

ELEVATOR SYSTEM

FIELD

Embodiments described herein relate generally to an elevator system to detect a user using a camera.

5

BACKGROUND

In elevator systems, usually, when a car arrives at a floor, its door opens. After a lapse of a predetermined time, the door closes and the car starts. When an elevator user gets in the car, the user may be hit by the closing door because the user does not know when the door closes.

In order to avoid such hitting on the user with the door when getting in the car, there has been proposed an elevator system provided with a camera in the car to detect a user getting in the car from the image taken by the camera, and controlling the opening/closing operation of the door.

In the elevator system as described above, a plurality of images are compared in a time series, and a portion of the image whose brightness has changed within a preset detection area is detected as a user. For example, when an elevator hall is darker than the interior of the car, a shadow of the closing door may be generated on the floor by illumination in the car. When the shadow enters the detection area, it is likely that the shadow will be erroneously detected as a user due to a change in brightness and the door will be reopened.

In order to avoid the shadow of the door, the detection area may be narrowed in advance. If, however, the detection area is narrowed, a user cannot be detected before he or she is made close to the car, which causes a delay in the door open/close control.

It is an object of the present invention to provide an elevator system capable of preventing a door

from being reopened by a shadow of the door generated on an elevator hall when the floor is in a dark state.

SUMMARY

According to one embodiment, an elevator system
5 includes a camera capable of picking up an image from a vicinity of a door of a car towards a hall, performs an analysis process to detect a user from the image picked up by the camera and control opening and closing of the door in accordance with a result of the analysis
10 process.

The elevator system includes illuminance determination means and analysis control means. The illuminance determination means determines whether illuminance of a hall is lower than illuminance of a
15 car, based on a brightness value of a preset measurement area on the image picked up by the camera, when the door fully opens. The analysis control means limits the analysis process of the image, considering that the hall is in a dark state, when the illuminance
20 determination means determines that the illuminance of the hall is lower than the illuminance of the car.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing a configuration of an elevator system according to a first embodiment.

25 FIG. 2 is a diagram showing an example of an image picked up by a camera of the elevator system according to the first embodiment.

FIG. 3 is a diagram illustrating a high-brightness portion and a low-brightness portion of the image
30 picked up by the camera of the elevator system according to the first embodiment.

FIG. 4 is a top schematic view showing a full-open car door of the elevator system according to the first embodiment.

35 FIG. 5 is a diagram showing a shadow of the car

door generated on an elevator hall when the car door closes in the elevator system according to the first embodiment.

5 FIG. 6 is a flowchart showing a process operation of the elevator system according to the first embodiment.

FIG. 7 is a flowchart showing a process operation of an elevator system according to a second embodiment.

10 FIG. 8 is a top schematic view showing a full-open car door of a side open type in an elevator system according to a modification.

FIG. 9 is a diagram showing a shadow of the car door of a side open type generated on an elevator hall when the car door closes in the elevator system
15 according to the modification.

DETAILED DESCRIPTION

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

(First Embodiment)

20 FIG. 1 is a block diagram showing a configuration of an elevator system according to a first embodiment. Although a single car will be described here as an example, the same configuration is applied to a plurality of cars.

25 A camera 12 is installed at an upper part of the doorway of a car 11. Specifically, a lens portion of the camera 12 is disposed in a modesty panel 11a covering the upper part of the doorway of the car 11 so as to face an elevator hall 15. The camera 12 is a
30 small-sized security camera such as an in-vehicle camera, and includes a wide-angle lens to allow images of several frames (e.g., 30 frames per second) to be captured for one second. When the car 11 arrives at
35 each floor and its door opens, the state of the hall 15 is imaged including the state of the vicinity of a car

door 13 in the car 11.

The range of the imaging is adjusted to $L1 + L2$ ($L1 \gg L2$). $L1$ represents an imaging range on the hall side and is set to a predetermined value from the car door 13 toward the hall 15. $L2$ represents an imaging range on the car side and is set to a predetermined value from the car door 13 toward the back of the car. Note that $L1$ and $L2$ are ranges in the depth direction, and the range in the width direction (the direction orthogonal to depth direction) is larger than at least the width of the car 11.

