, 0), the number of users appeared within a hall call duration of 10 seconds is recorded, and in the number of long-waiting users by time table (0, 0, 0, 1), the number of users appeared within a hall call duration of 20 seconds is recorded. Fig. 7 is an example of a diagram illustrating the number of long-waiting users by time table (K, J, I, N).

[0058]

If the CPU judges in step S15 that the hall call duration on the floor is equal to or less than the time

indicated in the number of long-waiting users recording time table (N) (YES in S15), the CPU substitutes the cumulative number of long-waiting users table (K, J, I) into the number of long-waiting users by time table (K, J, I, N) (step S16), and ends the series of steps.

[0059]

[Example 3]

Example 3 is an example of performing long-wait evaluation on each floor by using the number of long-waiting users by time table (K, J, I, N). Fig. 8 is an example of a flowchart illustrating a flow of a process of performing long-wait evaluation on each floor according to Example 3.

[0060]

First, the CPU judges whether or not the hall call duration measurement timer on each floor is in operation (step S21). If the timer is not in operation (NO in S21), the CPU resets the corresponding number of long-waiting users by time table (K, J, I, N) and cumulative number of long-waiting users table (K, J, I) (step S22) and the process returns to step S21.

[0061]

If the timer is in operation (YES in S21), the CPU subtracts the number of long-waiting users recording time table (N) from the hall call duration of the floor so as to calculate the waiting time of each user, and adds a

predicted time to when an assigned unit arrives to the waiting time of each user so as to predict the waiting time of each user (step S23). Subsequently, the CPU judges whether or not the predicted waiting time of each user exceeds a long-wait judgment time (step S24). If not (NO in S24), the process returns to step S21.

[0062]

If the predicted waiting time of each user exceeds the long-wait judgment time (YES in S24), the CPU subtracts the judgment time in Fig. 9 from the predicted waiting time of each user so as to calculate a future long-wait remaining time (N) (step S25). Fig. 9 is an example of a diagram illustrating a long-wait judgment time by traffic demand table (M). In the long-wait judgment time by traffic demand table (M) in Fig. 9, a predetermined value that is set in advance for each traffic flow mode may be used. However, a judgment time suitable for the characteristics of each building can be easily set by learning a daily usage status and using a learned time created for each traffic flow mode.

[0063]

Subsequently, the CPU multiplies the square of the future long-wait remaining time (N) by the number of long-waiting users by long-wait remaining time, so as to obtain a long-wait load (N) by long-wait remaining time on the floor (step S26). The number of long-waiting users by long-wait

remaining time is obtained by subtracting the number of long-waiting users by time table (K, J, I, N-1) from the number long-waiting users by time table (K, J, I, N). Here, the waiting time after the lapse of the long-wait judgment time is assumed as a time in which a user is impatient (impatience time). The impatience time is evaluated by squaring the future long-wait remaining time (N) under the assumption that a temporal weight of the square of a normal waiting time when no long wait occurs is added.

[0064]

Subsequently, the CPU obtains the sum of long-wait loads (N) by long-wait remaining time on the floor and calculates the long-wait evaluation value of the floor (step S27). The calculation of the long-wait evaluation value is performed for all the floors or all the floors provided with a service before the floor where there is a new user. That is, evaluation is performed in consideration of a long-wait status on other floors as well as the floor where there is a new user. Subsequently, the CPU calculates an overall evaluation value on the basis of the long-wait evaluation value of the floor and other evaluation values such as a waiting time evaluation value and an interval evaluation value, determines a unit to be assigned (step S28), and ends the series of steps for performing long-wait evaluation on each floor.

[0065]

Here, the waiting time evaluation performed by the waiting time evaluation section 22 is evaluation on a predicted time from the current time point to the arrival of an elevator, and the interval evaluation performed by the interval evaluation section 23 is evaluation on the equality of intervals among in-service units in the future. That is, the waiting time evaluation and the interval evaluation are performed in consideration of only the maximum long waiting time, and the long waiting time of each user and the number of long-waiting users are not considered therein. In this embodiment, long-wait evaluation is performed on the basis of information about a long wait. Thus, risk avoidance can be achieved while keeping the balance with the risk of increase in the waiting time on the other floors by predicting a floor where the waiting time is likely to be increased as well as by suppressing an increase in a long waiting time and the number of long-waiting users.

