

GROUP MANAGEMENT SYSTEM OF ELEVATORS

FIELD

Embodiments described herein relate generally to a group management system of elevators which are assigned to a floor where a destination call is registered at an elevator hall, and to a floor where an up/down call is registered at an elevator hall.

BACKGROUND

In general, at an elevator hall of each floor of a building, an up/down call button for registering an up/down call as a hall call is installed. The "up/down call" is a call which is created when a user has operated an up button or a down button. In the up/down call, a car is assigned on a floor-by-floor basis.

In recent years, a group management system of elevators, which can register a destination call at an elevator hall, has been put to practical use. The "destination call" is a call which is created when a user inputs a destination floor at a hall. In this destination call, a car is assigned on a user-by-user basis.

A system, which can register a destination call at a hall, is called "destination control system (DCS)". In the destination control system, an optimal car among cars is assigned, based on a destination call registered at a hall, thereby improving the transportation efficiency.

A group management system of elevators, which are distributed to a floor at which a destination call is registered, and to a floor at which an up/down call is registered, has been thought. This system is called "hybrid DCS". In this hybrid DCS, an evaluation method at a time of assigning a car is different between a destination call and an up/down call. Thus, depending on the condition of congestion, there is a case in which a wait time for either the destination call or the up/down call becomes longer. In general, the wait

time for the destination call is longer than the wait time for the up/down call.

Conventionally, in the group management system of elevators, there have been proposed various methods for evaluation of assignment. The target of these methods, however, is only the destination call or the up/down call.

As has been described above, in the hybrid DCS in which the destination call and the up/down call are mixedly present, the evaluation for assignment differs between the destination call and the up/down call. Thus, depending on the condition of congestion, feelings of inequality occur with respect to the wait time.

The object of the invention is to provide a group management system of elevators, which can perform an operation service while reducing feelings of equality with respect to wait time between the destination call and the up/down call.

SUMMARY

In general, according to one embodiment, a group management system of elevators, the system comprising a first call registration device configured to register a destination call of a user at a first floor, and a second call registration device configured to register an up/down call of a user at a second floor which is different from the first floor includes an operation estimation module configured to estimate a future operation of each of cars when a call has been registered by the first or second call registration device, taking into account calls including an assignment-completed call; a first evaluation module configured to calculate, with respect to the destination call, a first evaluation value at a time when each of the cars is operated, in accordance with an estimation result of the operation estimation module, by using a first evaluation formula in which a

wait time and a travel time are targets of evaluation;
a second evaluation module configured to calculate,
with respect to the up/down call, a second evaluation
value at a time when each of the cars is operated, in
5 accordance with the estimation result of the operation
estimation module, by using a second evaluation formula
in which a no-response time is a target of evaluation;
an assigned car determination module configured to
select an assigned car from among the cars, based on
10 the first evaluation value obtained by the first
evaluation module and the second evaluation value
obtained by the second evaluation module, and to cause
the selected assigned car to respond; a first
totalization module configured to totalize a wait time
15 at a time when an assigned car responds, by the
destination call, to a registration floor of the
destination call; a second totalization module
configured to totalize a no-response time at a time
when an assigned car responds, by the up/down call, to
20 a registration floor of the up/down call; and a
weighting adjustment module configured to adjust
weighting of assignment evaluation in the first or
second evaluation module, based on an average value of
the wait time totalized by the first totalization
25 module and an average value of the no-response time
totalized by the second totalization module.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating a structure
of a group management system of elevators according to
30 a first embodiment.

FIG. 2 is a view for explaining a destination call
and an up/down call of the group management system of
elevators in the embodiment.

FIG. 3 is a flowchart illustrating a process
operation of a group management control apparatus in
35 the embodiment.

FIG. 4 is a view illustrating an example of a

congestion management table which is provided in the group management control apparatus in the embodiment.

FIG. 5 is a view illustrating an example of a destination call assignment memory module which is provided in the group management control apparatus in the embodiment.

FIG. 6 is a flowchart illustrating a process operation of a group management control apparatus in a second embodiment.

FIG. 7 is a block diagram illustrating a structure of a group management system of elevators according to a third embodiment.

FIG. 8 is a flowchart illustrating a process operation of the group management control apparatus of the third embodiment.

DETAILED DESCRIPTION

Various embodiments will be described hereinafter with reference to the accompanying drawings.

(First embodiment)

FIG. 1 is a block diagram illustrating a structure of a group management system of elevators according to a first embodiment. In the example shown in FIG. 1, a structure, in which three elevator cars A, B and C are group-managed, is illustrated. Each of the plural elevator cars is referred to as "car".

In FIG. 1, numerals 11a to 11c denote car controllers, and numerals 12a to 12c denote cars. The car controllers 11a to 11c are provided in association with the respective cars, and control the operations of the associated cars. Specifically, the car controllers 11a to 11c execute control of motors (winders) (not shown) for performing elevation operations of the cars 12a to 12c, and execute open/close control of doors. The car controllers 11a to 11c are composed of computers, and are connected to a group management control apparatus 30 which is an upper-level apparatus.

The cars 12a to 12c move up and down within

elevation shafts by the driving of the motors.

Operation boards 13a to 13c are disposed in the cars 12a to 12c. Each of the operation boards 13a to 13c is provided with various operation buttons including a destination button for inputting a destination floor, a door-opening button, and a door-closing button.

