

## ELEVATOR CONTROL SYSTEM

### FIELD

Embodiments described herein relate generally to an elevator control system.

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### BACKGROUND

Recently, mobile terminals such as smartphones and tablet terminals have been widespread. In accordance with this, development of a technology associated with the mobile terminals has also been pursued in the technical field of elevators.

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### SUMMARY

According to one embodiment, an elevator control system may include a hall call accepting module, a car response module, a door opening time calculator and a door opening/closing controller. The hall call accepting module is configured to accept an input of a hall call generated from a mobile terminal. The car response module is configured to urge a car to respond to a registered floor of the hall call having the input accepted. The door opening time calculator is configured to calculate a door opening time indicating a time to maintain a state of the car after a door of the car is closed, based on number of hall calls having the input accepted. The door opening/closing controller is configured to control opening/closing of the door of the car, based on the calculated door opening time. The elevator control system may further include an image taking means for, if the car arrives at the registered floor of the hall call and the door opens, sequentially taking images of the hall of the registered floor including the car, wherein the door opening time calculating means calculates an extension time to extend the door opening time, based on each of the images taken, and calculates the door opening time again by adding the calculated extension time to the

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door opening time.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated  
in and constitute a part of the specification,  
5 illustrate embodiments of the invention, and together  
with the general description given above and the  
detailed description of the embodiments given below,  
serve to explain the principles of the invention.

FIG. 1 is a diagram showing a schematic structure

example of an elevator control system according to one of embodiments.

FIG. 2 is an illustration for explanation of analyzing processing executed by an image processing device in the elevator control system according to the  
5 embodiment.

FIG. 3 is another illustration for explanation of the analyzing processing executed by the image processing device in the elevator control system  
10 according to the embodiment.

FIG. 4 is a flowchart showing an example of operations executed by the elevator control system according to the embodiment.

FIG. 5 is a flowchart showing an example of operations executed by the elevator control system according to a first modified example of the  
15 embodiment.

FIG. 6 is a flowchart showing an example of operations executed by the elevator control system according to a second modified example of the  
20 embodiment.

#### DETAILED DESCRIPTION

Embodiments will be described hereinafter with reference to the accompanying drawings.

FIG. 1 shows a schematic structure example of an elevator control system according to one of  
25 embodiments. The elevator control system shown in FIG. 1 comprise a car 11, camera 12, an image processor 13, a mobile terminal 14, a call receiver 15 and an elevator controller 16. One car is illustrated in  
30 FIG. 1 but the elevator control system may comprise a plurality of cars. A functional configuration of each of the modules 11 to 16 will be hereinafter described.

The camera 12 is installed at an upper part of a doorway of the car 11. More specifically, the camera  
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12 is installed inside a modesty panel 11a which covers the upper part of the car 11 such that a lens portion of the camera 12 faces a hall 20.

5 The camera 12 is, for example, a small monitoring camera such as an in-vehicle camera, equipped with a wide-angle lens, and is capable of sequentially taking images at the rate of several frames per second (for example, 30 frames/sec). When the car 11 arrives at each floor and the door is opened, the camera 12 takes  
10 images of the states of the hall 20 including the state around a car door 11b inside the car 11.

Each of images (video) sequentially taken by the camera 12 is subjected to analytical processing by the image processor 13 in real time. The image processor  
15 13 extracts, for example, a person from each of the images and performs the analytical processing such as tracking the motion of the person.

More specifically, the image processor 13 extracts the person showing its back near the car door 11b  
20 inside the car 11 from each of the images and tracks the motion of the person showing its back as shown in FIG. 2(a). According to this, if the motion of the person showing its back is the motion of moving toward the hall 20 as shown in FIG. 2(b), the image processor  
25 13 can regard the person as a passenger getting off the car 11 and then calculate the number of passengers getting off the car 11. Similarly, the image processor 13 extracts a person facing the front side at the hall 20 from each of the images and tracks the motion of the  
30 person facing the front side as shown in FIG. 3(a). According to this, if the motion of the person facing the front side is the motion of moving toward the car 11 as shown in FIG. 3(b), the image processor 13 can regard the person as a passenger getting into the car  
35 11 and then calculate the number of passengers getting

into the car 11.