Lighting equipment 16 is also installed at the central part of the ceiling surface of the car 11. Note that the lighting equipment 16 can be installed anywhere if it can illuminate the entire interior of the car 11. The number of pieces of lighting equipment 16 is optional, as is the size of the lighting equipment 16.

A hall door 14 is installed at the doorway of the car 11 on the hall 15 of each floor so as to be freely opened and closed. The hall door 14 is engaged with the car door 13 to open and close upon the arrival of the car 11. A power source (door motor) is provided alongside the car 11, and the hall door 14 only opens and closes following the car door 13. Assume in the following description that the hall door 14 opens when the car door 13 opens, and the hall door 14 closes when the car door 13 closes.

Each image (video) captured by the camera 12 is analyzed and processed in real time by an image processor 20. In FIG. 1, the image processor 20 is removed from the car 11 for the sake of convenience; however, the image processor 20 is actually housed in the modesty panel 11a together with the camera 12.

The image processor 20 extracts a person (a user

of the elevator) from each image and tracks a motion of the person to detect that the person has got in the elevator, to detect that the person has got in the elevator or got off the elevator, to detect that the person is pulled into a door bag, and the like, thus taking safety measures such as generation of an alarm as required. In the example of FIG. 1, the image processor 20 is provided independently of an elevator controller 30; however, the function of the image processor 20 may be included in the elevator controller 30.

The image processor 20 includes a storage unit 21 and a user detection unit 22. The storage unit 21 has a buffer area to sequentially store images picked up by the camera 12 and temporarily store data necessary for processing by the user detection unit 22. The user detection unit 22 analyzes a plurality of images picked up by the camera 12 in a time series and detects the presence or absence of a user who gets in the car 11.

In the first embodiment, the user detection unit 22 includes an illuminance determination unit 22a and an analysis control unit 22b as functions of achieving the present invention. When the car door 13 is fully opened, the illuminance determination unit 22a determines whether the illuminance of the hall 15 is lower than that of the car 11, based on the brightness value of a preset measurement area on an image picked up by the camera 12.

The "illuminance" in the first embodiment represents the degree of brightness. In the case of the interior of the car 11, the "illuminance" represents the degree of brightness when the lighting equipment 16 of the car 11 illuminates the floor of the car. In the case of the hall 15, the "illuminance" represents the degree of brightness when lighting

equipment (not shown) of the hall 15 illuminates the surface of the hall. In the case of the hall 15, however, the illuminance varies between an area influenced by the lighting equipment 16 of the car 11 (referred to as "car illumination" hereinafter) and an area not influenced thereby when the car door 13 is opened.

In the first embodiment, an area in the hall 15 which is greatly influenced by the car illumination is defined as a first measurement area and an area which is less influenced by the car illumination is defined as a second measurement area. The "area which is greatly influenced by the car illumination" means an area that is susceptible to the car illumination and an area where a shadow of the car door 13 is likely to be generated on the hall 15 when the door is closed. The "area which is less influenced by the car illumination" means an area that is unsusceptible to the car illumination or an area where the influence is small enough to be ignored and an area where a shadow of the car door 13 is hardly generated on the hall 15 when the door is closed. These measurement areas will be described in detail later with reference to FIGS. 3 and 4.

When the illuminance determination unit 22a determines that the illuminance of the hall 15 is lower than that of the car 11, the analysis control unit 22b limits the image analysis in consideration of the fact that the hall 15 is in a dark state. Specifically, the analysis control unit 22b analyzes an image by making a preset detection area smaller than usual, or invalidates an analysis result of the image and does not reflect it in the door open/close control.

The elevator controller 30 transmits and receives various signals of a floor call, a car call and the

like. The "floor call" is a call signal registered by operating a floor call button (not shown) provided at the hall 15 of each floor, and includes information of a registered floor and a destination. The "car call" is a call signal registered by operating a destination call button (not shown) provided in the interior of the car 11, and includes information of a destination floor.

The elevator controller 30 includes a door open/close control unit 30a. The door open/close control unit 30a controls the door open/close of the car door 13 when the car 11 arrives at the hall 15. Specifically, the door open/close control unit 30a opens the car door 13 when the car 11 arrives at the hall 15 and closes it after a lapse of a predetermined time. If, however, the user detection unit 22 detects a user during the closing of the car door 13, the door open/close control unit 30a prohibits the closing of the car door 13 and reopens the car door 13 to maintain the door opening state.