Load sensors 14a to 14d for sensing live loads in the cars are disposed at bottom parts of the cars 12a to 12c. The load data sensed by the load sensors 14a to 14c are transmitted, together with car call information registered by operations of destination buttons, to the group management control apparatus 30 via the car controllers 11a to 11c.

In addition, a first call registration device 21 or a second call registration device 22 is disposed at an elevator hall of each floor. The first call registration device 21 is called "hall destination registration device", which is a device for registering a destination call at an elevator hall. The second call registration device 22 is a device for registering an up/down call at an elevator hall.

The "destination call" is a call which is created when a user has input a destination floor at an elevator hall, and includes information on a registration floor and a destination floor. In this destination call, a car is assigned on a user-by-user basis. The "up/down call" is a call which is created when the user has operated an up/down button at the elevator hall, and includes information on a registration floor and a destination direction. In this up/down call, a car is assigned in association with each combination of the registration floor and the destination direction. In the meantime, a car, to which a destination call or an up/down call has been assigned, is called "assigned car".

The first call registration device 21 includes an input module 21a for inputting a destination floor, and

a display module 21b for displaying an assigned car. A method of inputting a destination floor may be a method using a button operation, or may be a method in which information on a destination floor, which is
5 prerecorded on a magnetic card possessed by a user, is scanned.

The second call registration device 22 includes an up button 22a for inputting an upward direction as a destination direction, and a down button 22b for
10 inputting a downward direction as a destination direction. In the meantime, at the lowermost floor, the second call registration device 22 includes only the up button 22a. At the uppermost floor, the second call registration device 22 includes only the down
15 button 22b.

The advantage of the destination call is that users, whose destination floors agree, are made to get in the same car, whereby the go-around time of the car is reduced and the transportation capacity is enhanced.
20 Thus, in usual cases, the first call registration device 21, which can register a destination call, is used at a floor (for example, a reference floor) on which there are a relatively large number of users. On the other hand, the second call registration device 22,
25 which includes the up/down buttons that can easily be used, is used at a floor on which there are a relatively small number of users.

In the example of FIG. 1, the first call registration device 21 is disposed at a first floor 23
30 on which the number of users is relatively large, and the second call registration device 22 is disposed at a second floor 24.

Actually, the first call registration device 21 or the second call registration device 22 is disposed at
35 each of the floors. In this case, both the first call registration device 21 and the second call registration device 22 are not disposed at the elevator hall of the

same floor. The reason for this is that if both the first call registration device 21 and the second call registration device 22 are disposed at the same floor, the user is unable to understand which call has been answered when the assigned car has responded to the elevator hall, and the user is confused.

The first call registration device 21 and the second call registration device 22 are connected to the group management control apparatus 30 via transmission cables (not shown). This group management control apparatus 30 is an apparatus for executing group management control of operations of a plurality of cars, and is composed of a computer, like the car controllers 11a to 11c.

In the present embodiment, the group management control apparatus 30 includes a destination call assignment memory module 31, an up/down call assignment memory module 32, an operation estimation module 33, a first evaluation module 34, a second evaluation module 35, and an assigned car determination module 36.

The destination call assignment memory module 31 stores information (registration floor, destination floor) of a destination call which is registered by the first call registration device 21, and information of a car to which the destination call has been assigned. The up/down call assignment memory module 32 stores information (registration floor, destination direction) of an up/down call which is registered by the second call registration device 22, and information of a car to which the up/down call has been assigned.

When a call has been registered by the first call registration device 21 or second call registration device 22, the operation estimation module 33 estimates a future operation of each car, taking into account calls including an assignment-completed call (hall call) and a car call registered by each of the operation boards 13a to 13c. Incidentally, the

"assignment-completed call" is also referred to as "call of completed assignment".

5 The completed assignment of an up/down call is retained in the up/down call assignment memory module 32, until an assigned car responds to a registration floor of this call. By contrast, the completed assignment of a destination call is retained in the destination call assignment memory module 32, until an assigned car arrives at a destination floor of this
10 call and the door is opened.

 The first evaluation module 34 calculates a first evaluation value at a time when each car is operated in accordance with an estimation result of the operation estimation module 33, by using a first evaluation
15 formula E_1 in which a wait time and a travel time are set to be targets of assignment evaluation in connection with a destination call.

 • First evaluation formula

$$E_1 = T_1 \times p + T_2 \times (1 - p)$$

20 where T_1 is a wait time (estimation value), and T_2 is a travel time (estimation value).

 In addition, p is a weighting coefficient, and p takes a value in a range of from 0 to 1. In the meantime, in a fixed mode, for example, p is set at $p =$
25 0.6. In this case, the first evaluation value is expressed by $E_1 = T_1 \times 0.6 + T_2 \times 0.4$.

 The second evaluation module 35 calculates a second evaluation value at a time when each car is operated in accordance with an estimation result of the operation estimation module 33, by using a second
30 evaluation formula E_2 in which a no-response time is set to be a target of assignment evaluation in connection with an up/down call.

 • Second evaluation formula

35 $E_2 = T_3$

 where T_3 is a no-response time (estimation value).

 In this case, T_1 , T_2 and T_3 are defined as

follows.

Wait time T_1 of a destination call: a time from when a destination call is registered to when an assigned car responds to a registration floor of this call.

