

METHOD AND APPARATUS FOR DISPLAYING DATA OF GROUP SUPERVISORY CONTROL OF ELEVATORS

CROSS REFERENCE TO RELATED APPLICATIONS

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This application claims the foreign priority benefit under Title 35, United States Code, §119(a)-(d) of Japanese Patent Application Publication No. 2006-188932 filed on July 10, 2006 in the Japan Patent Office, the disclosure of which is herein incorporated by reference in its entirety.

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BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

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The present invention relates to a method and an apparatus for displaying data of a group supervisory control of elevators through which a comprehensive control of operation of a plurality of elevators is performed.

DESCRIPTION OF THE RELATED ART

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A supervisory control system of elevators provides an operating service to a user in a more efficient manner, by handling a plurality of elevator cars as one group.

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To be specific, a plurality of elevator cars (typically 3 to 8 cars) are controlled as one group, and when an elevator stop call is registered at a floor, a most appropriate car is selected among the cars and then a process of allocating the selected car to the elevator stop call is performed.

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In the present elevator group supervisory control system, a selection of a car to be allocated is made using an evaluation function having a plurality of evaluation items. Each a membership function of a fuzzy control and an input/output function of a neural network can be employed as an evaluation function. When a new elevator stop call is registered, an evaluation value of each car is calculated based on the evaluation function, assuming that each car is allocated provisionally to the newly registered elevator stop call, and a car having the best evaluation value is allocated to the elevator stop call. For instance, if it is assumed that the evaluation is performed only by a

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predicted waiting time after the newly registered elevator stop call, the predicted waiting time of each car to the newly registered elevator stop call (corresponding to a predicted arrival time at the floor) is calculated and a car which has gotten the lowest evaluation value is allocated to the newly registered elevator stop call.

In the elevator group supervisory control system which performs the above-described control, a method which enables to understand an operating status and a control status easily is disclosed in Japanese Laid-open Patent Application Publication No. 06-100249.

In the Japanese Laid-open Patent Application Publication No. 06-100249, an evaluation index indicating a non-uniformity degree of a position of each car is calculated based on data of a present position and a moving direction of each elevator car, and a method for displaying a change with time of the index being combined with an operating diagram indicating a status of an operation of each elevator car is disclosed.

In Japanese Laid-open Patent Application Publication No. 2001-139248, an example in which a predicted evaluation value being utilized for determining an operation and an actual value corresponding to the predicted evaluation value are displayed at the same time is disclosed. The predicted evaluation value means a predicted value when a car is allocated to an elevator stop call. To be specific, a predicted number of stops, a predicted running time, a predicted time for opening/closing a door and a predicted time for getting on and off are listed.

According to the conventional arts, it is difficult to evaluate and examine whether an allocation operation is performed properly in response to an allocation control which is a point of the elevator group supervisory control.

In the Japanese Laid-open Patent Application Publication No. 06-100249, because the index value indicating the non-uniformity degree of the position of each car being calculated based on data of the present position and the moving direction of each elevator car is displayed in combination with the operation diagram, the index value indicating the non-uniformity degree of a position of each car being obtained as a result of the allocation control and the operation diagram can be understood. However, with the above information only, it is unknown how effectively the allocation control operated. For instance, a result is assumed such that each the index

indicating the non-uniformity degree and the operation diagram indicates that each elevator is at an equal-interval position. However, it is understood only by an imagination whether the result is attributed to the allocation control, whether the result is brought by chance, and further, which evaluation item among the plurality of evaluation items operates effectively, even if the preferable result can be attributed to the allocation control.

Specifically, because it seems difficult for each elevator car to keep the equal-interval position relationship constantly, a much deflected position relation may possibly occur in actuality. Because the index indicating the non-uniformity degree of the present position and the operation diagram indicate a result of the control only, it is difficult to understand why such a result is brought.

In the Japanese Laid-open Patent Application Publication No. 2001-139248, the predicted evaluation value which is utilized for determining the operation and the actual value corresponding to the predicted evaluation value are displayed at the same time. However, as the predicted evaluation value therein, To be specific, the predicted number of stops, the predicted running time, the predicted time for opening/closing the door and the predicted time for getting on and off are listed. Because the above data relate to the operation of the elevator group supervisory control, it is difficult to determine whether the allocation control is performed properly, by referring to the data. For instance, even if the predicted number of stops coincides with an actual number of stops, it can not be said that the coincidence occurs because the allocation control operates properly. A comparison between the predicted number of stops and the actual number of stops indicates only an accuracy of the prediction. Again, even if the predicted evaluation value and the actual value are compared as described in the conventional art, only the accuracy of the prediction is indicated, and it is not indicated how the allocation control effects to a difference therebetween. The difference does not occur by the effect of the allocation control. Accordingly, with the method being described in the conventional art, it is difficult to evaluate and examine whether the allocation control is performed properly.

SUMMARY OF THE INVENTION

The present invention seeks to provide a method and an apparatus for displaying data which enables to evaluate and examine whether an allocation operation is performed properly in an allocation control through which an elevator car is selected and allocated to an elevator stop call using an allocation evaluation index including a plurality of allocation evaluation items.

According to an aspect of the present invention, in a method for displaying data of a group supervisory control of elevators, including: controlling an operation of a plurality of elevators; and selecting an elevator car to be allocated to a registered elevator stop call based on an evaluation index including a plurality of evaluation items, a predicted value and an actual value of a performance index of each elevator being under the group supervisory control or a relation between the predicted value and the actual value is displayed in a chronological order.

According to another aspect of the present invention, the predicted value and the actual value of the performance index of the group supervisory control or the relation between the predicted value and the actual value is displayed on a time axis.

According to a preferred embodiment of the present invention, a difference between the predicted value and the actual value is calculated as a relation between the predicted value and the actual value, and a width corresponding to the difference is displayed in a chronological order.

According to further another aspect of the present invention, the performance index of the group supervisory control is displayed in a chronological order, and a contribution degree of each evaluation item to the allocation to an elevator stop call is displayed in a chronological order.

According to the preferred embodiment of the present invention, in the allocation control which selects an appropriate elevator car based on the evaluation index including the plurality of evaluation items, it is possible to evaluate and examine understandably whether the allocation operation is performed properly.