FIG. 2 is a diagram showing an example of an image picked up by the camera 12. In FIG. 2, E1 represents a detection area.

The camera 12 is provided at an upper part of the doorway of the car 11. When the car 11 arrives at the hall 15 and its car door 13 opens, a predetermined range (L1) on the hall side and a predetermined range (L2) in the car are imaged. The detection area E1 is set in the predetermined range (L1) in order to detect a user who gets in the car 11.

In real space, the detection area E1 has distance L3 from the center of the car door 13 (doorway) toward the hall ($L3 \leq$ imaging range L1 on the hall side). The width W1 of the detection area E1 is set to a distance that is equal to or greater than the width W0 of the

car door 13. The shape of the detection area E1 may be a rectangular or a trapezoid excluding the blind spots of jambs 17a and 17b. The size of the detection area E1 in its vertical direction (Y direction) and its
5 horizontal direction (X direction) may be fixed or may be changed in accordance with the open/close operation of the car door 13.

The camera 12 picks up an image in which a direction that is horizontal to the car door 13
10 provided at the doorway of the car 11 is an X axis, the direction of the hall 15 from the center of the car door 13 (a direction perpendicular to the car door 13) is a Y axis, and the height direction of the car 11 is a Z axis. In the images picked up by the camera 12,
15 portions of the detection area E1 are compared in units of blocks to detect the movement of user's feet while the user is moving in the direction of the hall 15 from the center of the car door 13, that is, the direction of the Y axis.

20 The example of FIG. 2 is directed to the car 11 of center open type. The car door 13 includes two door panels 13a and 13b that move in opposite directions on a sill 13c. Similarly, the hall door 14 includes two door panels 14a and 14b that move in opposite
25 directions on a sill 14c. The door panels 14a and 14b of the hall door 14 moves in the door open/close direction together with the door panels 13a and 13b of the car door 13.

FIG. 3 is a diagram illustrating a high-brightness portion and a low-brightness portion of an image picked
30 up by the camera 12.

Assuming that the entire floor surface of the hall 15 is of the same color and the same material, the brightness of a portion of the image exposed to light
35 is higher than that of a portion thereof not exposed to

light. When the door of the car 11 is opened, the light of the car illumination leaks from the doorway of the car 11 to the hall 15. There is a difference in brightness between a portion of the floor surface of the hall area 15 to which the car illumination is applied and a portion thereof to which the car illumination is not applied. In particular, when the light of the hall 15 is turned off for the purpose of, e.g., energy saving, a difference in brightness between the portion to which the car illumination is applied and the portion to which the car illumination is not applied becomes more remarkable.

Usually, the hall floor surface in front of the doorway of the car 11 is greatly influenced by the car illumination and becomes bright when the door opens, and its image brightness increases. The jambs 17a and 17b are provided on both sides of the doorway of the car 11. The jambs 17a and 17b are provided as elevator structures that block the light of the car illumination extending from the doorway of the car 11 to both sides of the doorway. Thus, the hall floor surface around the jambs 17a and 17b is less influenced by the car illumination and becomes dark when the door opens, and its image brightness decreases. In the first embodiment, it is determined whether the illuminance of the hall 15 is lower than that of the car 11 using a difference in brightness between a portion (A) that is greatly influenced by the car illumination and a portion (B) that is less influenced by the car illumination.

FIG. 4 is a top schematic view of the car door 13 that is fully opened. In FIG. 4, the door panels 13a and 13b of the car door 13 and the door panels 14a and 14b of the hall door 14 are indicated by dotted lines.

Straight lines connecting a light source (here,

the lighting equipment 16 installed on the ceiling surface) of the car 11 and distal end portions Pa and Pb of the jambs 17a and 17b in their insides are projected onto the floor surface of the hall 15. If
5 the straight lines extend in a direction away from the car 11 toward the hall 15, the extended lines correspond to boundaries 31a and 31b between the portion (A) that is greatly influenced by the car illumination and the portion (B) that is less
10 influenced by the car illumination.