Travel time T_2 of a destination call: a time from when an assigned car responds to a registration floor to when the assigned car arrives at a destination floor and the door is opened.

No-response time T_3 of an up/down call: a time from when an up/down call is registered to when an assigned car responds to a registration floor of this call.

The assigned car determination module 36 selects an assigned car from among the respective cars, based on the first evaluation value obtained by the first evaluation module 34 and the second evaluation value obtained by the second evaluation module 35, and causes the selected assigned car to respond. Specifically, an operation controller (not shown) is provided in the group management control apparatus 30. This operation controller outputs an operation instruction to the car controller which is associated with the assigned car, whereby the assigned car responds to the registration floor of the present call.

For the purpose of easier understanding, a description is given of an assignment process in the group management system.

The assignment process is a process of determining a car to which a newly registered call (destination call or up/down call) is assigned. In order to determine to which of the cars a call is to best assigned, a future operation of each car is estimated.

The estimation of the future operation is executed with respect to each car in the following two cases:

- An estimation in a case where a newly registered call has been assigned to the present car.

- An estimation in a case where a newly registered call has not been assigned to the present car.

In each of these estimations, the following information is used.

5 • The position and direction of the car at a start time point of estimation, and the condition of opening of the door.

- Information on hall calls (up/down call and destination call) of completed assignment.

10 • Information on a new call in an estimation in a case where this new call has been assigned.

- Information on an already registered car.

From the result of this estimation, the estimation value of the wait time T_1 of a destination call, the
15 estimation value of the travel time T_2 of the destination call, and the estimation value of the no-response time T_3 of an up/down call are obtained.

The evaluation time of a destination call is calculated with respect to each of destination calls.
20 As indicated in the above-described first evaluation formula E_1 , the evaluation value of the destination call is a weighted sum of the wait time T_1 (estimation value) and the travel time T_2 (estimation value).

The evaluation time of the up/down call is
25 calculated with respect to each of up/down calls. As indicated in the above-described second evaluation formula E_2 , the evaluation value of the up/down call is the no-response time T_3 .

The evaluation value for a certain car is a sum of
30 an evaluation value of a destination call and an evaluation value of an up/down call. An assigned car is selected so that the sum becomes a minimum. In the calculation of the evaluation value, a lower evaluation value means higher evaluation.

35 Since targets of assignment evaluation are different between a destination call and an evaluation value of an up/down call, there is a case in which

feelings of inequality occur with respect to the wait time. The group management control apparatus 30 of the present system includes a wait time actual-result totalization module 37, a no-response time actual-
5 result totalization module 38, a weighting adjustment module 39, and a congestion condition determination module 40.

The wait time actual-result totalization module 37 is used as a first totalization module. The wait time
10 actual-result totalization module 37 totalizes the wait time T_1 at a time when the assigned car responds, by a destination call, to the registration floor of the destination call, and stores the totalization result.

The no-response time actual-result totalization
15 module 38 is used as a second totalization module. The no-response time actual-result totalization module 38 totalizes the no-response time T_3 at a time when the assigned car responds, by an up/down call, to the registration floor of the up/down call, and stores the
20 totalization result.

The weighting adjustment module 39 adjusts the weighting of the assignment evaluation in the first or second evaluation module, based on an average value of the wait times T_1 totalized by the wait time actual-
25 result totalization module 37, and an average value of the no-response times T_3 totalized by the no-response time actual-result totalization module 38.

Specifically, the weighting adjustment module 39 adjusts a weighting factor p for the wait time T_1 of
30 the first evaluation formula E_1 , so that the difference between the average value of the wait time T_1 and the average value of the no-response time T_3 becomes smaller.

The congestion condition determination module 40
35 determines the congestion condition of each floor. Incidentally, a concrete determination method will be described later. In the case where the congestion

condition determination module 40 has determined that there is no congestion on the first floor 23, the first evaluation module 34 applies the weighting factor p , which has been adjusted by the weighting adjustment module 39, to the first evaluation formula E_1 . In the case where the congestion condition determination module 40 has determined that there is congestion on the first floor 23, the first evaluation module 34 applies a fixed value (e.g. $p = 0.6$) of the preset weighting factor p to the first evaluation formula E_1 .

FIG. 2 is a view for explaining a destination call and an up/down call in the group management system of elevators in the embodiment.

The first call registration device 21 is disposed at the first floor 23 (e.g. a reference floor) where the number of users is large. If a user inputs a destination floor by operating the input module 21a of the first call registration device 21, a destination call including information on the input destination and the registration floor is created. This information of the destination call is sent to the group management control apparatus 30 and is stored in the destination call assignment memory module 31. In the example of FIG. 2, the destination floor is 10F, and the registration floor is 1F.

The second call registration device 22 is disposed at the second floor 24 where the number of users is small. If a user inputs a destination direction by operating the up button 22a or down button 22b of the second call registration device 22, an up/down call including information on the input destination direction and the registration floor is created. This information of the up/down call is sent to the group management control apparatus 30 and is stored in the up/down call assignment memory module 32. In the example of FIG. 2, the destination direction is an upward direction, and the registration floor is 2F.

The group management control apparatus 30 includes the operation estimation module 33 which estimates a future operation of each car, in accordance with assignment-completed calls (calls of completed
5 assignment) and a newly registered call. Incidentally, the "newly registered call" is a call for which assignment is to be made hereafter, and is referred to as "call of an assignment request".