The first passenger information indicating the number of passengers getting off the car and the second passenger information indicating the number of  
5 passengers getting into the car as calculated by the image processor 13 are appropriately transmitted to an elevator controller 16.

The mobile terminal 14 is a terminal capable of wireless communication with a call receiver 15 and  
10 corresponds to, for example, a smartphone or a tablet terminal. An application of capable of generating a hall call is preinstalled in the mobile terminal 14. The "hall call" indicates a signal to call the car 11 for the hall 20, including information on a  
15 registration floor and a destination direction. The mobile terminal 14 may be appropriately replaced with the other element capable of generating the hall call (for example, an IC card on which a destination floor is registered, or the like). For example, if the  
20 mobile terminal 14 is replaced with an IC card on which a destination floor is registered, the call receiver 15 may also be replaced with an IC card reader. In this case, when the IC card is read by the IC card reader, a floor on which the IC card reader is installed is set  
25 as a registered floor, and a direction from the registered floor to the destination floor recorded on the IC card is set as a direction to destination. Thereby, a hall call is generated.

The call receiver 15 is installed on the hall 20  
30 of each floor to receive the hall call generated by the mobile terminal 14. In addition, the call receiver 15 transmits the received hall call to the elevator controller 16.

The elevator controller 16 performs, for example,  
35 the whole elevator operation control including control

of the speed of the car 11, control of opening and closing of the car door 11b, control corresponding to various operation buttons, and the like. A hall call registration device 17 and a door opening time calculator 18 are installed at the elevator controller 16 as shown in FIG. 1.

The hall call transmitted from the call receiver 15 is registered in the hall call registration device 17. If the hall call is registered in the hall call registration device 17, the elevator controller 16 outputs an allocation signal of the hall call to the car 11. That is, the car 11 travels to a registered floor of the hall call in response to the hall call registered in the hall call registration device 17.

If the door opening time calculator 18 accepts the input of the hall call transmitted from the call receiver 15, the door opening time calculator 18 registers the hall call in a temporary memory (not shown) in the own device. At this time, 1 is added to a value of a counter which counts the number of hall calls registered in the temporary memory. The hall call in which the registered floor registered in the temporary memory is a predetermined floor is deleted when the car 11 travels to the registered floor (predetermined floor) and leaves from the registered floor (predetermined floor) in response to the hall call. In accordance with this, the value of the counter which counts the number of hall calls at the predetermined floor is also reset to 0.

In addition, the door opening time calculator 18 calculates the time (door opening time) in which, after the car door 11b has opened (opening the car door has completed), its state (door-opened state) is maintained. The calculated door opening time is used for control of opening and closing the car door 11b by

the elevator controller 16.

Next, an example of operations executed by the elevator control system will be explained with reference to a flowchart of FIG. 4.

5           First, when a hall call is generated from the mobile terminal 14 (step S1), the call receiver 15 receives the hall call (step S2). The received hall call is transmitted to the elevator controller 16.

10           If the elevator controller 16 accepts the input of the hall call transmitted from the call receiver 15, the elevator controller 16 determines whether the accepted hall call is a hall call which has been already registered in the hall call registration device 17 or not (step S3). If the hall call is determined to  
15           be the already registered hall call (YES in step S3), the processing shifts to step S6 to be explained later.

          If it is determined that the hall call is a hall call which has not been registered yet (NO in step S3), the elevator controller 16 registers the accepted hall  
20           call in the hall call registration device 17 (step S4). After that, the elevator controller 16 outputs the allocation signal of the hall call registered in the hall call registration device 17 to the car 11 (step  
25           S5). If the car 11 accepts the input of the allocation signal, the car 11 starts traveling to the registered floor of the hall call registered in the hall call registration device 17.

