

IMAGE DETECTION DEVICE

FIELD

Embodiments described herein relate generally to an image detection device used for the door open/close control of elevator doors.

BACKGROUND

Recently, a technique of detecting the presence or absence of a user who intends to board and controlling the opening and closing of doors by analyzing the chronologically-successive images captured in a direction from the vicinity of the doors of the car of an elevator to the hall has been suggested.

Elevator doors have several types in terms of the opening direction of doors, such as center opening, left opening and right opening. If the opening direction of doors is set incorrectly, specifically if the analytical algorithm of images on an image detection unit (image detection device) is switched incorrectly, there is a possibility that a user who intends to board cannot be appropriately detected, thereby detecting such a user excessively or failing to detect such a user.

When, as a measure for excluding a human error, an image detection unit in which the analytical algorithm of images is fixed is prepared individually based on the opening direction of doors for each of center opening, left opening, right opening, etc., it is necessary to control manufacturing and inventory for each type of image detection unit.

SUMMARY

According to one embodiment, an image detection device includes a camera, an image analysis module and a switching module. The image analysis module is configured to analyze an image captured by the camera based on setting of an opening direction of elevator

doors and detect a user near the elevator doors. The switching module is configured to detect the opening direction of the elevator doors or obtain information related to the opening direction of the elevator doors, and switch the setting. The image detection device is installed in a board covering an upper part of a doorway of a car.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram showing a configuration of a boarding detection system of an elevator to which the image detection device of a first embodiment is applied.

FIG. 2 is a diagram showing an example of an image captured in the image detection device of a first embodiment.

FIG. 3 is a diagram for explaining types of opening direction of elevator doors and a relationship between the opening direction of elevator doors and an installation position of the image detection device.

FIG. 4 is a diagram for explaining how a setting of the opening direction of the doors is automatically switched in the image detection device of the first embodiment.

FIG. 5 is a flowchart showing the flow of operation related to the setting of the opening direction of the elevator doors in the image detection device of the first embodiment.

FIG. 6 is a block diagram showing a configuration of an image detection device of a second embodiment.

FIG. 7 is a diagram showing how the elevator doors open and close based on each type of the opening direction of the doors.

FIG. 8 is a diagram showing how outside light comes into a car when the elevator doors open based on each type of the opening direction of the doors.

DETAILED DESCRIPTION

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

(First Embodiment)

5 A first embodiment is explained.

FIG. 1 a diagram showing a configuration of a boarding detection system of an elevator to which the image detection device 20 of the present embodiment is applied. Here, a car 11 is explained as an example.
10 However, the same configuration is applied to even the case of a plurality of cars 11.

The image detection device 20 comprises a monitoring camera 21 comprising a predetermined number of pixels, an image analysis engine 22 which analyzes
15 an image captured by the camera 21 and detects a user who boards the car 11 from a hall 15, and a switching module 23 which is mounted on the image analysis engine 22 and switches the setting of the opening direction of elevator doors related to the analytical algorithm of
20 images for detecting a user near the elevator doors, specifically, a user who intends to board, from an image as described later. The image detection device 20 is structured as an integrated unit in which the camera 21, the image analysis engine 22 and the
25 switching module 23 are mounted on a single housing unit. The image detection device 20 having this structure is installed in a board 12 covering the upper part of the doorway of the car 11 such that the lens portion of the camera 21 faces the hall 15 side.

30 The camera 21 is a compact monitoring camera such as an in-vehicle camera, comprises a wide-angle lens, and is capable of serially capturing images of several frames in a second (for example, 30 frames per second). When the car 11 arrives at each floor and opens, the
35 camera 21 captures a state of the hall 15 including a

state of the vicinity of car doors 13 provided in the car 11.

5 In the hall 15 of each floor, hall doors 14 are provided in the gate of arrival of the car 11 such that the hall doors 14 are allowed to open and close. The hall doors 14 open and close in connection with the car doors 13 when the car 11 arrives. A power source (door motor) is provided on the car 11 side. The hall doors 14 merely open and close following the car doors 13.

10 In the following explanation, it is assumed that the hall doors 14 open when the car doors 13 open, and the hall doors 14 close when the car doors 13 close.