According to a more concrete preferred embodiment, it can be indicated how an operation of the group supervisory control is improved by the allocation control, and can be indicated how each evaluation item of the

evaluation index effects to the result of the improvement understandably and clearly.

Consequently, the allocation operation of the elevator supervisory control system being under operating in a building can be evaluated and examined easily, and even when an undesirable operation occurs in the worst case, the undesirable operation can be understood easily and an improvement of the performance can be followed thereto.

Further, even a person who does not have an expertise on the elevator supervisory control can evaluate easily whether the allocation operation is performed properly, can make the performance evaluation easily, and even for a group supervisory control of a larger number of elevators, the present invention can provide an elevator group supervisory control system which performs a more stable performance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a configuration diagram of an elevator group supervisory control system being provided with an apparatus for displaying data of a group supervisory control of elevators according to a preferred embodiment of the present invention.

FIG. 2 is a drawing summarizing a feature and a performance index of each evaluation item being included in an allocation evaluation index of the elevator group supervisory control system of elevators.

FIG. 3 is a block diagram showing a detailed function of a control data calculation unit according to the preferred embodiment of the present invention.

FIG. 4 is a drawing summarizing a predicted performance index and an actual performance index of each an evaluation of a car interval at a time in future and an evaluation of a waiting time after an elevator stop call to be predicted, according to the preferred embodiment of the present invention.

FIG. 5 is a block diagram showing a detailed function of a statistical calculation unit, according to the preferred embodiment of the present invention.

FIG. 6 is an example of a screen display of an apparatus for displaying data of the group supervisory control of elevators according to the preferred embodiment of the present invention.

FIG. 7 is an example of a screen display of an apparatus for displaying data of the group supervisory control of elevators according to another preferred embodiment of the present invention.

5 FIG. 8 is a processing flow chart of a control data calculation unit (refer to FIG. 3), according to the preferred embodiment of the present invention.

FIG. 9 is a processing flow chart for calculating a performance index of a car interval, according to the preferred embodiment of the present invention.

10 FIG. 10 is a processing flow chart for calculating a performance index of along waiting time, according to the preferred embodiment of the present invention.

FIG. 11 is a processing flow chart of a method for calculating a contribution degree of an evaluation value of a waiting time after a registered call, according to the preferred embodiment.

15 FIG. 12 is a processing flow chart of a method for calculating a contribution degree of a non-uniformity of a car interval according to the preferred embodiment.

20 FIG. 13 is a processing flow chart of a method for calculating a contribution degree of an evaluation of a long waiting time after an elevator stop call to be predicted according to the preferred embodiment.

FIG. 14 is a configuration diagram of a computer simulator having an apparatus for displaying data according to another preferred embodiment of the apparatus for displaying data of the group supervisory control of elevators of the present invention.

25 FIG. 15 shows a status in which the apparatus for displaying data of a group supervisory control of elevators is used.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

30 Hereunder, a description is given on a preferred embodiment according to the present invention, referring to the drawings.

FIG. 1 is a configuration diagram of an elevator group supervisory control system having an apparatus for displaying data of the group supervisory control of elevator apparatus composed of elevator devices
35 according to a preferred embodiment of the present invention. Each of n elevator devices of "61", "62", ---, "6n" is provided with an elevator car, a drive

unit, a weight and a rope, etc.. The elevator devices are controlled by an elevator controller "71", "72", ---, "7n", each. Each elevator stop call registration unit "81", "82", ---, "8n" is installed at a hall of each floor. In FIG. 1, while the n elevators are aligned vertically, the elevators are aligned horizontally in fact.

In order to control the n elevator devices comprehensively, an elevator group supervisory controller 10 is provided. The elevator group supervisory controller 10 includes a control panel, a control board with a microcomputer, etc., and a process computer, etc.. The elevator group supervisory controller 10 includes, as a functional unit being related to the preferred embodiment, a group supervisory controller 101, a control data calculation unit 102, a statistical calculation unit 103, a time data unit 104, and a storage unit 105.

Meanwhile, in order to complete the preferred embodiment of the present invention, a control data display unit 20 including a computer (including a personal computer), a mobile terminal and a desk top terminal, etc., is provided. The control data display unit 20 includes a display output unit 21 and a display condition setting unit 22.

A storage media 3, a communication line 4 and a printer 5 which prints results on the control data display unit 20, are installed between the control data display unit 20 and the elevator group supervisory controller 10.

In the above-described configuration, the control data calculation unit 102, the statistical calculation unit 103 and the display output unit 21 are main units indicating significant features of the control data display unit 20. A detailed description will be given hereinafter.

Firstly, at a hall of each floor, a user registers an elevator stop call of a direction in which he wants to go, by pressing a button of one of the registration units "81", "82", "83" ---. For instance, it is assumed that an elevator stop call in an upward direction is registered at the third floor. The elevator stop call information is transmitted to the elevator group supervisory controller 10. The elevator group supervisory controller 10 calculates an evaluation value, that is, an allocation evaluation index, at the group supervisory controller 101, using an allocation evaluation function based on information from each elevator controller "71", "72", ---, "7n", assuming that each elevator car provides a service to the elevator stop call. The information from each elevator controller "71", "72", ---, "7n" includes a position of each elevator, an operation status such as a speed, a car call, the

number of passengers who are on board, a duration time of a call which has been already allocated and a boarding time, etc..

A car to which a best allocation evaluation index is given is selected and the car is allocated to the elevator stop call.

5 The allocation evaluation index is a multipurpose evaluation function including a plurality of evaluation items, as expressed in equation (1), for example.

$$F(k) = \sum_{i=1}^M \{W_i \times F_i(k)\} \text{-----} (1)$$

10 In equation (1), $F(k)$ is a synthetic evaluation value of a "n"th car (hereinafter "n" car), " $f_i(k)$ " is an evaluation value of "i"th evaluation item on "k" car, " w_i " is a weighting coefficient and "M" is a total number of the evaluation items. As the evaluation item, the followings are listed:

15 (1) A predicted waiting time, that is, a predicted waiting time after a newly registered elevator stop call, or a predicted waiting time for an elevator stop call already allocated.

 (2) A position relation with time between each car.

 (3) A boarding rate in a car.

 (4) On board time.

20 (5) A waiting time after a elevator stop call to possibly come.

A synthetic evaluation value " $F(k)$ " is calculated for each car, and then, a car which is given a best value (a minimum value in general) is selected to be allocated.