The operation estimation module 33 executes, with
10 respect to each of cars which are in operation, an estimation in a case where a call of an assignment target has been assigned to the car, and an estimation in a case where the call of the assignment target has not been assigned to the car. Then, in the respective
15 estimations, with respect to the call of completed assignment and the call of an assignment request, the operation estimation module 33 calculates estimation values of the wait time T_1 and travel time T_2 of the destination call and the no-response time T_3 of the
20 up/down call.

When an assigned car is to be determined, it is necessary to calculate evaluation values with respect to all calls of completed assignment and calls of an assignment request, and to evaluate the sum of these
25 evaluation values.

For example, in the system comprising cars A, B and C, the following three operations are estimated, and the evaluation values obtained in the estimation of each operation are evaluated with respect to each of
30 the cars.

- Operation estimation in a case where a call has been assigned to the car A.

A sum of evaluation values of all cars in a case where a call of an assignment request is assigned to
35 the car A, but not to the car B or C.

- Operation estimation in a case where a call has been assigned to the car B.

A sum of evaluation values of all cars in a case where a call of an assignment request is assigned to the car B, but not to the car A or C.

5 • Operation estimation in a case where a call has been assigned to the car C.

A sum of evaluation values of all cars in a case where a call of an assignment request is assigned to the car C, but not to the car A or B.

10 In the above-described three operation estimations, the car with a least sum of evaluation values is determined to be the assigned car.

15 As regards the destination call, an evaluation value is calculated by using the first evaluation formula E_1 in which the wait time T_1 and travel time T_2 are the targets of evaluation. As regards the up/down call, an evaluation value is calculated by using the second evaluation formula E_2 in which the no-response time T_3 is the target of evaluation.

20 In this manner, since the targets of assignment evaluation are different between the destination call and the up/down call, there is a tendency that the wait time of the destination call becomes longer than the wait time of the up/down call. The reason for this is that in the assignment evaluation of the destination
25 call, the travel time T_2 is taken into account, and the assigned car is not determined by the evaluation of the wait time T_1 alone.

30 The purpose of adding the travel time T_2 to the assignment evaluation is to make users, whose destination floors is the same, get in the same car, thereby making this car arrive at the destination floor earlier, and to quicken the go-around of the car, thereby enhancing the transportation capacity (the
35 limit of the number of persons who can use the car).

Next, a description is given of the method of eliminating the feelings of inequality of wait time between the destination call and the up/down call.

FIG. 3 is a flowchart illustrating a process operation of the group management control apparatus 30 in the embodiment. The process illustrated in this flowchart is executed by a predetermined program being read in the group management control apparatus 30 which is a computer.

To start with, the congestion condition determination module 40 provided in the group management control apparatus 30 determines the congestion condition of the elevator hall of each floor (step S101). It is assumed that, as the method of determining the congestion condition, any one of the following three methods is used.

In the meantime, "congested condition" means the condition in which a predetermined number or more of users are waiting for an elevator (car) (for example, the number of users waiting for a car is double or more the rated number of persons of the car).

(1) Time zone

For example, in the case of an office building, the tendency of flow of persons using an elevator is determined based on time zones. Specifically, in a time zone of the start of working hours, the number of users, who go from a reference floor at the entrance/exit of the building to each floor, is large, and the reference floor is most congested. In addition, in a time zone of the end of working hours, the number of users, who go from each of the floors, other than the reference floor, to the reference floor, is large.

Thus, the time zone of congestion is learned in advance with respect to each floor, and the result of learning is stored in a congestion management table 41 as illustrated in FIG. 4. This congestion management table 41 is provided in the group management control apparatus 30. By referring to the congestion management table 41, the congestion condition

determination module 40 determines a congested floor with respect to each time zone.

(2) Live load

5 The load sensors 14a to 14c for detecting live loads are disposed on the respective cars 12a to 12c. When each car has arrived at each floor, the congestion condition determination module 40 estimates the number of users who get in or out of the cars at each floor, based on variations of load signals which are output
10 from the load sensors 14a to 14c, and determines whether each floor is congested or not, based on the estimation result.

(3) Destination call

15 The destination call, which is registered by the first call registration device 21, includes information on a destination floor of a user and a registration floor at which this call has been registered. Accordingly, if the information on destination calls is monitored, the congestion condition of each floor can
20 be determined. The information on destination calls is stored in the destination call assignment memory module 31 with respect to each of users.

FIG. 5 is a view illustrating an example of information on destination calls stored in the
25 destination call assignment memory module 31. The congestion condition determination module 40 refers to the destination call assignment memory module 31, thereby determining the congestion condition of each floor. Although not shown in FIG. 5, actually, in
30 addition to the information on destination calls, information on cars, to which the destination calls are assigned, is also stored in the destination call assignment memory module 31.

35 In this case, if it is determined that the first floor 23, at which the first call registration device 21 (the registration device of a destination call) is disposed, is congested (Yes in step S102), a fixed mode

is applied to the first evaluation formula E_1 and assignment control is executed (step S103).

Specifically, when a destination call has been registered, the first evaluation module 34 evaluates
5 each car by setting the weighting factor p for the wait time T_1 at $p = 0.6$.