As shown in FIG. 3, the coordinate locations of the boundaries 31a and 31b on the image can easily be calculated. An area which is inside the boundaries 31a and 31b and which is obtained by dividing a hall floor
15 near the doorway of the car 11 into rectangles of a predetermined size, will be defined as a first measurement area 32. An area of a predetermined size which is outside the boundaries 31a and 31b and which is surrounded by the boundary 31a and the jamb 17a will
20 be defined as a second measurement area 33a, and an area of a predetermined size which is surrounded by the boundary 31b and the jamb 17b will be defined as a second measurement area 33b.

The first measurement area 32 corresponds to the
25 portion (A) that is greatly influenced by the car illumination. The second measurement areas 33a and 33b correspond to the portion (B) that is less influenced by the car illumination. The brightness of the first measurement area 32 and that of the second measurement
30 areas 33a and 33b are compared when the car door 13 is fully opened. If a difference in brightness between them is great, it can be determined that the illuminance of the hall 15 is lower than that of the car 11, that is, the hall 15 is in a dark state. When
35 the hall 15 is in a dark state, a shadow of the car

door 13 is likely to be generated on the hall 15 when the door is closed.

FIG. 5 shows an example of a shadow of the car door 13 generated on the hall 15 when the door of the car 11 closes. In the example of FIG. 5, the lateral (X-direction) size of the detection area E1 is narrowed in accordance with the closing of the car door 13.

If the hall 15 is in a dark state, when the car door 13 of the car 11 closes, it is exposed to the car illumination, its shadows 34a and 34b are generated on the hall 15 and move in accordance with the closing of the car door 13. If the shadows 34a and 34b move within the detection area E1, they may be erroneously detected as a user and the car door 13 may be reopened.

In this case, the car door 13 can be prevented from being reopened if it is known in advance that the illuminance of the hall 15 is lower than that of the car 11 (that is, the hall 15 is in a dark state). However, for example, in a condominium in which an automatic fire extinguishing system is installed on the hall 15 of each floor, it is difficult to know the illuminance of the hall 15 in advance because the lighting environment of the hall 15 varies from floor to floor.

FIG. 6 is a flowchart showing a process operation of the elevator system according to the first embodiment.

When the car 11 arrives at the hall 15 of a floor, the elevator controller 30 opens the car door 13 to await a user who is getting in the car 11. At this time, the camera 12 installed at an upper part of the doorway of the car 11 picks up images of a predetermined range (L1) on the hall side and a predetermined range (L2) in the car at a given frame rate (e.g., 30 frames per second). The image processor

20 captures the images picked up by the camera 12 in a time series, and executes the following process in real time while storing the images sequentially in the storage unit 21. The following process is executed by the user detection unit 22 provided in the image processor 20.

First, when the car door 13 fully opens (Yes in step S11), the illuminance determination unit 22a of the user detection unit 22 calculates an average brightness value of the first measurement area 32 in an image (step S12). Then, the illuminance determination unit 22a calculates an average brightness value of each of the second measurement areas 33a and 33b in the same image (step S13). The "average brightness value" is an average value of brightness values of all pixels in each of the measurement areas. As for the second measurement areas 33a and 33b, an average brightness value of one of the areas may be obtained and compared with the average brightness value of the first measurement area 32.

As described with reference to FIG. 4, the first measurement area 32 and the second measurement areas 33a and 33b are determined by the relationship in position between the light source (lighting equipment 16) of the car 11 and the jambs 17a and 17b. The first measurement area 32 is greatly influenced by the car illumination. The second measurement areas 33a and 33b are less influenced by the car illumination.

The illuminance determination unit 22a determines a difference between the average brightness value of the first measurement area 32 and that of each of the second measurement areas 33a and 33b (step S14). Assuming that the average brightness value of the first measurement area 32 is K1 and the average brightness value of each of the second measurement areas 33a and

33b is K2, a brightness difference is obtained by $(K1 - K2)$. The illuminance determination unit 22a determines whether the brightness difference $(K1 - K2)$ is equal to or greater than a threshold value (Th1) that is preset as a determination reference (step S15).

The threshold value Th1 is set to an appropriate value in consideration of the environment of the hall 15 and the like. The threshold value Th1 may be varied for each hall 15 on each floor. In some buildings, the color of the floor surface of the hall may vary from floor to floor, so that it is preferable to set a threshold value corresponding to the color of the floor surface. The threshold value Th1 is stored in the storage unit 21 shown in FIG. 1, and is read out by the user detection unit 22 when the door of the car 11 opens.