A car control device 40 transmits and receives various signals such as a hall call and a car call

15 to/from an elevator control device which controls the elevator as a whole. It should be noted that a hall call corresponds to a signal which indicates a call registered by operating a hall call button provided in the hall 15 of each floor, and includes information of

20 a registration floor and a destination direction. A car call corresponds to a signal which indicates a call registered by operating a destination call button provided inside the car 11, and includes information of a destination floor.

25 The car control device 40 comprises a door open/close controller 41. The door open/close controller 41 controls the opening and closing of the car doors 13 when the car 11 arrives at the hall 15. More specifically, the door open/close controller 41

30 opens the car doors 13 when the car 11 arrives at the hall 15, and closes the doors after the elapse of a predetermined time. However, when a person who intends to board is detected by the image analysis engine 22 after the elapse of a predetermined time, the door

35 open/close controller 41 prohibits the close operation

of the car doors 13 and maintains the door opened state. When a person who intends to board is detected by the image analysis engine 22 while the car doors 13 close, the door open/close controller 41 stops the close operation of the car doors 13 and performs the open operation of the doors again.

FIG. 2 is a diagram showing an example of an image captured by the camera 21. In FIG. 2, a1 indicates a detection area. Elevator doors have several types in terms of the opening direction of doors, such as center opening, left opening and right opening. FIG. 2 shows an example of an image captured by the camera 21 when the elevator doors are center opening doors. When the opening direction of the elevator doors in the image detection device 20 is correctly set as center opening, the image analysis engine 22 is capable of appropriately detecting, for example, a user who approaches the center portion and intends to board while the doors are closing. In other words, when the opening direction of the elevator doors in the image detection device 20 is incorrectly set as left opening or right opening, the image analysis engine 22 is not capable of appropriately detecting a user who intends to board because of, for example, a premise that a user who intends to board approaches the left end portion or right end portion while the doors are closing. Thus, there is a possibility that a user is excessively detected or is not detected.

If a device is individually provided for each of center opening, left opening and right opening to prevent incorrect setting of the opening direction of elevator doors, in other words, if the image detection device 20 is prepared for each opening direction of elevator doors, it is necessary to control the manufacturing and inventory of the image detection

device 20 based on each type.

To solve this problem, the image detection device 20 of the present embodiment comprises a mechanism which allows the automatic setting of the opening
5 direction of elevator doors. In this respect, this specification explains the details below.

With reference to FIG. 3, this specification explains the types of the opening direction of the elevator doors and the relationship between the opening
10 direction of the elevator doors and the installation position of the image detection device 20.

FIG. 3 assumes a case where the doors (hall doors 14) are seen from the hall 15. In FIG. 3, (A) assumes the case of center opening doors, and (B) assumes the
15 case of left opening doors, and (C) assumes the case of right opening doors. Here, left opening means that the doors open from the left side when they are seen by a user who is present in the hall 15. Right opening means that the doors open from the right side when they
20 are seen by a user who is present in the hall 15.

Thus, here, with respect to the car doors 13 and the hall doors 14, each door located on the right side when it is seen by a user who is present in the hall 15 is called a right door, and each door located on the left
25 side when it is seen by a user who is present in the hall 15 is called a left door.

As shown in FIG. 3(A), in the case of center opening doors, to allow the camera 21 to capture the state of the hall 15 as appropriately as possible while
30 the hall doors 14 (and the car doors 13) are closing, the image detection device 20 is installed such that the camera 21 is located in the center portion of the doorway. Similarly, in the case of left opening doors, to allow the camera 21 to capture the state of the hall
35 15 as appropriately as possible while the hall doors 14

(and the car doors 13) are closing, as shown in
FIG. 3(B), the image detection device 20 is installed
such that the camera 21 is located on the left side
from the center portion of the doorway (when seen from
5 the hall 15). Similarly, in the case of right opening
doors, to allow the camera 21 to capture the state of
the hall 15 as appropriately as possible while the hall
doors 14 (and the car doors 13) are closing, as shown
in FIG. 3(C), the image detection device 20 is
10 installed such that the camera 21 is located on the
right side from the center portion of the doorway (when
seen from the hall 15).