[0066]

In this embodiment, a description has been given mainly of general users. However, a special user such as a physically handicapped person or a VIP satisfying a condition registered in advance may be identified through ID authentication or user information read from a mobile terminal, and a special service may be provided to the

special user. For example, a situation may occur where a special user such as a physically handicapped person or a VIP is to be allowed to enter an in-service unit that arrives as soon as possible and a car with a lower occupation rate of users in the in-service unit.

[0067]

In such a case of a special user, the long-wait judgment time is set to a minimum judgment time (for example, zero seconds), the judgment time is set to be shorter than that for general users, or the number of users is set to be plural so as to increase the service priority. In this way, a special user such as a physically handicapped person or a VIP is regarded as a long-waiting user, and a friendly service can be provided to the special user while paying attention to the waiting time and long wait of general users.

[0068]

[Example 4]

Example 4 is a modification example of Example 3, in which a new evaluation index is taken into account to calculate a long-wait remaining time (N). Fig. 10 is an example of a flowchart illustrating a flow of a process of performing long-wait evaluation on each floor according to Example 4.

[0069]

In the flowchart in Fig. 10, step S25A is different

from step S25 in the flowchart in Fig. 8. In step S25A, the CPU calculates a future long-wait remaining time (N) by taking into account, as a new evaluation index, a predicted average ride time and a predicted average walking time recorded in a table similar to the number of long-waiting users by time table (K, J, I, N). The predicted average ride time can be calculated on the basis of the destination floor information of each user detected in advance.

[0070]

With the predicted average ride time being taken into account as an evaluation index, a service completion time to the time point of arrival at an origin floor can be evaluated. Furthermore, with a predicted average walking time from a detection device installed away from the entrance or hall of a building to the hall being taken into account, a movement time in the building can be evaluated. Furthermore, if the movement time after exiting a unit significantly varies according to a user, the time after exiting can also be included. In this way, by taking into account various movement times in the building in addition to the waiting time in an elevator hall, the overall movement time in the building can be shortened.

[0071]

[Example 5]

Example 5 is a modification example of Example 3. In

Example 3, long-wait evaluation is performed by waiting time of each user. In this case, N times of detailed calculation is necessary and thus an amount of computation increases.

Example 5 is an example in which the amount of computation is reduced relative to Example 3 and a substantially equivalent effect can be obtained.

[0072]

Fig. 11 is a flowchart illustrating a flow of a process of performing long-wait evaluation on each floor according to Example 5.

[0073]

First, the CPU judges whether or not the hall call duration measurement timer on each floor is in operation (step S31). If the timer is not in operation (NO in S31), the CPU resets the corresponding number of long-waiting users by time table (K, J, I, N) and the corresponding cumulative number of long-waiting users table (K, J, I) (step S32), and the process returns to step S31.

[0074]

If the timer is in operation (YES in S31), the CPU subtracts the number of long-waiting users recording time table (N) from the hall call duration on the floor so as to calculate the waiting time of each user, and adds a predicted time until the arrival of an assigned unit to the waiting time of each user so as to predict the waiting time

of each user (step S33). Subsequently, the CPU judges whether or not the predicted waiting time of each user exceeds the long-wait judgment time (step S34). If the predicted waiting time does not exceed the long-wait judgment time (NO in S34), the process returns to step S31.

[0075]

If the predicted waiting time of each user exceeds the long-wait judgment time (YES in S34), the CPU calculates a long waiting time load (step S35). The long waiting time load can be calculated by squaring {(hall call duration + predicted arrival time of assigned unit) - long-wait judgment time}. That is, the waiting time after the lapse of the long-wait judgment time is assumed as a time in which a user is impatient (impatience time). The impatience time is assumed to be applied with a temporal weight of the square of a normal waiting time when no long wait occurs and is regarded as a long waiting time load.