The reason why the fixed mode is applied when the first floor 23 is congested is that, in the fixed mode, the weighting factor p , which places priority on the
10 transportation capacity, is set. As regards the up/down call, regardless of the congestion condition, the second evaluation module 35 evaluates each car by using the above-described second evaluation formula E_2 .

If it is determined that the first floor 23 is not
15 congested (No in step S102), the weighting factor p is adjusted as described below.

Specifically, when the assigned car has responded, in answer to a destination call, to the registration floor of this call, the wait time actual-result
20 totalization module 37 totalizes the wait time T_1 as an operation actual result at this time (step S104). At the same time, when the assigned car has responded, in answer to a up/down call, to the registration floor of this call, the no-response time actual-result
25 totalization module 38 totalizes the no-response time T_3 as an operation actual result at this time (step S105).

In the meantime, the group management control apparatus 30 includes an operation state monitoring
30 module (not shown) which monitors the operation state of each car. The wait time actual-result totalization module 37 and the no-response time actual-result totalization module 38 determine the response states of the cars through this operation state monitoring
35 module. In addition, the operation state monitoring module includes a function of deleting the information on the destination call from the destination call

assignment memory module 31 when the assigned car of
this destination call has arrived at the destination
floor, and deleting the information on the up/down call
from the up/down call assignment memory module 32 when
5 the assigned car of this up/down call has arrived at
the registration floor of this call.

The totalization processes of the wait time T_1 and
no-response time T_3 are continuously executed during
normal operations. The totalization results are
10 delivered to the weighting adjustment module 39.

The weighting adjustment module 39 compares an
average value of the wait time T_1 totalized by the wait
time actual-result totalization module 37, and an
average value of the no-response times T_3 totalized by
15 the no-response time actual-result totalization module
38 (step S106). As a result of comparison, if the
average value of the wait time T_1 is greater than the
average value of the no-response time T_3 (Yes in step
S106), the weighting adjustment module 39 raises the
20 weighting factor p for the wait time T_1 of the above-
described first evaluation formula E_1 to a higher value
than in the fixed mode (step S107).

For example, when the weighting factor p is $p =$
0.6 in the fixed mode, the weighting factor p is set at
25 $P = 0.7$. To raise the weighting factor p for the wait
time T_1 is to execute assignment control by placing a
higher priority on the wait time T_1 than in the fixed
mode.

On the other hand, if the average value of the
30 wait time T_1 is less than the average value of the no-
response time T_3 (No in step S106), the weighting
adjustment module 39 lowers the weighting factor p for
the wait time T_1 of the above-described first
evaluation formula E_1 to a lower value than in the
35 fixed mode (step S108).

For example, when the weighting factor p is $p =$
0.6 in the fixed mode, the weighting factor p is set at

$P = 0.5$. To lower the weighting factor p for the wait time T_1 is to execute assignment control by placing a higher priority on the no-response time T_3 than in the fixed mode.

5 Specifically, since the "priority on the travel time T_2 is raised, relative to the wait time T_1 ", assignment is executed such that the wait time T_1 becomes longer and the travel time T_2 becomes shorter. As a result, a higher priority is placed on the no-
10 response time T_3 than on the wait time T_1 , and the balance between the wait time T_1 and the no-response time T_3 is corrected.

 In the meantime, in the above-described embodiment, when the weighting factor p is adjusted,
15 the weighting factor p is made higher or lower by 0.1 than in the fixed mode. However, the amount of adjustment of the weighting factor p is not limited to 0.1, and may be any other value. Furthermore, the adjustment value of the weighting factor p may be
20 varied stepwise in accordance with the difference between the average value of the wait time T_1 and the average value of the no-response time T_3 .

 In this manner, based on the totalization results of the wait time T_1 and the no-response time T_3 , the
25 weighting factor p for the wait time T_1 of the first evaluation formula E_1 is adjusted. Thereby, the feelings of inequality of wait time between the destination call and the up/down call can be reduced.

 In particular, when the first floor 23, at which
30 the first call registration device 21 is disposed, is not congested, the advantage of the destination call is not exhibited, and there is a tendency that the wait time of the destination call becomes longer than the wait time of the up/down call. In such a case, by
35 adjusting the weighting factor p , the operation service can be performed, with the feelings of inequality of wait time between the destination call and the up/down

call being reduced.

(Second embodiment)

Next, a second embodiment is described.

In the first embodiment, when the first floor 23,
5 at which the first call registration device 21 is
disposed, is not congested, the weighting factor p is
adjusted according to whether the average value of the
wait time T_1 is larger or smaller than the average
value of the no-response time T_3 . However, in the
10 situation that the average value of the wait time T_1
and the average value of the no-response time T_3 are
substantially equal, it is not always necessary to
adjust the weighting factor p .

Thus, in the second embodiment, the weighting
15 factor p is adjusted only when the difference between
the average value of the wait time T_1 and the average
value of the no-response time T_3 is a predetermined
value or more.

Since the basic apparatus structure is the same as
20 in FIG. 1, a description is given of only the process
operation of the group management control apparatus 30
with reference to FIG. 6.

FIG. 6 is a flowchart illustrating a process
operation of the group management control apparatus 30
25 in the second embodiment. The process illustrated in
this flowchart is executed by a predetermined program
being read in the group management control apparatus 30
which is a computer.