Thus, firstly, as the position of the image
detection device 20 (camera 21) is changed based on the
15 opening direction of the elevator doors, the detection
area a1 to be set in an image is changed. Secondly, as
the movement direction of a user who intends to board
while the doors are closing is also changed based on
the opening direction of the elevator doors, the method
20 for tracking a user is changed. Therefore, it is
necessary to switch the analytical algorithm of images
for detecting a user who intends to board from an image
on the image analysis engine 22 depending on the
opening direction of the elevator doors. In the image
25 detection device 20 of the present embodiment, the
switching module 23 automatically switches the
analytical algorithm (in other words, sets the opening
direction of the doors).

Now, this specification explains how the switching
30 module 23 of the image detection device 20
automatically switches the setting of the opening
direction of the doors with reference to FIG. 4.

As shown in FIG. 4, the image detection device 20
of the present embodiment comprises a connector 24 for
35 the connection to the car control device 40. By

connecting a harness 51 in which the signal lines from the car control device 40 are bundled and housed to the connector 24, the image detection device 20 and the car control device 40 can be connected to each other. The connection surface of the connector 24 and the harness 51 has the shape of point asymmetry. For example, the harness 51 cannot be connected to the connector 24 in a state where the harness 51 is vertically or horizontally inverted.

A jumper 52 (52a, 52b, 52c) is provided in the harness 51 based on the opening direction of the elevator doors. The jumper 52 functions to change the state of the signal lines drawn out to outside from the image detection device 20 by the connector 24. For example, the jumper 52 causes the signal lines to transition from an ON state (pull-up state) to an OFF state, or reversely, causes the signal lines to transition from an OFF state to an ON state (pull-up state). The former can be realized by, for example, connecting pulled up signal lines to grounded signal lines. The latter can be realized by, for example, connecting signal lines which are neither pulled up nor grounded to pulled up signal lines.

In the case of center opening, the harness 51 (FIG. 4: (A)) in which jumper 52a for changing the state of signal lines indicating center opening is provided is connected to the connector 24 of the image detection device 20. In the case of left opening, the harness 51 (FIG. 4: (B)) in which jumper 52b for changing the state of signal lines indicating left opening is provided is connected to the connector 24 of the image detection device 20. In the case of right opening, the harness 51 (FIG. 4: (C)) in which jumper 52c for changing the state of signal lines indicating right opening is provided is connected to the connector

24 of the image detection device 20.

The switching module 23 detects and sets the opening direction of the elevator doors based on the change in the state of signal lines caused by the connection of the harness 51 to the connector 24. More specifically, the switching module 23 switches the analytical algorithm of images on the image analysis engine 22 based on the result of detection of the opening direction of the doors.

FIG. 5 is a flowchart showing the follow of operation related to the setting of the opening direction of the elevator doors in the image detection device 20 of the present embodiment.

The switching module 23 determines the opening direction of the doors based on the state of the signal lines drawn out to outside by the connector 24 (step S1). When the result of determination indicates center opening (step S2: YES), the switching module 23 sets the algorithm of the image analysis engine 22 such that it is used for center opening (step S3).

When the result of determination indicates left opening (step S2: NO, step S4: YES), the switching module 23 sets the algorithm of the image analysis engine 22 such that it is used for left opening (step S5). When the result of determination indicates right opening (step S4: NO), the switching module 23 sets the algorithm of the image analysis engine 22 such that it is used for right opening (step S6).

In the image detection device 20 of the present embodiment, when the harness 51 in which the jumper 52 is provided depending on the opening direction of the doors is connected to the connector 24, the opening direction of the doors is automatically set, thereby preventing a human error, for example, preventing a worker, etc., from incorrectly setting the opening

direction of the doors. In this way, such a human error can be excluded with only one type of image detection device 20 without preparing the image detection device 20 for each opening direction of the doors.

The image detection device 20 of the present embodiment is capable of automatically setting the opening direction of the elevator doors.