25 The control data calculation unit 102 in the elevator group supervisory controller 10 calculates a control data such as a performance index value and a contribution degree of an evaluation value both of which are described hereinafter, based on the information being employed in the allocation evaluation. The control data constitute indexes for evaluating whether an allocation operation is performed properly. The statistical calculation unit
30 103 performs a statistical calculation on each control data being calculated at the control data calculation unit 102. The storage unit 105 registers the above data together with data on the elevator operation which are transmitted from the time data unit 104 and the group supervisory controller 101

35 The data which is recorded in the storage unit 105 are forwarded to the control data display unit 20, through a storage media such as a memory card,

a hard disk, a floppy disk (a registered trademark), etc., and a communication line 4.

In the control data display unit 20, the display output unit 21 displays a graph of a change with respect to time of each control data being drawn on a time axis on a screen, based on the control data (being applied a statistics processing), the operation data and the time data which are forwarded. The display condition setting unit 22 sets a mode of the graph, etc., to be displayed. The printer 5 prints a graph of each control data with regard to the time axis displayed at the display output unit 21, on a paper, etc..

The configuration of the elevator group supervisory control system having the data display device of the group supervisory control of an elevator apparatus, according to the preferred embodiment of the present invention is described as above. As described above, the significant features of the preferred embodiment are represented by the control data calculation unit 102, the statistical calculation unit 103 in the elevator group supervisory controller 10, and the display output unit 21 in the control data display unit 20.

Referring to FIG. 2, a description is given about features of the evaluation items included in the allocation evaluation index in the elevator group supervisory control which is a background of the present invention, and about indexes for learning a performance of each evaluation item which is an object of the present invention.

FIG. 2 summarizes the features of the evaluation items being included in the allocation evaluation index in the elevator group supervisory control and the index for learning the performance of each evaluation item. While the allocation evaluation index includes the plurality of evaluation items as shown in equation (1), the evaluation items being related to the waiting time which is a basic performance is divided to the following two groups:

- 1) An evaluation group to a registered elevator stop call.
- 2) An evaluation group to an elevator stop call to be predicted.

From a macroscopic point of view, it can be considered that the allocation evaluation function is regarded as constituted by the above two evaluation groups, as shown in equation (2).

Allocation evaluation function =

Evaluation items which belong to the evaluation group to a registered elevator stop call + Evaluation items which belong to the

evaluation group to an elevator stop call to be predicted
----- (2)

In the evaluation group to the registered elevator stop call, the waiting
5 time after the registered elevator stop call is a main factor thereof. The
followings are examples of the evaluation:

a) A method in which the cars are allocated to make the maximum
waiting time as short as possible. The maximum waiting time is obtained
for each car allocation among the waiting times after the registered elevator
10 stop call is made.

b) A method in which the cars are allocated to make an average
waiting time as short as possible. The average waiting time is obtained for
each car allocation among the average waiting times after the registered
elevator stop call is made.

15 c) A method in which the cars are allocated to make a square sum of
the waiting time as small as possible. The square sum of the waiting time
is obtained for each car allocation among the square sums after the
registered elevator stop call is made.

In the evaluation group for the registered elevator stop call, the call is
20 already made and the performance of the allocation control can be
understood relatively easily, by the information of the operation diagram.
For instance, according to the Japanese Laid-open Patent Application
Publication No. 05-57193, an example of the operation diagram which
indicates an operation trajectory of each elevator and information of the
25 registered elevator stop calls on a time axis is disclosed.

The evaluation group for the elevator stop call to be predicted
corresponds to an evaluation for an elevator stop call not yet made, that is,
an evaluation for a potential elevator stop call to be predicted and includes
the following two factors:

30 1) An evaluation of a space interval or a time interval between
nearest cars at a time thereafter (at a time in future).

2) An evaluation of a waiting time after an elevator stop call to be
predicted, specifically of a long waiting time.

Each factor evaluates the potential waiting time after the elevator stop call
35 to be predicted. The former evaluates by an interval between nearest cars,
and is based on the following relation:

A time interval between nearest cars $\geq$

A waiting time after an elevator stop call to be made at a time in future at a floor between the nearest cars.

The latter evaluates thereof by the waiting time or a predicted arrival time at the floor directly.

The evaluation items, different from the evaluation group for the registered elevator stop call as described above, assumes an elevator stop call which is not registered at the time and may not occur. Therefore, the performance of the evaluation can not be understood easily. For instance, it can not be understood when the evaluation of a car interval is performed and on which elevator stop call to be predicted the evaluation is performed, even if the operation diagram is referred to, because no information is given in the operation diagram.

The present preferred embodiment shows clearly the performance of each evaluation item using an index called "performance index", on each of the two main evaluation items which belongs to the evaluation group to the elevator stop call to be predicted. To be specific, the indexes as described in FIG. 2 are used.

Firstly, in order to evaluate the space interval or the time interval between nearest cars at a time in future, a predicted value and an actual value of a non-uniformity degree of the space interval or the time interval between nearest cars are used as the indexes. A difference between the predicted value and the actual value of the non-uniformity degree of the intervals indicates an effect of an evaluation of the intervals between nearest cars at a time in future. That is, the predicted value of the non-uniformity degree of the intervals represents a non-uniformity degree of the car intervals between nearest cars which is evaluated based on the present value. If a car interval at a time in future is evaluated and applied to the above evaluation, the actual car interval is improved and the result brings an actual value of the non-uniformity degree of the intervals. Accordingly, referring to the difference, a degree of improvement of the actual value (corresponding to a status after control) to the predicted value (corresponding to a status before control) can be evaluated.

In a similar way, in order to evaluate the waiting time after the elevator stop call to be predicted, an index of a potential long waiting time after the elevator stop call to be predicted and an index of an actual long

waiting time after the registered elevator stop call are used. Briefly, the former means a predicted value of the potential long waiting time, and the latter means the actual long waiting time. The difference indicates an effect of the evaluation of the waiting time after the elevator stop call to be predicted. If the effect of the evaluation of the waiting time after the elevator stop call to be predicted is absent, it proves that the long waiting time is improved to a result being shown in the actual long waiting time by the effect of the evaluation, even though the long waiting time corresponding to the predicted value of the potential long waiting time occurs.