          Then, the elevator controller 16 registers the accepted hall call in the door opening time calculator  
30           18 (step S6). In accordance with this, the door opening time calculator 18 adds 1 to the value of the counter which counts the number of hall calls registered in the own device (step S7). More specifically, the door opening time calculator 18 adds  
35           1 to the value of the counter which counts the number

of hall calls for the same registered floor.

Next, the elevator controller 16 determines whether the car 11 has reached a deceleration start point or not (step S8). The deceleration start point  
5 indicates a point at which the car 11 starts deceleration to stop at the registered floor of the hall call.

If it is determined that the car 11 has not reached the deceleration start point (NO in step S8),  
10 the elevator controller 16 determines whether a new hall call transmitted from the call receiver 15 has been inputted or not (step S9). If the new hall call is inputted (YES in step S9), the processing returns to step S3 and corresponds to occurrence of a new hall  
15 call. If the new hall call is not inputted (NO in step S9), the processing returns to step S8 and the elevator controller 16 determines again whether the car 11 has reached the deceleration start point or not.

In contrast, if it is determined in the processing  
20 of step S8 that the car 11 has reached the deceleration start point (YES in step S8), the door opening time calculator 18 calculates the door opening time, based on the counter value at this time (step S10). For example, if the door opening time for one hall call is  
25 preset at two seconds and the counter value is 3, the door opening time (i.e., an estimated time for the passengers to get into the car 11) of six seconds ( $=2*3$ ) is obtained.

When the car 11 arrives at the registered floor,  
30 the elevator controller 16 opens the car door 11b (step S11). When the car door 11b fully opens and becomes the door-opened state, countdown of the obtained door opening time is started.

In contrast, the image processor 13 extracts the

person showing its back near the car door 11b inside the car 11 from each of the images sequentially taken by the camera 12, tracks the motion of the person showing its back and calculates the number of passengers getting off the car 11.

The door opening time calculator 18 acquires the first passenger information indicating the number of passengers getting off the car from the image processor 13 (step S12). The door opening time calculator 18 extends the door opening time in accordance with the number of passengers getting off the car indicated by the acquired first passenger information (step S13). More specifically, if the door opening time for one hall call is preset at two seconds as mentioned above and the number of passengers getting off the car is five, the extension time of ten seconds ( $=2*5$ ) is obtained, and the extension time (i.e., an estimated time for the passengers to get off the car 11) is added to the door opening time. That is, as mentioned above, countdown of the door opening time which has been six seconds is started and, if the remaining door opening time is two seconds, the door opening time is extended to twelve seconds ( $=2+10$ ).

During this time, the image processor 13 extracts the person facing the front side at the hall 20 from each of the images sequentially taken by the camera 12, tracks the motion of the person facing the front side and calculates the number of passengers getting into the car 11.

Next, the door opening time calculator 18 acquires the second passenger information indicating the number of passengers getting into the car from the image processor 13 (step S14). The door opening time calculator 18 calculates a difference between the

number of passengers getting into the car indicated by the acquired second passenger information and the number of hall calls registered in the own device. Then, the door opening time calculator 18 further  
5 extends the door opening time in accordance with the difference (step S15). More specifically, if the door opening time for one hall call is preset at two seconds as mentioned above and the above-mentioned difference is one, the extension time of two seconds ( $=2*1$ ) is  
10 obtained, and the extension time (i.e., an estimated time for the passengers to get into the car 11) is added to the door opening time. That is, as mentioned above, countdown of the door opening time which has been six seconds is started, the door opening time is  
15 extended to twelve seconds during the countdown and, if the remaining door opening time is four seconds, the door opening time is extended to six seconds ( $=4+2$ ).

The above difference corresponds to the number of passengers who are to get into the car 11 though the  
20 hall call is not registered by using the mobile terminal 14.

When the countdown of the door opening time is ended, the elevator controller 16 closes the car door 11b, the car 11 starts traveling to the destination  
25 floors of the passengers (step S16) and the processing is ended. At this time, the hall call registered in the hall call registration device 17 and the door opening time calculator 18 is deleted, and the value of the counter which is counted by the door opening time  
30 calculator 18 in relation to the hall call is reset to 0.