In the above explanation, this specification shows an example in which the switching module 23 of the image detection device 20 detects and sets the opening direction of the elevator doors by providing the jumper 52 (52a, 52b, 52c) in the harness 51 based on the opening direction of the elevator doors. However, the method for setting the opening direction of the elevator doors in a hardware manner is not limited to the provision of the jumper 52 in the harness 51. Various methods can be applied. For example, the shape of the harness 51 may be made variable as long as it can be connected to the connector 24. The opening direction of the elevator doors may be detected from the shape of the harness 51 and set.

(Second Embodiment)

Now, a second embodiment is explained.

In a manner similar to that of the first embodiment, the image detection device 20 of the present embodiment is also applied to a boarding detection system of an elevator. The same structural elements as the first embodiment are denoted by the same reference numbers. Thus, overlapping descriptions are omitted.

FIG. 6 is a block diagram showing a configuration of an image detection device 20 of the present embodiment.

As shown in FIG. 6, in the image detection device

20 of the present embodiment, an image analysis engine
22 comprises a door opening direction detection module
22A. The door opening direction detection module 22A
is a module which detects the opening direction of the
5 doors from a chronological change in the luminance of
pixels in a plurality of images captured by a camera 21
sequentially in terms of time. The image analysis
engine 22 of the present embodiment comprises a
function of detecting the opening direction of the
10 doors from images (obtained by sequentially capturing
the situation in which the doors open and close) in
addition to a function of detecting a user who intends
to board from an image.

In the present embodiment, for example, when a
15 setting button provided in the peripheral wall of the
housing unit of the image detection device 20 is
operated, or when a signal instructing the setting of
the opening direction of the doors is received from a
car control device 40, a switching module 23 causes the
20 door opening direction detection module 22A of an image
analysis engine 22 to detect the opening direction of
the doors in cooperation with the car control device
40, receives the result of the detection and sets the
opening direction of the doors.

25 For example, the switching module 23 sends an
instruction to repeat the opening and closing of the
doors a predetermined number of times to the car
control device 40. In parallel with this operation,
the switching module 23 instructs the image analysis
30 engine 22 to cause the door opening direction detection
module 22A to detect the opening direction of the
doors. The door opening direction detection module 22A
of the image analysis engine 22 which received this
instruction detects the motion of the elevator doors
35 from the change in the luminance of images.

Specifically, the door opening direction detection module 22A detects whether the detected motion corresponds to center opening doors, left opening doors or right opening doors.

5 Alternatively, the switching module 23 may instruct the car control device 40 to close the doors, turn off the light of a car 11, and open and close the doors in this order. The door opening direction detection module 22A of the image analysis engine 22
10 may not detect the motion of the elevator doors, but may detect how outside light comes into the car when the doors open (when the doors transition from a closed state to an opened state), how a shadow is formed by outside light when the doors close (when the doors
15 transition from an opened state to a closed state), or how the shape of a shadow changes when the doors open. Specifically, the door opening direction detection module 22A may detect whether the way light comes into the car, the way a shadow is formed by outside light or
20 the way the shape of a shadow changes corresponds to center opening doors, left opening doors or right opening doors.

FIG. 7 is a diagram showing how the elevator doors (car doors 13 and hall doors 14) open and close based
25 on each type of the opening direction of the doors.

FIG. 7 assumes a case where the elevator doors (the car doors 13 and the hall doors 14) are seen from above. In FIG. 7, (A) assumes the case of center opening doors, and (B) assumes the case of left opening
30 doors, and (C) assumes the case of right opening doors. As a matter of course, the direction of the car doors 13 from the boundary between the car doors 13 (a left door 13a and a right door 13b) and the hall doors 14 (a left door 14a and a right door 14b) is the car 11 side,
35 and the direction of the hall doors 14 from the

boundary is the hall 15 side. Here, similarly, for example, a right direction, a left direction, a right side, a left side, a right end and a left end indicate right and left when they are seen from the hall 15 side.

As shown in FIG. 7(A), in the case of center opening doors, when the doors transition from a closed state to an opened state, the left door 13a of the car doors 13 and the left door 14a of the hall doors 14 move in the left direction and are accommodated in the left door pocket, and the right door 13b of the car doors 13 and the right door 14b of the hall doors 14 move in the right direction and are accommodated in the right door pocket. When the doors transition from an opened state to a closed state, the left door 13a of the car doors 13 and the left door 14a of the hall doors 14 emerge from the left door pocket and move in the right direction until the right ends reach the center portion, and further, the right door 13b of the car doors 13 and the right door 14b of the hall doors 14 emerge from the right door pocket and move in the left direction until the left ends reach the center portion.