[0076]

Subsequently, the CPU multiplies a normalized value of the total number of long-waiting users by the long waiting time load so as to obtain a long-wait evaluation value (step S36). Here, the normalized value of the total number of long-waiting users is a value obtained by normalizing the total number of long-waiting users with the capacity of an in-service unit. As a result of normalizing the total

number of long-waiting users with the capacity of the in-service unit, the dependence of each case can be reduced, and evaluation can be performed without depending on the size of an in-service unit. Furthermore, for example, if the number of users corresponding to 80% of the capacity of an in-service unit is assigned, the number of users beyond the assigned number of users is considered as the number of users left behind. These users may perform reregistration, and thus the timer is kept activated and the left users are taken into account as the next user. Accordingly, long-wait evaluation can be performed with high accuracy during rush hours.

[0077]

When the maximum value of N representing the size of a table is decreased as much as possible, the system resources can be minimized. Thus, all the users generated in the time beyond the number of long-waiting users recording time table (N_MAX), which is the maximum recording time, are included in the number of long-waiting users recording time table (N_MAX). If the number of users on a specific floor is extremely large, for example, in the morning rush hours, a plurality of units are assigned to the specific floor and the hall call duration becomes bloated.

[0078]

In this case, a hall call duration measurement timer

may be provided for each in-service unit, or the hall call duration measurement timer is not necessarily provided for each in-service unit so as to maintain system resources. In a case where the hall call duration measurement timer is not provided for each in-service unit, the number of excessive users is included in the maximum value of the table as described above. Accordingly, when the number of users on a specific floor is extremely large, units can be assigned to the specific floor more preferentially, and thus congestion on the specific floor can be quickly relieved.

[0079]

Here, it is desirable to set the number of long-waiting users recording time table (N_MAX) so that the maximum recording time is normally about 5 to 10 minutes. If a hall call duration is 5 minutes or more, there is a high possibility that the hall on a specific floor is crowded, and an average waiting time in the entire building is substantially equal to the waiting time on the specific floor. In this case, the average waiting time in the entire building can be shortened by assigning in-service units in a concentrated manner. On the other hand, in a building where a specific floor is not so crowded even at the peak of morning rush hours, long-wait evaluation is low, a plurality of units are less likely to be assigned to the specific floor, departure with a small number of users can be

suppressed and the occupancy rate increases, and thus the waiting time can be shortened.

[0080]

The sum of long-wait evaluation values of all floors may be calculated for each in-service unit and the calculation result may be added as an evaluation penalty value to the floor that is not assigned with the in-service unit, and thereby an increase in the long waiting time and the number of long-waiting users can be suppressed. Specifically, to the floor where a hall call newly occurs, a unit that takes charge of a floor having low long-wait evaluation is more likely to be assigned than a unit that takes charge of a floor having high long-wait evaluation, and thus an increase in the long waiting time and the number of long-waiting users can be suppressed.

[0081]

Furthermore, an upper limit of the number of stops of each in-service unit may be set in accordance with the long-wait evaluation value of the in-service unit during the morning rush hours, and thereby the transport capacity can be increased. For example, the upper limit of the number of stops of an in-service unit having a large long-wait evaluation value is set to be relatively low, whereas the upper limit of the number of stops of an in-service unit having a small long-wait evaluation value is set to be

relatively high. Accordingly, for a long-waiting user, an increase in the long waiting time can be suppressed and also the ride time in an in-service unit can be shortened.

[0082]

Finally, the CPU calculates an overall evaluation value on the basis of the long-wait evaluation value of the floor and other evaluation values such as a waiting time evaluation value and an interval evaluation value, determines a car to be assigned (step S37), and then ends the series of steps for performing long-wait evaluation on each floor.

[0083]

In Example 5, a normal usage method is assumed in which each user is registered once. However, actual usage includes irregular usage. For example, there is a case where one user registers the same destination floor a plurality of times and calls a plurality of in-service units, and there is a case where only one representative performs registration although a plurality of users are going to enter an elevator in group use. The following practice may be performed in the case of irregular usage.

[0084]

Regarding a user who registers the same destination floor a plurality of times, if the user consecutively registers the same destination floor a predetermined number

of times within a predetermined period using the same registration device (for example, the hall call registration part 3 in Fig. 1), it is determined that the same user has performed registration a plurality of times. Also, the number of registered users is set to one, the number of users set in advance, or the number of users learned from a daily usage history. In this way, irregular usage case can be suppressed.