In the flowchart of FIG. 6, steps S201 to S206 are
30 the same as steps S101 to S106 in the flowchart of
FIG. 3. Specifically, to start with, the congestion
condition of each floor is determined (step S201).
Then, when the first floor 23, at which the first call
registration device 21 is disposed, is congested, the
35 fixed mode is applied to the first evaluation formula
 E_1 and assignment control is executed (steps S202 and
S203).

When the first floor 23 is not congested, the average value of the wait time T_1 and the average value of the no-response time T_3 are compared in order to adjust the weighting factor p for the wait time T_1 of the first evaluation formula E_1 (steps S204 to S206).

In this case, in the second embodiment, if the average value of the wait time T_1 is greater than the average value of the no-response time T_3 (Yes in step S206), the weighting adjustment module 39 determines whether the difference between both the average values is a predetermined value or more (step S207).

Specifically, the difference between the average value of the wait time T_1 and the average value of the no-response time T_3 is calculated, and it is determined whether a ratio, which is obtained by dividing this difference by the wait time T_1 , is a predetermined value or more (e.g. 0.5 or more).

When the average value of the wait time $T_1 >$ the average value of the no-response time T_3 ,

$$r_1 = |T_1 - T_3|/T_1 \quad \dots(1)$$

where r_1 is a ratio, T_1 is the average value of wait time T_1 , and T_3 is the average value of no-response time T_3 . If the result of the above equation (1) is 0.5 or more, the weighting adjustment module 39 determines that the adjustment of the weighting factor p is necessary.

For example, if $T_1 = 60$ seconds and $T_3 = 30$ seconds, then $r_1 = 0.5$ and it is determined that the adjustment of the weighting factor p is necessary. In addition, if $T_1 = 60$ seconds and $T_3 = 40$ seconds, then $r_1 = 0.3$ and it is determined that the adjustment of the weighting factor p is not necessary.

When there is a difference of the above-described predetermined value or more and it is determined that the adjustment of the weighting factor p is necessary (Yes in step S207), the weighting adjustment module 39 raises the weighting factor p for the wait time T_1 of

the first evaluation formula E_1 to a higher value than in the fixed mode (step S208). For example, when $p = 0.6$ in the fixed mode, the weighting factor p is set at $P = 0.7$. The first evaluation module 34 evaluates each car by using the first evaluation formula E_1 in which the weighting factor p has been adjusted.

When there is no difference of the above-described predetermined value or more and it is determined that the adjustment of the weighting factor p is not necessary (No in step S207), the weighting adjustment module 39 does not adjust the weighting factor p , and the currently set value of the weighting factor p is kept as such.

The same applies to the case in which the average value of the wait time T_1 is less than the average value of the no-response time T_3 (No in step S206). The weighting adjustment module 39 determines whether the difference between both the average values is a predetermined value or more (step S209).

Specifically, the difference between the average value of the wait time T_1 and the average value of the no-response time T_3 is calculated, and it is determined whether a ratio, which is obtained by dividing this difference by the response time T_3 , is a predetermined value or more (e.g. 0.5 or more).

• When the average value of the wait time $T_1 <$ the average value of the no-response time T_3 ,

$$r_2 = |T_1 - T_3|/T_3 \quad \dots(2)$$

where r_2 is a ratio, T_1 is the average value of wait time T_1 , and T_3 is the average value of no-response time T_3 . If the result of the above equation (2) is 0.5 or more, the weighting adjustment module 39 determines that the adjustment of the weighting factor p is necessary.

For example, if $T_1 = 30$ seconds and $T_3 = 60$ seconds, then $r_2 = 0.5$ and it is determined that the adjustment of the weighting factor p is necessary. In

addition, if $T_1 = 40$ seconds and $T_3 = 60$ seconds, then $r_2 = 0.3$ and it is determined that the adjustment of the weighting factor p is not necessary.

5 When there is a difference of the above-described predetermined value or more and it is determined that the adjustment of the weighting factor p is necessary (Yes in step S209), the weighting adjustment module 39 lowers the weighting factor p for the wait time T_1 of the first evaluation formula E_1 to a lower value than
10 in the fixed mode (step S210). For example, when $p = 0.6$ in the fixed mode, the weighting factor p is set at $P = 0.5$. The first evaluation module 34 evaluates each car by using the first evaluation formula E_1 in which the weighting factor p has been adjusted.

15 When there is no difference of the above-described predetermined value or more and it is determined that the adjustment of the weighting factor p is not necessary (No in step S209), the weighting adjustment module 39 does not adjust the weighting factor p , and
20 the currently set value of the weighting factor p is kept as such.

In the meantime, the amount of adjustment of the weighting factor p is not limited to 0.1, and may be any other value. Furthermore, the adjustment value of
25 the weighting factor p may be varied stepwise in accordance with the difference between the average value of the wait time T_1 and the average value of the no-response time T_3 .

In this manner, by adjusting the weighting factor p when the difference between the average value of the wait time T_1 and the average value of the no-response time T_3 is a predetermined value or more, it becomes
30 possible to prevent the weighting factor p from being unnecessarily adjusted when the difference between both the average values is small, and a disturbance in the
35 assignment evaluation can be prevented.

(Third embodiment)

Next, a third embodiment is described.

Since all users register destination calls without fail, one call corresponds to one user. On the other hand, an up/down call is registered by only the first one of the users, if the users agree with respect to the "registration floor and the direction of use". Thus, the number of users per up/down call is not limited to one.