As shown in FIG. 7(B), in the case of left opening doors, when the doors transition from a closed state to an opened state, all of the left door 13a and the right door 13b of the car doors 13 and the left door 14a and the right door 14b of the hall doors 14 move in the right direction and are accommodated in the right door pocket. When the doors transition from an opened state to a closed state, all of them emerge from the right door pocket. The left door 13a of the car doors 13 and the left door 14a of the hall doors 14 move in the left direction until the left ends reach the left end portion. The right door 13b of the car doors 13 and

the right door 14b of the hall doors 14 move in the left direction until the left ends reach the center portion.

5 As shown in FIG. 7(C), in the case of right opening doors, when the doors transition from a closed state to an opened state, all of the left door 13a and the right door 13b of the car doors 13 and the left door 14a and the right door 14b of the hall doors 14 move in the left direction and are accommodated in the left door pocket. When the doors transition from an
10 opened state to a closed state, all of them emerge from the left door pocket. The left door 13a of the car doors 13 and the left door 14a of the hall doors 14 move in the right direction until the right ends reach the center portion. The right door 13b of the car
15 doors 13 and the right door 14b of the hall doors 14 move in the right direction until the right ends reach the right end portion.

Thus, center opening doors, left opening doors and
20 right opening doors differ from each other in terms of the open/close operation of elevator doors. Therefore, the door opening direction detection module 22A of the image analysis engine 22 is capable of detecting the opening direction of the doors by analyzing the
25 temporally-successive images which are captured by the camera 21 and include the car doors 13 as subject images. For example, when both an object moving in the right direction and an object moving in the left direction are detected while the doors open or close,
30 the doors can be determined as center opening doors. When only an object moving in one of the right direction and the left direction is detected, the doors can be determined as left opening doors or right opening doors based on the direction.

35 FIG. 8 is a diagram showing how outside light

comes into the car when the elevator doors (the car doors 13 and the hall doors 14) open based on each type of the opening direction of the doors.

5 FIG. 8 assumes a case where the inside of the car 11 is seen from above. In FIG. 8, (A) assumes the case of center opening doors, and (B) assumes the case of left opening doors, and (C) assumes the case of right opening doors. Further, here, it is assumed that, when the doors open, the light in the car 11 is turned off,
10 and light having an illuminance of a certain value or greater is emitted to the hall doors 14 in the hall 15.

 As shown in FIG. 8(A), in the case of center opening doors, light comes into the car from the center portion (b1-1), and its range expands to right and left
15 (b2-1 and b3-1). As shown in FIG. 8(B), in the case of left opening doors, light comes into the car from the left end portion of the doorway when the car is seen from the hall 15 side (b1-2), and its range expands to right (b2-2 and b3-2). Further, as shown in FIG. 8(C),
20 in the case of right opening doors, light comes into the car from the right end portion of the doorway when the car is seen from the hall 15 side (b1-3), and its range expands to left (b2-3 and b3-3).

 Thus, center opening doors, left opening doors and
25 right opening doors differ from each other in terms of the way outside light comes into the car when the elevator doors open. Therefore, the door opening direction detection module 22A of the image analysis engine 22 is capable of detecting the opening direction
30 of the doors by analyzing the temporally-successive images which are captured by the camera 21 and include the car doors 13 as subject images. For example, when a change in which the luminance increases expands from pixels in images corresponding to the center portion of
35 the doorway to right and left pixels at the time of

door opening, the doors can be determined as center opening doors. When the change expands from pixels in images corresponding to the left end portion of the doorway to right pixels from the view of the hall 15 side, the doors can be determined as left opening doors. When the change expands from pixels in images corresponding to the right end portion of the doorway to left pixels from the view of the hall 15 side, the doors can be determined as right opening doors.

