

DOOR SYSTEM OF ELEVATOR

FIELD

Embodiments described herein generally relate to a door system of an elevator in which a car includes a car door provided with a camera.

BACKGROUND

In general, when a car of an elevator arrives at a hall, its door is opened. Then, after a predetermined time elapses, the door is closed, and the car departs for a destination floor. In this case, a passenger in a hall does not know when the door of the car will be closed. Thus, there is a case where when the passenger in the hall is getting into the car, the door of the car is being closed, and the passenger thus hits against the door.

Therefore, in order to prevent a passenger from hitting against the door of a car when the passenger gets into the car, it is conceivable that a sensor is provided to detect a passenger who will get into the car, and opening/closing of the door is controlled based on the result of the detection. As the sensor, in general, a photoelectric sensor is used. To be more specific, a photoelectric sensor is installed at an upper portion of the car, and optically detects a passenger who will get into the car. While the passenger is being detected, the door of the car can be kept opened. Thereby, it is possible to prevent the passenger from hitting against the door of the car when the door is being closed, and also from being caught in a door pocket for the door.

The detection range of the above photoelectric sensor is small; that is, the photoelectric sensor cannot detect a passenger until he or she enters the small detection range. Thus, it is highly possible that detection of the photoelectric sensor is erroneous. In view of this point, it is conceivable that for example, a monitoring camera to be installed

in a vehicle or the like is used to detect movement of a passenger with a high accuracy. However, in general, such a monitoring camera is large. In addition, in the case where a monitoring camera is applied, it needs to have a function of detecting movement of a passenger. For such a reason, the monitoring camera is restricted by its location when it is attached to a car.

SUMMARY

A door system of an elevator, according to one embodiment includes: a camera installed at an upper portion of a car, which is located above a doorway of the car, the camera being installed to perform an imaging operation at least in a predetermined range of a hall; and a control board installed at the upper portion of the car, and having a movement detection function of performing analysis processing on each of images obtained by the imaging operation of the camera to detect movement of a passenger in the hall who will get into the car. The camera and the control board are located in respective positions. Opening/closing of a door of the car is controlled based on the result of detection of the movement detection function.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view illustrating a configuration of a riding detection system of an elevator according to an embodiment.

FIG. 2 is a view illustrating an example of an image obtained by imaging of a camera in the embodiment.

FIG. 3 is a view for explaining a coordinate system in a real space in the embodiment.

FIG. 4 is a view schematically illustrating a relationship between a modesty panel of a car and a door thereof in the embodiment.

FIG. 5 is a view illustrating an example of setting of the camera in the embodiment.

FIG. 6 is a block diagram illustrating units

provided on a control board in the embodiment.

DETAILED DESCRIPTION

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

5 FIG. 1 is a view illustrating a configuration of a riding detection system of an elevator according to an embodiment. It should be noted that the following description is made by referring to a single car; however, in the case where a plurality of cars are
10 operated in the system, the system has the same structure as described as follows.

 A monitoring camera 20 and a control board 30 are individually installed at an upper portion of a car 11, which is located above a doorway of the car 11, the
15 camera 20 having a predetermined number of pixels, the control board 30 being provided to control an imaging operation of the camera 20. To be more specific, the camera 20 is installed at a modesty panel 12 which covers the above upper portion of the car 11, such that
20 a lens portion of the camera 20 faces a hall 15. The camera 20 is a small monitoring camera such as a vehicle-mounted camera, includes a wide-angle lens, and can perform continuous imaging to obtain images of dozens of frames per second (for example, 30
25 frames/second). When the car 11 arrives at each of floors and a car door 13 opens, the camera 20 images a state of the hall 15 along with a state of the vicinity of the car door 13 in the car 11.

 The range of the above imaging is adjusted such
30 that $L1 + L2$ ($L1 > L2$). $L1$ is an imaging range on a hall side, and a distance from the car door 13 to a location in the hall 15, for example, 3 m. $L2$ is an imaging range on a car side, and a distance from the car door 13 to a location in the car, for example,
35 50 cm. It should be noted that $L2$ and $L1$ are distances in a depth direction of the car and the opposite direction of the depth direction, and it is assumed

that the range of the imaging in a width direction (perpendicular to the depth direction and the opposite direction thereof) is greater than at least the width of the car 11.