According to one of the embodiments described above, the elevator control system comprises the door opening time calculator 18 which accepts input of the

hall calls generated from the mobile terminal 14 and which calculates the door opening time, based on the number of accepted hall calls (number of hall calls registered in the temporary memory), and the elevator controller 16 which controls opening and closing the car door 11b in accordance with the door opening time calculated by the door opening time calculator 18. According to this, the elevator control system capable of executing the control of opening and closing the elevator door in association with a mobile terminal can be provided.

<First Modified Example>

A first modified example will be hereinafter explained.

A case where the elevator controller 16 further comprises a door close promoting function will be explained here. The door close promoting function is a function of closing the car door 11b before the countdown of the door opening time is ended in a case where no passengers are not at the hall 20 although the car 11 travels to the registered floor of the hall call in accordance with generation of the hall call, the car door 11b becomes the door opened state and the countdown of the door opening time starts.

No passengers may be at the hall 20 irrespective of generation of the hall call in a case where the hall call has been generated by mischief or a case where the hall call has been generated but the passengers have moved out of the hall 20 before the car 11 arrives.

An example of operations executed by the elevator control system comprising the door close promoting function will be explained with reference to a flowchart of FIG. 5. However, the same processing steps as those of the processing in FIG. 4 are denoted by like reference numbers and detailed descriptions are

omitted.

After the processing in steps S1 to S14 has been executed, the door opening time calculator 18 determines whether the number of passengers indicated by the acquired second passenger information is greater than or equal to one or not (step S21). If the number of passengers indicated by the second passenger information is greater than or equal to one (YES in step S21), the operations shift to processing in step S15 and the door opening time is extended in accordance with the above difference.

In contrast, if the number of passengers indicated by the second passenger information is smaller than one, i.e., if the number of passengers is zero (NO in step S21), the elevator controller 16 confirms that the passengers finish getting off by using each of the images sequentially taken by the camera 12. Then, the elevator controller 16 executes the processing in step S16 and ends the processing even if the countdown of the door opening time is not ended.

According to the first modified example, the elevator controller 16 comprises the door close promoting function of closing the car door 11b without awaiting the end of countdown of the door opening time in a case where no passengers are not at the hall 20 irrespective of generation of the hall call. According to this, inconvenience that the door is not closed although no passengers are not at the hall can be solved and an environment more comfortable for the passengers can be provided.

#### <Second Modified Example>

Next, a second modified example will be explained.

A case where an upper limit (threshold) of the door opening time is set since the passengers feel inconvenience when the door opening time is so long

will be explained here.

FIG. 6 illustrates an example of an operation implemented by the elevator control system in a case where an upper limit of the door opening time is set.

5 However, the same processing steps as those of the processing in FIG. 4 are denoted by like reference numbers and detailed descriptions are omitted.

After the processing in steps S1 to S15 is executed, the door opening time calculator 18  
10 calculates a sum of the door opening time calculated by the processing in step S10 and the extension times calculated in the processing in steps S13 and S15, respectively (step S31). According to this, the final door opening time is calculated.

15 Next, the door opening time calculator 18 determines whether the door opening time calculated in the processing in step S31 exceeds the preset upper limit of the door opening time or not (step S32). If the door opening time calculator 18 determines that the  
20 door opening time does not exceed the upper limit of the door opening time (NO in step S32), the operations shift to the processing in step S16. And, the door opening time calculator 18 closes the car door 11b as soon as the countdown of the door opening time is  
25 ended.

In contrast, if the door opening time calculator 18 determines that the door opening time exceeds the upper limit of the door opening time (YES in step S32), the elevator controller 16 urges a return call to be  
30 generated for the other car (step S33). The "return call" corresponds to a signal indicating a call to return (travel) the other car to the floor at which the car 11 currently stops (return floor) and includes information on the return floor.