In this case, the wait time is a time from when a user registers a call at an elevator hall to when an assigned car responds. Since the wait time (T_1) of a destination call is defined with respect to each of users, the wait time (T_1) can be easily calculated.

However, the wait time of an up/down call is not defined with respect to each of users. Thus, when plural users get in a car by one call, it is necessary to consider the number of the second and following users, and the time of occurrence of each user. For example, in a case where a second user has come to an elevator hall after a first user registered an up/down call, an expectation value of the wait time of the second user is about half the wait time of the first user.

In this manner, as regards the up/down call, since the number of users per call is different, it is preferable to execute evaluation in consideration of the number of users, in order to secure the equality between the up/down call and the destination call.

Thus, in the third embodiment, the feelings of inequality of the wait time between the destination call and the up/down call are reduced by correcting the no-response time T_3 that is the target of evaluation of the up/down call by taking into account the wait times for the number of users.

FIG. 7 is a block diagram illustrating a structure of a group management system of elevators according to

the third embodiment. In FIG. 7, the same parts as those in FIG. 1 of the first embodiment are denoted by like reference numerals, and a description thereof is omitted.

5 In the third embodiment, the group management control apparatus 30 includes a number-of-users totalization module 42. In addition, the congestion condition determination module 40 and number-of-users totalization module 42 are connected to the second
10 evaluation module 35.

 The number-of-users totalization module 42 totalizes the number w of users per up/down call with respect to each floor. The "number of users per up/down call" is the number of users who get in a car
15 which has responded to an up/down call when the up/down call has been registered. The number of users at this time can be estimated from a variation in load of the car. Incidentally, it is assumed that the number of users is totalized by classifying up/down calls into an
20 up call and a down call.

 The second evaluation module 35 corrects the no-response time T_3 of each car, based on the number w of users totalized by the number-of-users totalization module 42, and applies the corrected no-response time
25 T_3 to the second evaluation formula E_2 . In addition, the second evaluation module 35 applies the corrected no-response time T_3 to the second evaluation formula E_2 , only when the congestion condition determination module 40 has determined that the second floor 24 is
30 congested.

 FIG. 8 is a flowchart illustrating a process operation of the group management control apparatus 30 in the third embodiment. The process illustrated in this flowchart is executed by a predetermined program
35 being read in the group management control apparatus 30 which is a computer.

 To start with, the congestion condition

determination module 40 provided in the group management control apparatus 30 determines the congestion condition of the elevator hall of each floor (step S301).

5 As has been described in the first embodiment, the methods of determining the congestion condition include (1) a method of determination from a time zone, (2) a method of determination from a load variation, and (3)
10 a method of determination from information on destination calls. In addition, the "congested condition" means the condition in which a predetermined number or more of users are waiting for an elevator
15 (car) (for example, the number of users waiting for a car is double or more the rated number of persons of the car).

 If the second floor 24, at which the second call registration device 22 (the registration device of up/down calls) is disposed, is not congested (No in
20 step S302), the fixed mode is applied to the second evaluation formula E_2 and assignment control is executed (step S303).

 Specifically, when an up/down call has been registered, the second evaluation module 35 evaluates each car by using the above-described second evaluation
25 formula E_2 . In this case, as regards the no-response time T_3 that is the target of evaluation, the time from when the up/down call is registered to when the car responds is estimated. In the meantime, as regards the destination call, as has been described in connection
30 with the first embodiment, it is assumed that the first evaluation module 34 evaluates each car by adjusting the weighting factor p in accordance with the congestion condition.

 If it is determined that the second floor 24 is
35 congested (Yes in step S302), the following process is executed. In the meantime, the second floor 24 is congested, for example, in a time zone of the end of

working hours, when the number of users of elevators is large on floors other than the reference floor.

Specifically, when an up/down call has been registered by the second call registration device 22,
5 the number-of-users totalization module 42 totalizes the number w of users per up/down call (step S304). To be more specific, when the up/down call has been registered, the number of users getting in the car, which has responded to the up/down call, is estimated
10 from the variation in load of the car, and this number of users in the car is totalized as the number w of users per up/down call.

In this case, it is assumed that the number of users is totalized by classifying up/down calls into a
15 up call and a down call with respect to each of the floors. The totalization process of the number w of users is continuously executed during normal operations. When the second floor 24 is congested, the totalization result is delivered to the second
20 evaluation module 35.

The second evaluation module 35 corrects the no-response time T_3 , based on the number w of users (step S305). Specifically, according to the following equation, the no-response time T_3 is corrected by
25 substituting the no-response time T_3 for the wait time of users.

$$T_4 = w \times T_3' \quad \dots(3)$$

where w is the number (estimated value) of users per up/down call, T_3' is a value obtained by substituting
30 the wait time of users for the no-response time T_3 , and T_4 is a value corresponding to the sum of wait times of users (no-response time after correction).

When $w = 1$, $T_3' = T_3$. When $w \neq 1$ (excluding $w = 0$), T_3' can be obtained by the following equation:

35
$$T_3' = \{T_3 + T_3 \times (w - 1)/2\}/w \quad \dots(4)$$

Specifically, when the number of users is one, the no-response time T_3 becomes a wait time of a user as

such. On the other hand, when the number of users is two or more, the no-response time T_3 is changed to a wait time corresponding to the number w of users at that time.