5 It should be noted that in the hall 15 of each floor, a hall door 14 is installed openable/closable, in a place where the car 11 will arrive. The hall door 14 is opened as being engaged with the car door 13 when the car 11 arrives. A power source (door motor) is
10 provided in the car 11, and the hall door 14 is merely opened/closed in accordance with opening/closing of the car door 13. In the following explanation, it is assumed that when the car door 13 is opened, the hall door 14 is also opened, and when the car door 13 is
15 closed, the hall door 14 is also closed.

 The control board 30 is provided at the modesty panel 12 and independent of the camera 20. The control board 30 has a movement detection function (a movement detection unit 46 as illustrated in FIG. 6) of
20 analyzing each of images (video) obtained by an imaging operation of the camera 20 to detect movement of a passenger in the hall 15 which gets into the car 11.

 The car controller 40 is connected to an elevator controller not shown, and transmits and receives
25 various kinds of signals such as a hall call and a car call to and from the elevator controller. It should be noted that the hall call corresponds to a signal which indicates a call registered by operating any of hall call buttons (not shown) installed in the hall 15 of
30 each of the floors, and which includes information on a registration floor and a destination direction. The car call corresponds to a signal which indicates a call registered by operating any of destination floor buttons (not shown) installed in the car 11, and which
35 includes information on a destination floor.

 Furthermore, the car controller 40 controls opening and closing of the car door 13 when the car 11

arrives at the hall 15. To be more specific, the car controller 40 opens the car door 13 when the car 11 arrives at the hall 15, and then closes the car door 13 after a predetermined time elapses.

5 However, in the case where a person which will get into the car is detected based on images obtained by an imaging operation of the camera 20 during opening of the car door 13, the car controller 40 inhibits the car door 13 from being closed, thereby keeping the car door 10 13 opened. Furthermore, in the case where a person which will get into the car is detected based on images obtained by an imaging operation of the camera 20 during closing of the car door 13, the car controller 40 stops closing of the car door 13 and re-opens the 15 car door 13.

FIG. 2 is a view illustrating an example of an image obtained by an imaging operation of the camera 20. In FIG. 1, E1 denotes a movement detection area, and yn denotes a Y-coordinate of the position of a foot 20 of a passenger.

The camera 20 is installed above the doorway of the car 11 and at the upper portion of the car 11. Therefore, when the door of the car 11 is opened in the hall 15, an imaging operation is performed to image the 25 hall in a predetermined range (L1) and the car in a predetermined range (L2). By virtue of the camera 20, the range of the above detection is increased, and it is possible to detect even a passenger who is present a short distance away from the car 11. However, there is 30 a possibility that a person who merely passes through the hall 15 (a person who will not get into the car 11) may be detected by mistake as a passenger who will get into the car 11, and as a result the car door 13 may be opened.

35 In view of the above, in the system according to the embodiment, each of images obtained by an imaging operation of the camera 20 is divided into blocks each

having a predetermined size, and in the images, blocks showing movement of a person or an object are detected and the detected blocks are followed, to thereby determine whether the person is a passenger who will get into the car or not.

FIG. 3 is a view for explaining a coordinate system in a real space.

The camera 20 performs an imaging operation to obtain an image along X-, Y- and Z-axes as illustrated in FIG. 3. The X axis is an axis along which the car door 13 fitted on the doorway of the car 11 is opened/closed; the Y-axis is an axis parallel to a direction from the center of the car door 13 toward the hall 15 (a direction perpendicular to the car door 13); and the Z-axis is an axis parallel to the height direction of the car 11.

In the system according to the embodiment, images obtained by an imaging operation of the camera 20 are compared with each other in units of one block with respect to blocks corresponding to the motion detection area E1 as illustrated in FIG. 2. Based on the result of the above comparison, of blocks showing movement of the person or object in the direction from the hall 15 toward the center of the car door 13, i.e., in a direction along the Y-axis, a block showing part of the person or object which is the closest to the car door 13 is assumed as a block showing a foot of a passenger, and from variation of the position of the foot with the passage of time, it is determined whether the passenger will get into the car.