If $(K1 - K2) \geq Th1$, it can be assumed that the hall 15 is in a dark state and the first measurement area 32 is illuminated brightly by the car illumination. In this case, the shadows 34a and 34b of the car door 13 are generated on the hall 15 when the door closes, as described with reference to FIG. 5. When the shadows 34a and 34b enter the detection area E1, they may be detected erroneously as a user. Therefore, when $(K1 - K2) \geq Th1$ (Yes in step S15), the analysis control unit 22b limits the image analysis process, considering that the hall 15 is in a dark state (step S16).

Specifically, the analysis control unit 22b makes the longitudinal or lateral size of the detection area E1 smaller than normal to prevent the shadows 34a and 34b of the car door 13 from entering the detection area E1, and analyzes the image in the reduced detection area E1. If, in this case, the longitudinal or lateral size of the detection area E1 is reduced in accordance

with the closing of the car door 13, the longitudinal or lateral size of the detection area E1 is reduced to prevent the shadows 34a and 34b from entering the reduced detection area E1. If the size of the
5 detection area E1 is controlled to prevent the shadows 34a and 34b generated on the hall 15 from entering the detection area E1, reopening of the car door 13 due to the shadows 34a and 34b can be prevented.

As another method, the result of image analysis
10 may not be reflected in the door open/close control. Alternatively, the image analyze process itself may not be performed.

On the other hand, if $(K1 - K2) < Th1$, it can be assumed that the hall 15 is in a bright state. In this
15 case, it is considered that there is a low possibility that a shadow of the car door 13, which may cause erroneous detection, will be generated on the hall 15. If, therefore, $(K1 - K2) < Th1$ (No in step S15), the analysis control unit 22b performs a normal image
20 analysis process to detect a user from a change in image brightness (Step S17).

Specifically, the analysis control unit 22b reads images out of the storage unit 21 one by one and tracks a portion whose brightness varies in the detection area
25 E1 in a time series to detect a user who is coming from the hall 15 toward the car 11. In fact, a process of estimating a user's intention to get in the elevator is performed in another detection area that is set just before the doorway of the car 11, but its detailed
30 description will be omitted here.

When the user is detected, the image processor 20 outputs a user detection signal to the elevator controller 30. Upon receiving the user detection
35 signal, the elevator controller 30 inhibits the car door 13 from closing and maintains the door open state.

When a user is detected while the car door 13 is closing, the elevator controller 30 moves the car door 13 in the door open direction and reopens the car door 13.

5 As described above, according to the first embodiment, it is possible to determine whether the hall 15 is in a dark state by comparing the average brightness value K1 of the first measurement area 32 which is greatly influenced by the car illumination and
10 the average brightness value K2 of the second measurement areas 33a and 33b which are less influenced by the car illumination when the door fully opens. When the hall 15 is in a dark state, the door can be prevented from unnecessarily reopening by limiting the
15 image analysis process.

 In the first embodiment, for example, it is also possible to calculate, from the sizes of the jambs 17a and 17b on each floor, a difference in brightness which corresponds to the boundary between a part that is
20 greatly influenced by the car illumination and a part that is less influenced by the car illumination, and derive the first measurement area 32 and the second measurement areas 33a and 33b from the calculation result.

25 Furthermore, the shape and size of the first measurement area 32 and the second measurement areas 33a and 33b may be changed as long as they do not exceed the boundaries 31a and 31b but cover the hall floor surface that does not overlap the elevator
30 structures such as the jambs 17a and 17b. If, however, the illuminance of the hall 15 is higher than that of the car 11 (that is, if the hall 15 is in a bright state), neither of the boundaries 31a and 31b can be formed, with the result that the image analysis process
35 is not restricted.

When the brightness values of the first measurement area 32 and the second measurement areas 33a and 33b are compared, not only the average value of the brightness values of all pixels in each of the areas, but also, for example, a maximum value, a minimum value, and a mode value may be used as a target to be compared.

(Second Embodiment)

Next is a description of a second embodiment.

In the foregoing first embodiment, the brightness value of the first measurement area 32 that is greatly influenced by the car illumination and the brightness values of the second measurement areas 33a and 33b that are less influenced by the car illumination when the car door 13 fully opens, are compared with each other. In the second embodiment, paying attention only to the second measurement areas 33a and 33b that are less influenced by the car illumination, the average brightness value of each of the second measurement areas 33a and 33b obtained when the hall 15 is in a bright state and the average brightness value of each of the second measurement areas 33a and 33b obtained when the car door 33 fully opens are compared with each other.