The content of the performance index of each of the above-described two evaluation items is summarized in FIG. 4. The predicted performance index and the actual performance index for the evaluation of the space interval or the time interval between nearest cars at a time in future, or the evaluation of the waiting time after the elevator stop call to be predicted are summarized in FIG. 4.

Main points of the present preferred embodiment based on FIG. 2 as described above are summarized here. Because an elevator stop call which does not exist really is assumed in the evaluation group for the elevator stop call to be predicted, the performance of the control can not be understood easily. On the other hand, according to the present preferred embodiment, as shown in FIG. 2, in order to evaluate the space interval or the time interval between nearest cars at a time in future, the predicted index value and the actual index value of the non-uniformity degree of the space interval or the time interval between each nearest cars are used as an index. Further, in the evaluation of the waiting time after the elevator stop call to be predicted, the potential long waiting time index to the elevator stop call to be predicted and the actual long waiting time index to the registered elevator stop call are used. Thereby, the performance of the evaluation for the elevator stop call to be predicted can be displayed by referring to the difference between each the index value, and the above problem can be resolved.

Hereunder, a detailed description is given on the control data calculation unit 102 and the statistical calculation unit 103 which are main points of the present preferred embodiment, referring to FIG. 3 and FIG. 5.

Firstly, a detailed description is given on the control data calculation unit 102, referring to FIG. 3. The control data calculation unit 102 is

roughly divided into the following three units: a performance index value calculating unit 1021, a contribution degree calculating unit 1024 which calculates the contribution degree of the evaluation value for the registered elevator stop call and a contribution degree calculating unit 1027 which
5 calculates the contribution degree of the evaluation to the elevator stop call to be predicted.

The performance index value calculating unit 1021 calculates the performance index of the evaluation item which constitutes the evaluation group to the elevator stop call to be predicted, as described in FIG. 2. There
10 are two kinds of performance indexes. One is the predicted performance index value and the other is the actual performance index value. To be specific, in evaluating the space interval or the time interval between nearest cars at a time in future, the predicted performance index value calculating unit 1022 calculates the predicted index value of the
15 non-uniformity degree of the space interval or the time interval between each of the nearest cars. The actual performance index value calculating unit 1023 calculates the actual index value thereof. In a similar way, in order to evaluate the waiting time after the elevator stop call to be predicted, the predicted performance index value calculating unit 1022 calculates the
20 potential long waiting time index. The potential long waiting time index corresponds to the predicted long waiting time. The actual performance index value calculating unit 1023 calculates the index for the actual long waiting time after the registered elevator stop call.

The contribution degree calculating unit 1024 performs the evaluation
25 for the registered elevator stop call. The contribution degree calculating unit 1027 performs the evaluation for the elevator stop call to be predicted and calculates the contribution degree indicating the contribution degree of the evaluation value which belongs to the two evaluation groups as shown in FIG. 2 in determining the allocation. The objection of calculating the
30 contribution degree is to show clearly the performance of each evaluation index value which belongs to either of the two evaluation groups, in order to analyze the performance of the difference between the predicted performance index value and the actual performance index value being calculated at the performance index value calculating unit 1021. Further to be specific, the
35 predicted performance index value and the actual performance index value are the performance indexes of the evaluation item for the elevator stop call

to be predicted. If the following relation is satisfied, the evaluation for the elevator stop call to be predicted works properly.

The former (predicted) > The latter (actual)

However, the actual allocation evaluation function is expressed as the equation (2) and the allocation is not necessarily determined only by the evaluation on the elevator stop call to be predicted. Therefore, by showing both the effect of the evaluation of the registered elevator stop call and the effect of the evaluation to the elevator stop call to be predicted, it could be clear how the predicted performance index value and the actual performance index value correlate each other in a tendency of the difference. For instance, if the predicted performance index value is larger than the actual performance index value, the effect of an evaluation on the elevator stop call to be predicted should be stronger, and if the predicted performance index value is smaller than the actual performance index value, the effect of the evaluation to the elevator stop call to be predicted should be weaker. Instead, the effect of the evaluation to the registered elevator stop call should be strong. Each the effect of the evaluation to the elevator stop call to be predicted and the effect of the evaluation to the registered elevator stop call is quantified as the contribution degree.

Firstly, the contribution degree calculating unit 1024 calculates the ranking of cars which are already allocated to the registered elevator stop calls, according to the evaluation value on the registered elevator stop call. The ranking calculating unit 1025 performs the calculation as above. The evaluation value contribution degree calculating unit 1026 calculates the contribution degree of the evaluation value to the registered elevator stop call, based on the above ranking. The higher the ranking, the higher becomes the contribution degree of the evaluation. For instance, if the ranking is the first, the contribution degree becomes 100 %. The contribution degree is defined as such.

The contribution degree calculating unit 1027 calculates the ranking of the car which is already allocated to a registered elevator stop call according to the evaluation value to the elevator stop call to be predicted. The ranking calculating unit 1028 performs the calculation as above. The evaluation value contribution degree calculating unit 1029 calculates the contribution degree of the evaluation value on the elevator stop call to be predicted, based on the above ranking.

A detailed explanation is given on a method for calculating each the contribution degree, hereinafter.

Next, referring to FIG. 5, a detailed explanation is given about the statistical calculation unit 103 as shown in FIG. 1. The statistical
5 calculation unit 103 performs an averaging operation on the result calculated at the control data calculation unit 102 (FIG. 3). That is, the average value is calculated on the predicted performance index value, the actual performance index value, the evaluation value contribution degree to the registered elevator stop call and each data group (data in a chronological
10 order) of the evaluation value for the elevator stop call to be predicted. The averaging operation is performed in order to extract a comprehensive performance by applying the averaging process (the same function as a low pass filter), because the values of the above data group which are calculated at the control data calculation unit 102 change largely with time and it is
15 difficult to catch the performance of each data.

The screening processing unit 1031 performs a processing of screening object data in the data group of the predicted performance index value and then, the average value calculating unit 1032 calculates an average value of the data group within a predetermined time range.