35 Then, the elevator controller 16 announces to the

passengers that the other car is to arrive soon by a  
microphone (not shown). After that, the elevator  
controller 16 urges the countdown of the door opening  
time to be ended as soon as the door opening time  
5 reaches the preset upper time, executes the processing  
in step S16, and urges the processing of the operation  
to be ended.

According to the second modified example, the  
upper limit of the door opening time is set and the  
10 elevator controller comprises the function of urging  
the return call to be generated. According to this,  
the door opening time can be prevented from being  
unnecessarily extended and a passenger unable to get  
into the car can call the other car without generating  
15 the hall call again if the door opening time exceeds  
the upper limit. In other words, an environment more  
comfortable for the passengers can be provided.

While certain embodiments have been described,  
these embodiments have been presented by way of example  
20 only, and are not intended to limit the scope of the  
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  
25 may be made without departing from the spirit of the  
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.

CLAIMS:

[Claim 1]

An elevator control system comprising:

hall call accepting means for accepting an input of a

5 hall call generated from a mobile terminal;

car response means for urging a car to respond to a  
registered floor of the hall call having the input accepted;

door opening time calculating means for calculating a  
door opening time indicating a time to maintain a state of the  
10 car after a door of the car is closed, based on number of hall  
calls having the input accepted;

door opening/closing control means for controlling  
opening/closing of the door of the car, based on the calculated  
door opening time; and

15 image taking means for, if the car arrives at the  
registered floor of the hall call and the door opens,  
sequentially taking images of the hall of the registered floor  
including the car,

wherein

20 the door opening time calculating means calculates an  
extension time to extend the door opening time, based on each  
of the images taken, and calculates the door opening time again  
by adding the calculated extension time to the door opening  
time.

25 [Claim 2]

The elevator control system of Claim 1, wherein

the hall call accepting means accepts the inputs of one  
or more hall calls generated from the mobile terminal, and

the door opening time calculating means calculates the  
30 door opening time, based on number of hall calls for a same  
registered floor, of the hall calls having the inputs accepted.

[Claim 3]

The elevator control system of Claim 1, wherein

the door opening time calculating means calculates the  
35 door opening time by multiplying an estimated time for each

passenger to get into the car by the number of the hall calls having the inputs accepted.

[Claim 4]

5       The elevator control system of Claim 1, further comprising:

        number-of-passengers-off-car calculating means for calculating number of passengers getting off the car to the hall, based on each of the images taken,

        wherein

10       the door opening time calculating means calculates an estimated time for the passengers to get off the car as a first extension time, based on the calculated number of passengers getting off the car.

[Claim 5]

15       The elevator control system of Claim 1, further comprising:

        number-of-passengers-in-car calculating means for calculating number of passengers getting into the car from the hall, based on each of the images taken,

20       wherein

        the door opening time calculating means does not urge the hall call to be generated from the mobile terminal but an estimated number of passengers to get into the car, based on a difference between the calculated number of passengers and  
25       number of hall calls setting the hall to be on the registered floor, and calculates an estimated time for the passengers to get into the car as a second extension time, based on the number of passengers.

[Claim 6]

30       The elevator control system of Claim 1, wherein

        the door opening time calculating means comprises a counter which counts the number of hall calls having the inputs accepted.

[Claim 7]

35       The elevator control system of Claim 6, wherein

the door opening time calculating means resets a value of the counter if the door of the car is closed by the door opening/closing control means and the car departs to the other floor.

5 [Claim 8]

The elevator control system of Claim 1, wherein the door opening/closing control means closes the door of the car without awaiting the calculated door opening time elapsing if it is detected that the passengers are not at the  
10 hall, based on each of the images taken.

[Claim 9]

The elevator control system of Claim 1, wherein the door opening time calculating means determines whether the calculated door opening time exceeds a preset  
15 threshold value or not, and

the door opening/closing control means urges a return call to be generated to return the other car to the floor on which the car currently stops, if it is determined that the calculated door opening time exceeds the preset threshold  
20 value.