[0085]

In a case where only one representative performs registration although a plurality of users are going to enter an elevator, the number of users per registration is learned for each floor and each traffic flow mode on the basis of the number of registrations in the registration device and the number of users (the number of users entering an elevator), and the number of users per registration is changed. Accordingly, irregular usage case can be suppressed. The setting is performed for each floor because the occurrence rate of irregular usage varies according to a tenant or department. The setting is performed for each traffic flow mode because irregular usage is likely to occur when the waiting time is long, for example, during rush hours, and because there will be a user who is not able to enter an elevator if irregular usage occurs during rush hours.

[0086]

In Example 5, consideration is not given to each individual user, occasions where a user who often encounters a long wait encounters a long wait again are not reduced, and dissatisfaction of a specific user may increase. Thus, as in the case of the group-management elevator apparatus 50 according to the second embodiment (see Fig. 2), the user management part 5 that records and manages usage histories such as waiting times of individual users is provided. The number of times the waiting time of a currently registered user exceeds the long-wait judgment time in a past predetermined period is set as the number of long waits of the user, and a higher priority in service is given to the user. Accordingly, concentration of long waits to a specific user can be suppressed.

[0087]

Examples 6 to 12 described below are examples of providing (presenting) elevator operation information so that a user is able to see the information.

[0088]

The group-management elevator apparatus 10 according to the first embodiment and the group-management elevator apparatus 50 according to the second embodiment adopt a scheme for reducing the risk of increase in the waiting time in the entire building, and thus a waiting time is likely to

increase in a specific floor, such as a floor that is used less frequently. For example, among the floors where a long wait has occurred, the floor having a larger number of long-waiting users may be given priority, and the waiting time may become longer on the floor having a smaller number of long-waiting users.

[0089]

Thus, elevator operation information is provided so that users are able to see the information. With the information being provided, elevator users are able to understand the reason the waiting time is long, and thus impatience of the elevator users during a long wait can be relieved.

[0090]

[Example 6]

Example 6 is an example of presenting a predicted number of long-waiting users to elevator users. The predicted number of long-waiting users is displayed on a display device (the operation information display part 4 in Fig. 1 or the display part 8 in Fig. 2) installed in a hall, or on a display part of a mobile terminal. Fig. 12 is an example of an explanatory diagram illustrating display of a predicted number of long-waiting users according to Example 6.

[0091]

As illustrated in Fig. 12, in Example 6, a predicted number of long-waiting users in each elevator bank, a predicted number of long-waiting users in each service direction on each floor, the number of users in each in-service unit at departure, and the number of exiting users at arrival are displayed. The number of long-waiting users calculated by the long-wait evaluation section 24 is displayed as the predicted number of long-waiting users of each bank. With the information being provided, users are allowed to understand whether the long-wait index of the entire building is high or low.

[0092]

As the number of long-waiting users on each floor, a current predicted number of waiting users and a future predicted number of waiting users that is predicted for each traffic flow mode from a learning result on the basis of the current predicted number of waiting users are displayed, and also a degree of fatigue caused by a long wait is displayed. Furthermore, a long-wait load index (long-wait evaluation value) is obtained on the basis of the number of long-waiting users and the degree of fatigue and is displayed. When being provided with such prediction information, users can understand that the long-wait loads on the other floors are similar or higher, and thus dissatisfaction may decrease.

[0093]

In the case of providing information by displaying it in Example 6, information about the floor provided with a display device (the operation information display part 4 in Fig. 1 or the display part 8 in Fig. 2) is not displayed on the floor. Accordingly, users on the floor pay attention only to the other floors, and thus the users are allowed to grasp the usage status in the entire building more. Also, entering/exiting statuses at departure and arrival are displayed to notify the users that time is being taken for users on the other floors to enter and exit. Thus, if a unit other than an assigned unit arrives before the assigned unit, the users can understand the reason. In a case where a display device is installed near the door of each in-service unit, information on only the assigned unit may be displayed thereon. In this case, users are not able to know passage of other units and thus the positions of units may be simultaneously displayed.

[0094]

[Example 7]

Example 7 is an example of presenting a predicted number of long-waiting users to elevator users. The predicted number of long-waiting users is displayed on a display device (the operation information display part 4 in Fig. 1 or the display part 8 in Fig. 2) installed in a hall or on a display part of a mobile terminal. Fig. 13 is an

example of an explanatory diagram illustrating display of a predicted number of long-waiting users according to Example 7.