20 Here, data which are not desirable as the object are rejected by the screening process. For instance, if a car which stays at an elevator stop (a car which is not allocated to any elevator stop call and stops) exists, the non-uniformity degree index value of the time interval changes with time largely, in the predicted non-uniformity degree index of the space interval or
25 the time interval between each nearest cars. Because the car which stays can move in an upward and downward direction for service, the heavy change is attributed to a position relation between nearest cars which is not simple. In order to avoid the influence of the heavy change, the screening processing unit 1031 determines the existence of a car which stands by if any,
30 and performs a process for rejecting the data therein. In the same way, if the predicted performance index is the potential long waiting time index to the elevator stop call to be predicted, the potential long waiting time is hard to occur if a car which stands by exists, and thereby the value possibly changes largely, and the screening processing unit 1031 performs the process
35 for rejecting the data. Meanwhile, if it is presumed that the change of the performance index by the existence of the car staying is not necessarily a

wrong change, and the change reflects an actual status, instead, an improvement of the service performance to the elevator stop call to be predicted due to the existence of the car staying, the screening processing can be skipped.

5 The average value calculating unit 1032 performs the averaging operation in response to the number of the data group on a predetermined time range. For instance, an averaging on 5 minutes being assumed, the average value is calculated every 5 minutes. Meanwhile, instead of calculating the average value every predetermined time, the average value
10 among a predetermined number of samples can be calculated. By the averaging processing as above, the data group of the predicted performance index which change with time largely can be smoothed, and the comprehensive performance can be extracted.

15 On the data group of the actual performance index value, in the same way, the screening processing is performed (at the screening processing unit 1033) and the average value calculating unit 1034 calculates the average value on the predetermined time range.

20 In the data group of the contribution degree of the evaluation value (the evaluation value to the registered elevator stop call and the evaluation value to the elevator stop call to be predicted), in the same way as above, the average value calculating units 1035 and 1036 calculate the average value in the predetermined time range each. The data group of the contribution degree of the evaluation value can be smoothed, and the comprehensive performance thereof can be extracted, because the evaluation value changes
25 with time largely.

Returning to FIG. 1, details of the control data calculation unit 102 and the statistical processing unit 103 are described as above. The results are transferred to the control data displaying unit 20 and displayed in a graph on the display output unit 21. An example of the display is shown in FIG. 6.

30 Hereunder, a display result at the display output unit (process at the numeral "21" in FIG. 1) is described.

FIG. 6 is an example of a screen displayed on the data display unit of the elevator group supervisory control system according to the preferred embodiment of the present invention. It is a significant feature of the present preferred embodiment to display the data in such a way as shown in
35 FIG. 6, through calculating the control data such as the performance index,

etc., and performing the averaging processing. As such, the performance of the evaluation items for the elevator stop call to be predicted (described in FIG. 2) which is not easily understood can be shown understandably, and it becomes possible to evaluate and examine understandably whether the allocation operation is properly performed.

In the display area FG01 which corresponds to the screen of FIG. 6 or a printed paper, four graphs are shown, which display the followings.

1) A graph FG02 showing the operation trajectory of the cars under the group control (total number of cars is 3).

2) A graph FG03 which shows a change with time of the predicted value and the actual value of the non-uniformity index of the car interval, or the predicted value of the potential long waiting time index and the actual value of the long waiting time index after the elevator stop call to be predicted.

3) A graph FG04 which shows a change with time of the contribution degree of the evaluation value of the waiting time after the registered elevator stop call.

4) A graph FG05 which shows a change with time of the contribution degree of the evaluation value of the car interval, or the contribution degree of the evaluation value of the potential long waiting time after the elevator stop call to be predicted.

Firstly, the graph FG02 showing the operation trajectory of each car indicates a time dependent operation of each car on a graph in which a time is indicated in an abscissa and a car position (a floor number is taken as a unit) is indicated in an ordinate. Referring to the graph, a space interval of each car, etc., can be checked.

In the graph FG03 which shows a change with time of the predicted value and an actual value of the non-uniformity index of the car interval or the predicted value and the actual value of the potential long waiting time index after the elevator stop call to be predicted, time is indicated in the abscissa and the car position is indicated in the ordinate. A line FG03A which indicates the predicted value of the non-uniformity index of the car interval and a line FG03B which indicates the actual value are both shown on the graph. Here, the non-uniformity index of the car interval is calculated based on a variance of the car interval between nearest cars. The variation is an index indicating a degree of variance. The larger the

variation of the car interval (the non-uniformity is large), the variance grows larger. Consequently, the non-uniformity index of the car interval grows larger, too. As shown in the graph FG03A of FIG. 6, the non-uniformity index of the car interval of the actual value line FG03B is in a lower position than the predicted value line FG03A, indicating that the actual non-uniformity index of the car interval decreases as compared to the predicted non-uniformity index of the car interval. Namely, the actual non-uniformity of the car interval is improved as compared to the predicted non-uniformity of the car interval and it is understood that the evaluation of the non-uniformity of the car interval works effectively. If the evaluation of the non-uniformity of the car interval is not performed, the result as indicated by the predicted value line FG03A is given. It is understood that the improved result as indicated by the actual value line FG03B is given as a result of the effective effect being brought by the evaluation of the non-uniformity of the car interval. In this way, by displaying the predicted value and the actual value of the performance index indicating the non-uniformity index of the car interval, on the time axis on the graph, the effect of the evaluation of the non-uniformity of the car interval related to the performance index can be understood easily.

Here, the predicted value and the actual value of the performance index are displayed. Meanwhile, another method for displaying more understandably the improvement effect of the performance by the control can be applied. For instance, by displaying a width indicating the difference between the predicted value and the actual value of the performance index on the time axis, the degree of the improvement can be perceived directly. Further, by coloring the difference depending on the polarity thereof, it is obvious whether the improvement is done.

Meanwhile, while the data are displayed on the time axis in FIG. 6, if the data are displayed in a chronological order such that every instance when an allocation to an elevator stop call occurs, the data can be displayed on the expanded abscissa and a displaying effect can be attained, even if the data are not displayed on the abscissa according to the time.

Here, the non-uniformity index of the car interval and the evaluation of the non-uniformity of the car interval are exemplified. A similar effect can be obtained in the potential long waiting time index to the elevator stop call to be predicted and the evaluation of the potential long waiting time after the

elevator stop call to be predicted.