5 For example, if $T_3 = 30$ seconds, T_4 takes the following values in accordance with the number w of users:

 One user: $T_4 = 30$ seconds,

 Two users: $T_4 = 45$ seconds,

10 Three users: $T_4 = 60$ seconds, and

 Four users: $T_4 = 75$ seconds.

 The second evaluation module 35 evaluates each car by using this value of T_4 as the no-response time T_3 after correction, and by applying the second evaluation
15 formula E_2 (step S306).

 In this manner, by correcting the no-response time T_3 of the up/down call in accordance with the number of users, and by executing evaluation with the corrected value as the wait time of users, the feelings of
20 inequality of wait time between the destination call and the up/down call can be reduced. In particular, by changing to this evaluation method in the situation that the second floor 24, at which the second call registration device 22 is disposed, is congested, the
25 operation service can be performed while the feelings of inequality can effectively be reduced.

 According to at least one of the above-described embodiments, a group management system of elevators can be provided, which can perform operation services while
30 reducing the feelings of inequality of wait time between the destination call and the up/down call.

 In the meantime, in each of the embodiments, such a structure is adopted that the weighting on the assignment evaluation of the destination call is
35 adjusted in order to keep the balance in wait time between the destination call and the up/down call. Alternatively, the weighting on the assignment

evaluation of the up/down call may be adjusted.

While certain embodiments have been described,
these embodiments have been presented by way of example
only, and are not intended to limit the scope of the
5 inventions. Indeed, the novel embodiments described
herein may be embodied in a variety of other forms;
furthermore, various omissions, substitutions and
changes in the form of the embodiments described herein
may be made without departing from the spirit of the
10 inventions. The accompanying claims and their
equivalents are intended to cover such forms or
modifications as would fall within the scope and spirit
of the inventions.

WHAT IS CLAIMED IS:

1. A group management system of elevators, the system comprising a first call registration device configured to register a destination call of a user at
5 a first floor, and a second call registration device configured to register an up/down call of a user at a second floor which is different from the first floor, comprising:
 - an operation estimation module configured to
10 estimate a future operation of each of cars when a call has been registered by the first or second call registration device, taking into account calls including an assignment-completed call;
 - a first evaluation module configured to calculate,
15 with respect to the destination call, a first evaluation value at a time when each of the cars is operated, in accordance with an estimation result of the operation estimation module, by using a first evaluation formula in which a wait time and a travel
20 time are targets of evaluation;
 - a second evaluation module configured to calculate, with respect to the up/down call, a second evaluation value at a time when each of the cars is operated, in accordance with the estimation result of
25 the operation estimation module, by using a second evaluation formula in which a no-response time is a target of evaluation;
 - an assigned car determination module configured to select an assigned car from among the cars, based on
30 the first evaluation value obtained by the first evaluation module and the second evaluation value obtained by the second evaluation module, and to cause the selected assigned car to respond;
 - a first totalization module configured to totalize
35 a wait time at a time when an assigned car responds, by the destination call, to a registration floor of the destination call;

a second totalization module configured to totalize a no-response time at a time when an assigned car responds, by the up/down call, to a registration floor of the up/down call; and

5 a weighting adjustment module configured to adjust weighting of assignment evaluation in the first or second evaluation module, based on an average value of the wait time totalized by the first totalization module and an average value of the no-response time
10 totalized by the second totalization module.

2. The system of Claim 1, wherein the weighting adjustment module is configured to raise the weighting on the wait time of the first evaluation formula to a higher value than a reference value, when the average
15 value of the wait time totalized by the first totalization module is greater than the average value of the no-response time totalized by the second totalization module.

3. The system of Claim 1, wherein the weighting adjustment module is configured to raise the weighting on the wait time of the first evaluation formula to a higher value than a reference value, when the average
20 value of the wait time totalized by the first totalization module is greater than the average value of the no-response time totalized by the second totalization module and a difference between the
25 average value of the wait time and the average value of the no-response time is a predetermined time or more.

4. The system of Claim 1, further comprising a
30 congestion condition determination module configured to determine a congestion condition of each floor, and

 wherein the first evaluation module is configured to apply weighting after adjustment by the weighting adjustment module to the first evaluation formula, when
35 the congestion condition determination module has determined that the first floor is not congested.

5. The system of Claim 1, further comprising a

third totalization module configured to totalize a number of users per up/down call registered by the second registration device, and

wherein the second evaluation module is configured to execute assignment evaluation by correcting the no-response time of each car, based on the number of users totalized by the third totalization module, and by applying the corrected no-response time to the second evaluation formula.

6. The system of Claim 5, further comprising a congestion condition determination module configured to determine a congestion condition of each floor, and

wherein the second evaluation module is configured to execute assignment evaluation by correcting the no-response time of each car, based on the number of users totalized by the third totalization module, when the congestion condition determination module has determined that the second floor is congested, and by applying the corrected no-response time to the second evaluation formula.

7. The system of Claim 4 or Claim 6, wherein the congestion condition determination module is configured to determine the congestion condition of each floor, based on a time zone.

8. The system of Claim 4 or Claim 6, wherein the congestion condition determination module is configured to determine the congestion condition of each floor, based on a variation in live load at a time when each car has responded to each floor.

9. The system of Claim 4 or Claim 6, wherein the congestion condition determination module is configured to determine the congestion condition of each floor, based on information on a destination floor of a user, the information being included in the destination call registered by the first call registration device.