[0095]

As illustrated in Fig. 13, in Example 7, current predicted numbers of waiting users and future predicted numbers of waiting users on all floors, and the exiting/entering statuses are displayed for each in-service unit, and also only the operation information on the unit to be assigned is displayed. Users are able to grasp the long wait statuses on all floors and grasp the operation status of the unit to be assigned. Furthermore, since only the operation information on the unit to be assigned is displayed, the risk of increasing dissatisfaction caused by another nearby unit not providing a service can be avoided.

[0096]

[Example 8]

Example 8 is an example of presenting the number of long-waiting users and the degree of fatigue caused by long wait in the past to elevator users. The number of long-waiting users and the degree of fatigue caused by long wait in the past are displayed on a display device (the operation information display part 4 in Fig. 1 or the display part 8 in Fig. 2) installed in a hall or on a display part of a mobile terminal. Fig. 14 is an example of an explanatory

diagram illustrating display of the number of long-waiting users and the degree of fatigue caused by long wait in the past according to Example 8.

[0097]

As illustrated in Fig. 14, in Example 8, the number of long-waiting users in each service direction in the past during rush hours is displayed. With such display, users are able to grasp the long-wait status in the hours other than the hours when they usually use an elevator, and thus the time to use an elevator can be adjusted. A long-wait evaluation value that is calculated on the basis of the long waiting time and the number of long-waiting users, not on the basis of the number of long-waiting users, is displayed as the degree of fatigue caused by long wait, and accordingly wait information that matches the senses of actual users can be provided.

[0098]

[Example 9]

Example 9 is an example of presenting past impatience indexes to elevator users. The past impatience indexes are displayed on a display device (the operation information display part 4 in Fig. 1 or the display part 8 in Fig. 2) installed in a hall or on a display part of a mobile terminal. Fig. 15 is an example of an explanatory diagram illustrating display of past impatience indexes according to

Example 9.

[0099]

As illustrated in Fig. 15, in Example 9, the degree of fatigue caused by long wait, which is obtained by taking into account the number of long-waiting users and the long waiting time, is displayed as a long-wait load index. Accordingly, users are able to grasp, at a glance, the possibility that he or she will encounter an unpleasant situation. As a result, the users are able to act to avoid using elevators during hours when the encounter possibility is high. Furthermore, when the users know that the encounter possibility is currently high, the users are able to choose an action other than waiting for an elevator and to effectively use time.

[0100]

[Example 10]

Example 10 is an example of presenting a long-wait status at registration to elevator users. The long-wait status at registration is displayed on a display device (the operation information display part 4 in Fig. 1 or the display part 8 in Fig. 2) installed in a hall or on a display part of a mobile terminal. Fig. 16 is an example of an explanatory diagram illustrating display of a long-wait status at registration according to Example 10.

[0101]

As illustrated in Fig. 16, in Example 10, if it is predicted that the waiting time for the unit to be used will exceed the long-wait judgment time after the user registers a destination floor and the in-service unit to be used is displayed, a message indicating that the user will become a long-waiting user, for example, "the hall is very crowded", is displayed. Accordingly, if the user registers a destination floor at a position away from the hall, the user may spontaneously delay the movement to the hall, and thus congestion in the hall can be relieved. Furthermore, since the movement is spontaneously delayed, the user may be assigned with an in-service unit that he/she can take even if the speed of the movement to the unit is lower than a normal walking speed. For example, when the movement distance is 20 m, the walking speed is changed from a normal walking speed of 1.3 m/sec to a speed of 1.0 m/sec, and the in-service unit that will depart within 20 seconds is not assigned.

[0102]

[Example 11]

Example 11 is an example of presenting a long-wait status before registration to elevator users. The long-wait status before registration is displayed on a display device (the operation information display part 4 in Fig. 1 or the display part 8 in Fig. 2) installed in a hall or on a

display part of a mobile terminal. Fig. 17 is an example of an explanatory diagram illustrating display of a long-wait status before registration according to Example 11.

[0103]

In Example 11, a message indicating the long-wait status in a hall, for example, "the hall is very crowded" or "estimated number of long-waiting users: 20", is displayed before a user registers a destination floor. Accordingly, the user is able to check the long-wait status of the hall before registering a destination floor, and thus may spontaneously delay the movement to the hall as in Example 10.