In the graph FG04 which shows a feature of the contribution degree of the evaluation value of the waiting time after the registered elevator stop call, the time is indicated in the abscissa and the contribution degree of the evaluation value of the waiting time after the registered elevator stop call is indicated in the ordinate. The change with time of the contribution degree of the evaluation value of the waiting time after the registered elevator stop call is indicated by the line FG04A. In the graph FG05 which shows the change with time of the contribution degree of the evaluation value of the car interval or the contribution degree of the evaluation value of the potential long waiting time after the elevator stop call to be predicted, the time is indicated in the abscissa and the contribution degree of the evaluation value of the potential long waiting time after the elevator stop call to be predicted is indicated in the ordinate. The change with time of the contribution degree of the evaluation value of the car interval or the contribution degree of the evaluation value of the potential long waiting time after the elevator stop call to be predicted is indicated by the line FG05A.

Referring to the two graphs of FG04 and FG05, the effect of each evaluation item on the difference between the predicted value and the actual value being shown in the graph FG03 which indicates the performance index can be analyzed clearly. For example, in the graph FG03 which indicates the performance index, in a time zone around 10:10 on the abscissa of the graph (in the vicinity of a point at about one third of the full scale), the actual value of the non-uniformity index of the car interval is larger than the predicted value thereof. Namely, it is doubtful if the evaluation of the non-uniformity of the car interval works properly. Hereunder, the status of the allocation evaluation in the time zone is examined referring to the graph FG04 which indicates the contribution degree of the evaluation value of the waiting time after the registered elevator stop call and the graph FG05 which indicates the contribution degree of the evaluation value of the car interval. Looking at the time zone around 10:10 of each graph, it proves that the contribution degree of the evaluation value of the waiting time after the registered call grows larger and the contribution degree of the evaluation value of the car interval grows smaller. Accordingly, it proves that because the allocation is determined by giving top priority to the waiting time after the registered elevator stop call in the time zone, the result of the evaluation

of the car interval does not cause a large influence on the predicted non-uniformity index value of the car interval grows worse than the actual non-uniformity index value of the car interval. In other words, in the time zone, the status is such that the registered elevator stop call should be given
5 priority over the elevator stop call to be predicted, that is, the waiting time after the registered elevator stop call becomes longer, in this case. Accordingly, it is understood that the control for reducing the waiting time after the registered elevator stop call is given top priority.

As described above, it may not be understood whether the allocation
10 evaluation works properly only by comparison between the predicted non-uniformity index value and the actual non-uniformity index value of the car interval. Then, by showing together the contribution degree of the evaluation value of the waiting time and the contribution degree of the evaluation value of the car interval to the registered elevator stop call, a
15 detail of the evaluation effect can be understood easily.

While the contribution degree of the non-uniformity index of the car interval and the evaluation value of the car interval are exemplified, a similar effect can be given by the potential long waiting time index to the elevator stop call to be predicted and the evaluation of the potential long
20 waiting time after the elevator stop call to be predicted.

FIG. 7 is an example of a screen display in the data display unit of the group supervisory control system of an elevator apparatus according to another preferred embodiment of the present invention, and shows an example in which the averaging operation to be performed by the statistical
25 calculation unit 103 (FIG. 5) is not applied to the control data in FIG. 6. Each of the four graphs FG02, FG03, FG04 and FG05 in FIG. 7, shows the similar content to the content in FIG. 6, but the averaging processing is not applied thereto. Therefore, each of the graph FG03 which indicates the predicted value and the actual value, the graph FG04 and the graph FG05
30 which indicate the contribution degree, shows large change of the wave shape with time, and consequently, the performance of each graph can not be understood easily. On the other hand, in each graph in FIG. 6, the comprehensive performance is extracted understandably by applying the averaging processing. As such, the comprehensive performance can be
35 extracted by the effect of the averaging processing being performed at the statistical calculation unit 103 (FIG. 5).

FIG. 8 indicates a flow chart of a processing which is performed by the control data calculation unit (FIG. 3) according to the preferred embodiment of the present invention. Hereunder, the flow of the processing is described. The performance index value is updated at a predetermined interval. When
5 a time for updating the performance evaluation comes (ST1), the predicted performance index value is calculated (ST2), and the actual performance index value is calculated (ST3). The contribution degree of the evaluation value is calculated every time the allocation evaluation is performed. Accordingly, , the allocation evaluation is performed to the newly registered
10 elevator stop call (ST4) after checking that a new elevator stop call is registered, the contribution degree of the evaluation value to the newly registered elevator stop call is calculated based on the allocation evaluation firstly (ST5). Next, the evaluation value contribution degree to the elevator stop call to be predicted is calculated (ST6).

15 FIG. 9 shows a flow chart of a calculation processing of the performance index value according to the preferred embodiment of the present invention. While the performance index value is classified into the two categories depending on the allocation evaluation item as shown in FIG. 2, the non-uniformity degree index of the car interval between nearest cars is taken
20 as an example in FIG. 9. The flow of the processing includes a calculation processing of the predicted index value of the car interval and a calculation processing of the index value of the car interval at the present time point (the actual index value of the car interval). Hereunder, the processing flow is described. Firstly, the time of prediction when the car interval is predicted
25 is input (ST21A). The time of prediction is set as a time at a certain time interval ahead. This certain time interval is, for instance, a time which an elevator car takes to travel from the bottom through the top and back to the bottom of the elevator apparatus. Next, the information on the position and the moving direction of each car or the information of the predicted operation
30 trajectory of each car at the time of prediction is input (ST22A). The car interval between a couple of nearest cars in the car travel direction at the time of prediction is calculated using the above information, and then the predicted value indicates a variance of each car interval, and can be calculated based on a variation of each car interval value, for example.
35 Next, a calculation of the index value of the car interval at the present time point (a time point when the processing is performed) is performed firstly by

inputting the information of the position and the moving direction of each car (ST31A). Based on the information, each car interval between nearest cars at the present time point can be calculated, and the non-uniformity index of the nearest car interval at the present time can be calculated using each car interval value (ST32A).

FIG. 10 shows a flow chart of the calculation processing of the performance index value according to the preferred embodiment of the present invention, and the long waiting time index after the elevator stop call to be predicted is taken as an example of the performance index value.