It should be noted that actually, the motion detection area E1 is divided into an area for determining the position of a foot of a passenger, an area for determining whether the passenger will get into a car or not, etc.; and with respect to each of these areas, predetermined image processing is executed. This, however, is not directly relevant to

the embodiment, and its detailed explanation will thus be omitted.

It will be explained how the camera 20 and the control board 30 are installed.

5 FIG. 4 is a view schematically illustrating a relationship between the modesty panel 12 of the car 11 and the car door 13. In the following, the car door 13 is explained by way of example as a double-leaf door.

10 At the doorway of the car 11, two door panels 13a and 13b forming the car door 13 are respectively installed on left and right sides with respect to a center line of the doorway. When the car door 13 is opened, the door panels 13a and 13b are moved over door rails (not shown) in respective directions away from
15 each other. By contrast, when the car door 13 is closed, the door panels 13a and 13b are moved in respective directions toward each other.

 For example, in the case where the width and height of the doorway of the car 11 are 800 mm and
20 2,000 mm, respectively, the width (W) and height (H) of each of the door panels 13a and 13b are 40 to 45 mm and approximately 2,000 mm. However, these dimensions change in accordance with the size of the car 11.

 The modesty panel 12 is installed at the upper
25 portion of the car 11 and above the doorway thereof as illustrated in FIG. 4. The width (w) of the modesty panel 12 as illustrated in FIG. 4 falls within the range of 800 to 1,000 mm, and the height (h) and depth (d) of the modesty panel 12 fall with the range of 200
30 to 300 mm and the range of 40 to 50 mm, respectively.

 The camera 20 is installed at a center portion of the modesty panel 12 in the longitudinal direction thereof, which is located on the center line of the doorway. To be more specific, as illustrated in
35 FIG. 5, the camera 20 is located at an inner portion of the modesty panel 12, and attached thereto by a support member 21, such that a lens 20a is inclined at a

predetermined angle γ with respect to the modesty panel 12 to face the hall 15. A camera cover 22 is provided to cover the camera 20, with space interposed between the camera cover 22 and the camera 20, and a transparent acrylic cover 23 is also provided to face the lens 20a. The outer dimensions k of the camera 20 are approximately 35 mm $\times$ 35 mm (height $\times$ width), and the length r of a projected portion of the camera 20 is approximately 20 mm.

In the modesty panel 12, photoelectric sensors 32a and 32b, other devices 33 and 34, etc., are installed originally. The photoelectric sensors 32a and 32b are provided to prevent a passenger from being caught in door pockets for the door panels 13a and 13b. The photoelectric sensors 32a and 32b comprise light-emission units which emit light downwards from both sides of the doorway, and light-reception units which receive light which is reflected after emitted from the light-emission units. As the other devices 33 and 34, for example, a device for attaching a mirror to the modesty panel 12, a device for attaching a monitor to the modesty panel 12, etc., are provided. Furthermore, in the case where the car is of a two-way-gateway type, a two-way-gateway indicator, etc., are provided.

In such a manner, in general, at the modesty panel 12, a plurality of devices are installed originally. Thus, it is hard that the camera 20 and the control board 30 are formed integral with each other, and installed at the center portion of the modesty panel 12. In the embodiment, the camera 20 and the control board 30 are formed separate from each other, and made compact; the camera 20 is installed in the center portion of the modesty panel 12; and the control board 30 is installed in vacant space in the modesty panel 12.

In particular, it should be noted that in vacant space in the modesty panel 12 where the devices do not

interfere with each other, the control board 30 is located closest to the camera 20. This is intended to prevent noise from occurring due to a transmission loss. To be more specific, in the case where the camera 20 and the control board 30 are formed separate from each other, they are connected to each other by a cable 31. Through the cable 31, each of images obtained by an imaging operation of the camera 20 is sent to the control board 30. In this case, if the camera 20 and the control board 30 are separated from each other by a given distance, the cable 31 needs to have a length corresponding to the distance. Thus, if the distance is increased, the length of the cable 31 is also increased, thus increasing the rate of occurrence of noise due to a transmission loss.

As illustrated in FIG. 6, on the control board 30, the movement detection unit 46 is provided as a function unit which achieves the system according to the embodiment. The movement detection unit 46 is a unit which detects movement of a person or an object by performing an image analysis. To be more specific, the movement detection unit 46 detects movement of a passenger who will get into the car 11, based on images obtained by an imaging operation of the camera 20, and controls opening/closing of the car door 13 based on the result of the above detection.