In the second embodiment, the average brightness value of each of the second measurement areas 33a and 33b obtained from the images picked up by the camera 12 is stored in the storage unit 21 of the image processor 20 as a reference brightness value in advance when the hall 15 is in a bright state. The illuminance determination unit 22a determines whether the illuminance of the hall 15 is lower than that of the car 11 based on a difference between the reference brightness value and the brightness value of each of the second measurement areas 33a and 33b obtained when

the car door 13 fully opens.

FIG. 7 is a flowchart showing a process operation of an elevator system according to the second embodiment.

5 In the second embodiment, when the car 11 arrives at the hall 15 of a floor and its door opens, the image processor 20 captures the images picked up by the camera 12 in a time series, and executes the following process in real time while storing the images
10 sequentially in the storage unit 21. The following process is executed by the user detection unit 22 provided in the image processor 20.

 First, when the car door 13 fully opens (Yes in step S21), the illuminance determination unit 22a of
15 the user detection unit 22 calculates an average brightness value of each of the second measurement areas 33a and 33b in an image (step S22). As for the second measurement areas 33a and 33b, an average brightness value of one of the areas may be obtained
20 and compared with the reference average brightness value of the area obtained under predetermined environmental conditions to be described later.

 The illuminance determination unit 22a reads the reference brightness value of each of the second
25 measurement areas 33a and 33b, which is obtained when the hall 15 is under the predetermined environmental conditions, from the storage unit 21, and determines a difference between the reference brightness value and the average brightness value of each of the second
30 measurement areas 33a and 33b obtained when the car door 13 fully opens (step S23).

 The predetermined environmental conditions described above correspond to a state in which the hall
15 is bright enough not to generate a shadow of the car door 13. Since the second measurement areas 33a and
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33b are not influenced by the car illumination (even though they are influenced by the car illumination, the car illumination is so small that it can be ignored), they are considered to be areas reflecting only the brightness when the hall 15 is in a bright state.

Assuming that the reference brightness value of each of the second measurement areas 33a and 33b under the above predetermined environmental conditions is $K0$ and the average brightness value of each of the second measurement areas 33a and 33b when the door fully opens is $K2$, a difference in brightness is obtained by $(K0 - K2)$. The illuminance determination unit 22a determines whether the brightness difference $(K0 - K2)$ is equal to or greater than a threshold value ($Th2$) set in advance as a determination reference (step S24).

The threshold value $Th2$ is set to an appropriate value in consideration of the environment of the hall 15 and the like. The threshold value $Th2$ may vary with the hall 15 of each floor. Since, in some buildings, the color of the hall floor surface may vary from floor to floor, it is preferable to set a threshold value corresponding to the color of the hall floor surface. The threshold value $Th2$ is stored in the storage unit 21 shown in FIG. 1 and read out by the user detection unit 22 when the door of the car 11 opens.

If $(K0 - K2) \geq Th2$, it can be assumed that the hall 15 is in a dark state. In this case, as described with reference to FIG. 5, shadows 34a and 34b of the car door 13 are generated on the hall 15 when the door closes. When the shadows 34a and 34b enter the detection area $E1$, they are likely to be erroneously detected as a user. Therefore, when $(K0 - K2) \geq Th2$ (Yes in step S24), the analysis control unit 22b limits the image analysis process, considering that the hall 15 is in a dark state (step S25). A method of limiting

the image analysis process is the same as in the first embodiment described above.

On the other hand, if $(K0 - K2) < Th2$, it can be assumed that the hall 15 is in a bright state. In this case, it is considered that there is a low possibility that a shadow of the car door 13, which may cause erroneous detection when the door closes, will be generated on the hall 15. If, therefore, $(K0 - K2) < Th2$ (No in step S24), the analysis control unit 22b executes the image analysis process in the preset detection area E1 and detects a user from a change in image brightness (step S26).