The processing includes a calculation processing of the long waiting time index after the elevator stop call to be predicted and a calculation processing of the long waiting time index which occurs actually to the registered elevator stop call. Hereunder, the processing flow is described. Firstly, a predicted floor where a long waiting time occurs is searched at the present time (a time when the processing is performed) (ST21B). For example, a predicted arrival time of each car at each floor where an elevator stop call is not made is calculated, and the search can be performed assuming that a floor having the long predicted arrival time is a predicted floor where a potential long waiting occurs. Next, the long waiting time index to the elevator stop call to be predicted can be calculated based on the search result of the predicted floor where the potential long waiting occurs (ST22B). For example, the long waiting time index can be calculated using the longest waiting time at the floor where the predicted long waiting occurs, number and ratio of the floors where the predicted long waiting occurs and an average value of the waiting times at the floor where the predicted long waiting occurs, etc.. Next, it is determined whether a car provided a service to a floor where an elevator stop call is registered (ST31B), and if such a car exists, the actual waiting time after the registered elevator stop call is calculated (ST32B). The calculated actual waiting time is recorded together with the data on the time point when the elevator stop call is registered (ST33B). Based on the record of the actual waiting time, an actual long waiting time index at a time point in the past can be calculated (ST34B). The actual long waiting time index can be calculated using the longest waiting time, a generation ratio of a long waiting time which is longer than a predetermined time and an average value of the long waiting times, in the same way as the calculation of the long waiting time index to the elevator

stop call to be predicted.

FIG. 11 shows a flow chart indicating a calculation processing of the contribution degree of the evaluation value of the waiting time after the registered elevator stop call, according to the preferred embodiment of the present invention. Hereunder, the processing flow is described. Firstly, it is determined whether an allocation is done to the elevator stop call (ST51). If the allocation is done, sorting of the waiting time being registered at each car is performed in an ascending order and the ranking is calculated (ST52). Here, the ranking of the car "k" is $k_w(k)$. The car to be allocated finally by the allocation evaluation is a car "ka". Using the ranking $k_w(ka)$ of the car "ka", a contribution degree $V_w(ka)$ of the evaluation value of the waiting time after the registered elevator stop call is calculated by an equation (3).

$$V_w(ka) = (N - k_w(ka)) \times 100 / (N - 1) \text{ ----- (3)}$$

Here, N is a number of the elevators under the group supervisory control.

For example, assuming that the number of the elevators under the group supervisory control is three and the ranking $k_w(ka = 3)$ of the car being allocated (the car "3") in the present evaluation values is 1 (the first place), the contribution degree $V_w(ka = 3)$ is 100 (%). Actually, because the car being allocated is given the first place among the waiting time evaluation values after the registered elevator stop call, the contribution degree of the evaluation value to the allocation evaluation should be high, as indicated in the result of the contribution degree V_w . In a similar way, assuming that $k_w(ka = 3)$ is 2 (the second place) and $k_w(ka = 3)$ is 3 (the third place), $V_w(ka = 3)$ is 50 (%) and $V_w(ka = 3)$ is 0 (%), respectively. As described above, based on the ranking of the car being allocated, the contribution degree of the allocation evaluation item to the allocation determination can be evaluated quantitatively using the equation (3).

FIG. 12 shows a flow chart indicating a calculation process of the contribution degree of the non-uniformity evaluation of the car interval on the registered elevator stop call, according to the preferred embodiment of the present invention. The processing flow is the same as FIG. 11, except that only the evaluation item is different between FIG. 11 and FIG. 12 (a description of the processing flow is skipped). A contribution degree $V_w(ka)$ of the non-uniformity evaluation of the car interval is calculated by an equation (4).

$$V_i(ka) = (N - k_i(ka)) \times 100 / (N - 1) \text{ -----(4)}$$

Here, "ka" is a car number of the car which is to be allocated, $V_i(ka)$ is the contribution degree of the non-uniformity evaluation of the car interval, $k_i(ka)$ is the ranking of the car "ka" in the non-uniformity evaluation of the car interval and N is a number of the elevators under the group supervisory control.

The contribution degree of the evaluation of the non-uniformity of the car interval to the determination of the allocation can be evaluated quantitatively using the equation (4), in a similar way to the equation (3).

FIG. 13 shows a flow chart indicating a calculation processing of the contribution degree of the evaluation of the long waiting time after the registered elevator stop call, according to the preferred embodiment of the present invention. Because the processing flow is similar to FIG. 11, except that only the evaluation item is different between FIG. 11 and FIG. 13, a description of the processing flow is skipped. A contribution degree $V_l(ka)$ of the evaluation of the long waiting time after the elevator stop call to be predicted is calculated by an equation (5).

$$V_l(ka) = (N - k_l(ka)) \times 100 / (N - 1) \text{ -----(5)}$$

Here, "ka" is a car number of the car which is to be allocated, $V_l(ka)$ is the contribution degree of the evaluation of the long waiting time after the elevator stop call to be predicted, $k_l(ka)$ is the ranking of the car "ka" in the evaluation of the long waiting time after the elevator stop call to be predicted and N is the number of the elevators under the group supervisory control.

The contribution degree of the evaluation of the long waiting time after the elevator stop call to be predicted to the determination of the allocation can be evaluated quantitatively using the equation (5), in the similar way to the equation (3).

FIG. 14 is a configuration diagram of the elevator group supervisory control system having an apparatus for displaying data of the group supervisory control of an elevator apparatus according to another preferred embodiment of the present invention, and a computer simulator having a data display unit is employed, instead of the actual group supervisory control system of elevator apparatuses. Therefore, all the elements except the printer 5 are included in the group supervisory control simulator 9. The simulator performs a simulation by running a software on a computer (a computer, a micro computer, a personal computer, etc.). Because FIG. 14 is

a simulator, each element in FIG. 14 has the same function as the corresponding element in FIG. 1. A hardware unit is simulated by running a software. For example, an elevator device 61, 62, --- 6n, an elevator controller 71, 72, --- 7n, an elevator stop call registration unit 81, 82, --- in
5 FIG. 1 correspond to a simulator 61S, 62S, --- 6nS, a simulator 71S, 72S, --- 7nS, a simulator 81S, 82S, ---, respectively. Meanwhile, an indication of a hardware such as the elevator group controller 10 and the control data display unit 20 in FIG. 1 is skipped in FIG. 14. In addition, because a data transfer can be performed directly in the simulator, the data is transferred
10 directly between the storage unit 105 and the display output unit 21, without employing the record media and the communication line.

The example of the elevator group supervisory control system as shown in FIG. 14 indicates a simulator. While an entity of each element constituting the system is a hardware in FIG. 1 and is a software in FIG. 14,
15 the performance of each element in FIG. 14 is just the same as the corresponding element in FIG. 1. Accordingly, each element in FIG. 14 performs the same performance as the performance described so far, and each element in FIG. 14 provides the same effect as the corresponding element in FIG. 1.