10 The door opening direction detection module 22A may detect, for example, how a shadow is formed by outside light when the elevator doors close, or how the shape of a shadow changes when the elevator doors open. For example, in the case of center opening doors, and 15 in the former case, the door opening direction detection module 22A detects a shadow formed from both end portions. In the latter case, the door opening direction detection module 22A detects a change in the shape of the shadow from the center portion.

20 The flow of the operation related to the setting of the opening direction of the elevator doors in the image detection device 20 of the present embodiment is the same as that of the first embodiment other than the configuration in which the process of step S1 of FIG. 5 25 shown in the first embodiment is performed by cooperation between the switching module 23 and the door opening direction detection module 22A of the image analysis engine 22. Thus, the explanation thereof is omitted here.

30 In the image detection device 20 of the present embodiment, an image captured by the camera 21 is analyzed by the door opening direction detection module 22A of the image analysis engine 22, and the opening direction of the doors is automatically set, thereby 35 preventing a human error, for example, preventing a

worker, etc., from incorrectly setting the opening
direction of the doors. In this way, such a human
error can be excluded with only one type of image
detection device 20 without preparing the image
5 detection device 20 for each opening direction of
doors.

Thus, the image detection device 20 of the present
embodiment is also capable of automatically setting the
opening direction of the elevator doors.

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

WHAT IS CLAIMED IS:

1. An image detection device comprising:
a camera;

5 an image analysis module configured to analyze an
image captured by the camera based on setting of an
opening direction of elevator doors, and detect a user
near the elevator doors; and

a switching module configured to detect the
opening direction of the elevator doors or obtain
10 information related to the opening direction of the
elevator doors, and switch the setting,

wherein the image detection device is installed in
a board covering an upper part of a doorway of a car.

2. The image detection device of Claim 1, further
15 comprising a connector for a connection to a car
control device configured to perform control of the car
including opening and closing of the door,

wherein the switching module is configured to
detect the opening direction of the elevator doors
20 based on a state of a signal line drawn out to outside
by the connector.

3. The image detection device of Claim 2, wherein
a harness in which a jumper is provided based on the
opening direction of the doors is connected to the
25 connector.

4. The image detection device of Claim 1,
wherein:

the image analysis module comprises a door opening
direction detection module configured to analyze
30 temporally-successive images captured at least when the
doors open or when the doors close and including the
doors as subject images, and detect the opening
direction of the doors; and

the switching module is configured to obtain a
35 result of detection of the door opening direction

detection module as the information related to the opening direction of the elevator doors.

5 5. The image detection device of Claim 4, wherein the switching module is configured to instruct the car control device which performs the control of the car including the opening and closing of the doors to open and close the doors a predetermined number of times, instruct the image analysis module to detect the opening direction of the doors, and obtain the result
10 of detection of the door opening direction detection module.

6. The image detection device of Claim 4, wherein:

15 the door opening direction detection module is configured to detect the opening direction of the doors from a chronological change in luminance of pixels in the temporally-successive images; and

20 the switching module is configured to instruct the car control device which performs the control of the car including the opening and closing of the doors to turn off light in the car and at least open or close the doors, instruct the image analysis module to detect the opening direction of the doors, and obtain the result of detection of the door opening direction
25 detection module.

7. The image detection device of one of Claims 1 to 6, wherein in the setting, at least two of first setting for center opening in which the doors open from a center portion, second setting for left opening in
30 which the doors open from a left end portion when seen from a hall, and third setting for right opening in which the doors open from a right end portion when seen from the hall can be exclusively and selectively set.

8. The image detection device of one of Claims 1
35 to 7, wherein the image detection device is a single

housing unit in which the camera, the image analysis module and the switching module are mounted.

9. The image detection device of one of Claims 1 to 8, wherein:

5 the image detection device is installed in an area on the board corresponding to a center position of a doorway of the door in a case of center opening in which the doors open from a center portion;

10 the image detection device is installed in an area on the board corresponding to a side close to a left end from the center position of the doorway of the doors in a case of left opening in which the doors open from a left end portion when seen from the hall; and

15 the image detection device is installed in an area on the board corresponding to a side close to a right end from the center position of the doorway of the doors in a case of right opening in which the doors open from a right end portion when seen from the hall.