As described above, according to the second embodiment, it is also possible to determine whether the hall 15 is in a dark state by paying attention to the second measurement areas 33a and 33b which are less influenced by the car illumination and comparing the reference brightness value $K0$ obtained under the predetermined environmental conditions and the average brightness value $K2$ obtained when the door fully opens. Consequently, the door can be prevented from unnecessarily reopening by limiting the image analysis process when the hall 15 is in a dark state, as in the foregoing first embodiment.

(Modification)

The foregoing first and second embodiments have been described, taking the car 11 of center open type as an example, but the same is true for, e.g., a car of side open type. FIG. 8 shows an example of a single type car door 41. The car door 41 and hall door 42 are configured by a single door panel provided movably in the door open/close direction. In FIG. 8, reference numeral 41a denotes a sill of the car door 41, and reference numeral 42a denotes a sill of the hall door 42.

The camera 12 is provided at the upper part of the doorway of the car 11 and on the close end side of the car door 41. When the car 11 arrives at a floor and its door opens, the state of the hall 15 is imaged including the state of the vicinity of the car door 13 in the car 11.

Even in the case of the car 11 of side open type, when the hall 15 is in a dark state as shown in FIG. 9, a shadow 43 of the car door 41 is generated on the hall 15 by the car illumination when the door closes and causes erroneous detection when the shadow enters the detection area E1. If, therefore, the brightness values of boundaries 41a and 41b between a portion (A) which is greatly influenced by the car illumination and a portion (B) which is less influenced by the car illumination, using the same method as in the above-described first embodiment, it can be determined whether the hall 15 is in a dark state. Consequently, the door can be prevented from unnecessarily reopening by limiting the image analysis process when the hall 15 is in a dark state.

According to at least one of the foregoing embodiments, it is possible to provide an elevator system capable of preventing a door from being reopened by a shadow of the door generated on a hall when the hall is in a dark state.

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; 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 modifications as would fall within the scope and spirit of the inventions.

WHAT IS CLAIMED IS:

1. An elevator system including a camera capable of picking up an image from a vicinity of a door of a car towards a hall, performing an analysis process to
5 detect a user from the image picked up by the camera and controlling opening and closing of the door in accordance with a result of the analysis process, the elevator system comprising:

10 illuminance determination means for determining whether illuminance of the hall is lower than illuminance of the car, based on a brightness value of a preset measurement area on the image picked up by the camera, when the door fully opens; and

15 analysis control means for limiting the analysis process of the image, considering that the hall is in a dark state, when the illuminance determination means determines that the illuminance of the hall is lower than the illuminance of the car.

2. The elevator system of Claim 1, wherein when
20 an area of the hall which is greatly influenced by illumination light of the car is a first measurement area and an area of the hall which is less influenced by the illumination light is a second measurement area, the illuminance determination means determines whether
25 the illuminance of the hall is lower than the illuminance of the car, from a difference in brightness value between the first measurement area and the second measurement area.

3. The elevator system of Claim 2, wherein the
30 first measurement area and the second measurement area are determined by a relationship in position between a light source of the car and jambs of the hall.

4. The elevator system of Claim 2, wherein the
35 illuminance determination means determines that the illuminance of the hall is lower than the illuminance

of the car when the difference in brightness value between the first measurement area and the second measurement area is equal to or greater than a preset threshold value.

5 5. The elevator system of Claim 4, wherein the threshold value is set for a hall of each floor.

 6. The elevator system of Claim 1, wherein an area of the hall which is less influenced by illumination light of the car is a measurement area,
10 the illuminance determination means determines whether the illuminance of the hall is lower than the illuminance of the car, based on a difference between a reference brightness value of the measurement area determined when the hall is under predetermined
15 environmental conditions and a brightness value of the measurement area determined when the door fully opens.

 7. The elevator system of Claim 6, wherein the reference brightness value is obtained from the image picked up by the camera when the hall is in a bright
20 state.

 8. The elevator system of Claim 7, wherein the illuminance determination means determines that the illuminance of the hall is lower than the illuminance of the car when the difference between the reference
25 brightness value and the brightness value is equal to or greater than a preset threshold value.

 9. The elevator system of Claim 8, wherein the threshold value is set for a hall of each floor.

 10. The elevator system of Claim 1, wherein the analysis control means makes a preset detection area smaller than normal to perform an analysis process of
30 the image within the detection area.

 11. The elevator system of Claim 1, wherein the analysis control means inhibits the result of the analysis process of the image from being reflected in
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control of the opening and closing.