20 FIG. 15 shows a status where the data display unit of the elevator group supervisory control system according to the present invention is used. The status can be divided into two phases of a planning time and an operating time.

In the planning time, a building is still under a planning stage, and it is
25 presumed that a manufacturing & sales enterprise of an elevator apparatus explains a feature, a specification and a performance, etc., of the elevator group supervisory control system to a customer who plans to purchase an elevator. Then, the customer may require an explanation of a virtual operating status, specifically of a performance of the control of the group
30 supervisory control system after the building is constructed. In such a state, an embodiment using a simulator as shown in FIG. 14 can be applied. The performance of the allocation evaluation which is a feature of the group supervisory control can be shown understandably by displaying the feature on a screen as shown in FIG. 6, or showing a printed out result, by employing
35 the elevator group supervisory control simulator 9.

In a status where the product is installed and the elevator and the

group supervisory control system is under operating, it is presumed that a maintenance & service enterprise of the elevator apparatus checks the operating status of the group supervisory control system, and explains the status and the effect of the operation to the customer who purchased the elevator. The preferred embodiment as shown in FIG. 1 holds for such a status. The performance of the allocation evaluation can be shown understandably, by gathering the control data which is actually measured in the actually operating elevator group supervisory control system and displaying the data on a screen as shown in FIG. 6 or showing a printed out result, and it is evaluated whether the evaluation is performed properly. Even if the evaluation is not performed properly on the worst case, the result which is shown in FIG. 6 allows to catch the performance immediately, and the performance can be improved. Further, even if the customer (the owner of the elevator) requires an explanation on questions about the performance of the elevator group supervisory control system, the performance of the control can be explained understandably by demonstrating the result as shown in FIG. 6.

Finally, a supplementary explanation is given to the preferred embodiment as shown in FIG. 1. While the statistical calculation unit 103 is disposed in the elevator group supervisory controller 10 in the configuration of the preferred embodiment of FIG. 1, the statistical calculation unit 103 can be disposed in the control data display unit 20. By the configuration, because a time range in which the calculation of the average value is performed and a number of samples on which the calculation of the average value is performed can be chosen freely in the control data display unit 20, the analyzing can be performed in a more flexible manner by employing various averaging methods.

WHAT IS CLAIMED IS

1. A method for displaying data of an elevator apparatus
5 comprising a plurality of elevator cars under a group supervisory
control which indicates an operating status showing car position in
height with respect to time of each car, the method comprising:

selecting an elevator car to be allocated to a registered elevator
stop call based on an evaluation value for a plurality of evaluation
10 items;

calculating an index value for a non-uniformity degree of
intervals of the elevator car calculated from a present position and a
moving direction of each of the elevator cars as a performance index for
the evaluation items to display the index in chronological order; and

15 displaying a contribution degree indicating a ranking of the
evaluation value for the evaluation items of the selected car in all of
the elevator cars in chronological order.

2. The method according to claim 1, further comprising a step of
20 displaying a long waiting time index for an elevator stop call to be
predicted that is calculated from a predicted arrival time of each car to
a floor where no elevator stop call is made as the performance index in
chronological order.

25 3. The method according to claim 1 or 2, wherein the index value
for the non-uniformity degree of the elevator car interval includes a

predicted car interval index value for the non-uniformity degree of the car interval calculated from a position and a moving direction of each car at the time point of prediction and an actual car interval index value for the non-uniformity degree calculated from a present position
5 and a moving direction of each car at the present time point.

4. The method according to claim 1, wherein the contribution degree of the waiting time which is a time after either the registered elevator stop call or the elevator stop call to be predicted, is displayed
10 in the chronological order, as the contribution degree of the evaluation item to the allocation for the elevator stop call.

5. The method according to claim 4,
wherein the waiting time is a time after either the registered elevator stop call or the elevator stop call to be predicted,
15 otherwise after both the registered elevator stop call and the elevator stop call to be predicted.

6. The method according to claim 1,
wherein the contribution degree of a time interval or a
20 space interval between a couple of nearest cars is displayed in the chronological order, as the contribution degree of the evaluation item to the allocation for the elevator stop call.

25 7. An apparatus for displaying data of an elevator apparatus comprising a plurality of elevator cars under a group supervisory

control which indicates an operating status showing car position in height with respect to time of each car, the apparatus comprising:

means for selecting an elevator car to be allocated to a registered elevator stop call based on an evaluation value for a plurality of evaluation items;

means for calculating an index value for a non-uniformity degree of intervals of the elevator car calculated from a present position and a moving direction of each of the elevator car as a performance index for the evaluation items to display the index in chronological order; and

means for calculating a contribution degree indicating a ranking of the evaluation value for the evaluation items of the selected car in all of the elevator cars in chronological order;

wherein the apparatus for displaying data displays the calculated the index value for the non-uniformity degree of the elevator car interval and the contribution degree along with the operating status in a chronological order.

8. The apparatus according to claim 7, further comprising a step of displaying a long waiting time index for an elevator stop call to be predicted that is calculated from a predicted arrival time of each car to a floor where no elevator stop call is made as the performance index in chronological order.

9. The apparatus according to claim 7 or 8, wherein the index value for the non-uniformity degree of the elevator car interval includes a

predicted car interval index value for the non-uniformity degree of the car interval calculated from a position and a moving direction of each car at the time point of prediction and an actual car interval index value for the non-uniformity degree calculated from a present position
5 and a moving direction of each car at the present time point.

10. The apparatus according to claim 7, wherein the means for displaying the contribution degree of the evaluation item in the chronological order displays the contribution degree indicating a
10 ranking of the evaluation value for the evaluation items of the selected car of the waiting time which is a time after either the registered elevator stop call or the elevator stop call to be predicted as the evaluation item in chronological order.

15 11. The apparatus according to claim 10,
wherein the waiting time is a time after either the registered elevator stop call or the elevator stop call to be predicted, otherwise after both the registered elevator stop call and the elevator stop call to be predicted.

20

12. The apparatus according to claim 7,
wherein the means for displaying the contribution degree of the evaluation item in a chronological order displays the contribution degree of the time interval or the space interval between a couple of nearest cars.

25