[0104]

Furthermore, as in Example 9, the user is able to take an action other than waiting for an elevator. For example, the user may give up moving to the hall and change his/her action to, for example, going to a vending machine corner in the building, a convenience store, or a smoking area, or using stairs. Accordingly, congestion in the hall can be reduced. Also, the long-wait status before registration is displayed on a registration device (for example, the hall call registration part 3 in Fig. 1) or a mobile terminal carried by a user, and thus it is not necessary to newly install a display. Furthermore, a predicted value of the number of long-waiting users or the degree of fatigue caused

by long wait is displayed, that is, a future congestion status in the hall predicted based on the current status in the hall is displayed, which is also effective to relieve congestion in the hall in advance.

[0105]

[Example 12]

Example 12 is an example of presenting a long-wait judgment time setting to elevator users. The long-wait judgment time setting is displayed on a display device (the operation information display part 4 in Fig. 1 or the display part 8 in Fig. 2) installed in a hall or on a display part of a mobile terminal. Fig. 18 is an example of an explanatory diagram illustrating a long-wait judgment time setting according to Example 12.

[0106]

In Example 12, when a user performs a specific operation on a registration device (for example, the hall call registration part 3 in Fig. 1) or a mobile terminal, for example, an encryption operation or holding a manager card over the registration device or the mobile terminal, the registration device or the mobile terminal shifts to a manager mode, and the long-wait judgment time can be changed in the manager mode. Accordingly, the long-wait judgment time recorded in an external device or the group-management control part 2 can be changed for each time slot. That is,

settings can be changed by using a device used by a user (registration device or mobile terminal) without using a dedicated setting tool.

[0107]

In the case of displaying the number of long-waiting users or a long-wait load as in Examples 6 to 12, the value of a long-wait judgment time, which is a judgment criterion of a long wait, is important, and thus it is preferable that the settings can be easily changed. In particular, in the case of controlling the actions of users by providing the users with the number of long-waiting users or a long-wait load, the control can be performed by changing the long-wait judgment time. For example, to relieve congestion in a hall in the morning rush hour, the long-wait judgment time in the morning rush hour is set to be short so that a large number of long-waiting users or a high long-wait load is displayed. On the other hand, to increase the occupancy rate in the morning rush hour, the long-wait judgment time in the morning rush hour is set to be long so that a small number of long-waiting users or a low long-wait load is displayed.

[0108]

The present invention is not limited to the above-described examples and includes various modification examples. For example, the above examples have been described in detail in order to clearly explain the present

invention and do not limit the invention to the example having all the configurations described above. One means of a configuration of a certain example can be replaced by a configuration of another example, and a configuration of a certain example can be added to a configuration of another example. Furthermore, regarding one means of a configuration of each example, another configuration can be added, deleted, or replaced.

[Reference Signs List]

[0109]

- 1: elevator part
- 2: group-management control part
- 3: hall call registration part
- 4: operation information display part
- 5: user management part
- 6: arrival-at-building detection part
- 7: arrival-at-hall detection part
- 8: display part
- 10: group-management elevator apparatus according to

first embodiment

- 11_1, 11_2, 11_n: elevator (in-service unit)
- 20, 51: usage information acquisition section
- 21, 52: usage information prediction section
- 22: waiting time evaluation section
- 23: interval evaluation section

- 24: long-wait evaluation section
- 25: overall evaluation section
- 26: to-be-assigned unit determination section
- 27: operation information management section
- 28, 53: usage information management section
- 50: group-management elevator apparatus according to

second embodiment

- 54: operation information acquisition section
- 55: usage information transmission section
- 56: display information notification section

CLAIMS

[Claim 1]

An elevator apparatus that assigns one of in-service units providing a service to each of users, on the basis of an origin floor and a destination floor of the user and the number of users, the origin floor, the destination floor, and the number of users being registered before entering an elevator, the elevator apparatus comprising:

a prediction section that predicts a distribution of waiting times of all the users on the basis of arrival-at-hall times of the users and predicted arrival times of the individual in-service units to be assigned;

an evaluation section that evaluates a long-wait ratio by calculating, on the basis of the distribution of waiting times of all the users, the number of waiting users whose waiting time exceeds a long-wait judgment time and a long waiting time beyond the long-wait judgment time, for each of the in-service units to be assigned in each hall; and

a to-be-assigned unit determination section that assigns one of the in-service units providing a service to each of the users, on the basis of an evaluation result generated by the evaluation section,

wherein the long-wait judgment time is set on the basis of a time created for each traffic flow mode from a past learning result,

wherein the distribution of waiting times of all the users is calculated from destination floor registration times of the

individual users, hall call durations on individual floors, and predicted arrival times of the individual in-service units at the individual floors,

wherein the evaluation section evaluates a waiting time on each floor and equality of time intervals of each in-service unit in the future and calculates a long waiting time and the number of long-waiting users on each floor, on the basis of the waiting time of each user and the number of waiting users on each floor, predicted by the prediction section, and operation information on each in-service unit, and evaluates the long-wait ratio by normalizing the number of users waiting beyond the long-wait judgment time with a capacity of an in-service unit to be assigned, the long-wait ratio being a ratio of elevator users whose waiting time exceeds the long-wait judgement time, and

wherein the evaluation section sets the long-wait judgment time to a minimum judgment time to increase priority in service if the user is a special user satisfying a condition registered in advance.

[Claim 2]

The elevator apparatus according to Claim 1, wherein if an identical destination floor is consecutively registered a predetermined number of times within a predetermined period with an identical registration device at a time of registration of the origin floor and the destination floor of the user and the number of users, the number of users is reset to one under

presumption that an identical user has performed registration a plurality of times.

[Claim 3]

The elevator apparatus according to Claim 1, wherein, in a case of registering the origin floor and the destination floor of the user and the number of users by using a hall registration device installed in a hall, the number of users per registration is learned for each floor and each traffic flow mode on the basis of the number of times of registration in the hall registration device and the number of users, and the number of users per registration is changed.

[Claim 4]

The elevator apparatus according to Claim 1, wherein the prediction section records past waiting times of the users, and if a user is detected whose waiting time in a past predetermined period exceeds the long-wait judgment time a number of times, the number of times is set as the number of long waits of the user, and priority in service for the user is increased.

[Claim 5]

The elevator apparatus according to Claim 1, wherein the total number of users whose waiting time exceeds the long-wait judgment time and the number of the users on each floor are presented to the users.

[Claim 6]

The elevator apparatus according to Claim 1, wherein the number of past users whose waiting time exceeds the long-wait judgment time and a past time slot in which the waiting time exceeds the long-wait judgment time, or a future time slot in which the waiting time exceeds the long-wait judgment time is presented to the users.

[Claim 7]

The elevator apparatus according to Claim 1, wherein if a waiting time is predicted to exceed the long-wait judgment time when a destination floor is registered by the user, a notification indicating a possibility of becoming a long-waiting user or an estimated number of long-waiting users is presented to the user together with an in-service unit.

[Claim 8]

A method for controlling an elevator apparatus that assigns one of in-service units providing a service to each of users, on the basis of an origin floor and a destination floor of the user and the number of users, the origin floor, the destination floor, and the number of users being registered before entering an elevator, the method comprising:

predicting a distribution of waiting times of all the users on the basis of arrival-at-hall times of the users and predicted arrival times of the individual in-service units to be assigned;

evaluating a long-wait ratio by calculating, on the basis of the distribution of waiting times of all the users, the number of waiting users whose waiting time exceeds a long-wait judgment time and a long waiting time beyond the long-wait judgment time, for each of the in-service units to be assigned in each hall; and

assigning one of the in-service units providing a service to each of the users, on the basis of an evaluation result generated through the evaluating,

wherein a waiting time on each floor and equality of time intervals of each in-service unit in the future are evaluated and a long waiting time and the number of long-waiting users on each floor are calculated, on the basis of the waiting time of each user and the number of waiting users on each floor, predicted by the prediction section, and operation information on each in-service unit, and the long-wait ratio is evaluated by normalizing the number of users waiting beyond the long-wait judgment time with a capacity of an in-service unit to be assigned, the long-wait ratio being a ratio of elevator users whose waiting time exceeds the long-wait judgement time, and

wherein the long-wait judgment time is set to a minimum judgment time to increase priority in service if the user is a special user satisfying a condition registered in advance.