In the system, based on the result of comparison of the obtained images, of blocks of each of the images, a block showing part of the person or object which is the closest to the car door 13 is assumed as a block showing a foot of a passenger, and from variation of the position of the foot with the passage of time, it is determined whether the passenger will get into the car. However, if an obtained image or images contain much noise, there is a possibility that the position of a foot of a passenger will not be correctly detected. This influences the control over

opening/closing of the car door 13.

Therefore, it is preferable that the control board 30 be installed as close as possible to the camera 20. However, since a plurality of devices are installed in the modesty panel 12, in vacant space thereof where these devices are not located, the control board 30 is installed as close as possible to the camera 20.

On the control board 30, a log unit 41, an elevator unit 42, a door sensor unit 43, a setting unit 44, a camera unit 45, etc., are mounted, in addition to the above movement detection unit 46.

The log unit 41, for example, records an operation state of the camera 20. The elevator unit 42 performs a control related to an elevator operation including the operation of the car 11. The door sensor unit 43 performs a control related to opening/closing of the car door 13. The setting unit 44 performs various settings related to the imaging operation of the camera 20, which include the setting of exposure. The camera unit 45 is a unit which controls the imaging operation of the camera 20, and for example, adjusts exposure in accordance with the opening/closing of the car door 13.

Transmission of a signal between the camera 20 and the units 41 to 46 mounted on the control board 30 is carried out using the cable 31. Each of images obtained by the imaging operation of the camera 20 is sent to the control board 30 as a signal according to a signal conforming to the National Television System Committee (NTSC) standards. By contrast, signals representing, for example, various settings of the camera 20, are sent from the control board 30 to the camera 20 as signals conforming to a serial communication method with Inter-Integrated Circuit (I2C).

In such a manner, according to the embodiment, the camera 20 and the control board 30 are formed separate from each other, and thus made compact, as a result of

which they can be installed in proper positions in the car 11. The proper positions are located in the upper portion of the car 11, which is located above the doorway of the car 11, i.e., in the modesty panel 12.

5 The camera 20 is installed at the center portion of the modesty panel 12 in the longitudinal direction thereof, which is located on the center line of the doorway, whereby it is possible to reliably perform in a predetermined range an imaging operation on a passenger
10 who is going from the hall 15 toward the car door 13, to obtain an image of the passenger.

Furthermore, the control board 30 is installed as close as possible to the camera 20 in the modesty panel 12, whereby noise can be prevented from occurring due
15 to a transmission loss, and movement of the passenger can be detected with a high accuracy. Thereby, it is possible to prevent, for example, a person who merely passes by the car, from being mistakenly detected as a passenger who will get into the car, and correctly
20 detect only a passenger who will get into the car; and control opening/closing of the car door based on the result of the detection.

Furthermore, since the camera 20 and the control board 30 are formed separate from each other, for
25 example, in the case where the camera 20 breaks down, only the camera 20 can be replaced by a new one. Also, in the case where a malfunction such as a failure occurs in the control board 30, it suffices that only the control board 30 can be exchanged for a new one,
30 thus reducing the time and cost required for such replacement.

In addition, since the camera 20 and the control board 30 are provided separated from each other, various kinds of cameras (a wide-angle camera, an
35 infrared camera, a time-on-flight [TOF] camera) can be applied as the camera 20, and any of them can be exchangeably installed as the camera 20 in the car 11.

Also, the control board 30 can be easily replaced by a control board conforming to the kind of the camera.

5 It should be noted that in the above embodiment, signals are transmitted between the camera 20 and the control board 30 through the cable; however, the signals may be transmitted wirelessly, for example, using Bluetooth (registered trademark) or the like.

10 According to at least one of the above embodiments, it is possible to provide an elevator system in which constraints on the attachment of the camera to the car are reduced, the camera is installed in a proper location to correctly detect movement of a passenger, and opening/closing of the car door can be controlled based on the result of the detection.

15 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; 20 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 25 modifications as would fall within the scope and spirit of the inventions.

WHAT IS CLAIMED IS:

1. A door system of an elevator, comprising:
a camera installed at an upper portion of a car,
which is located above a doorway of the car, the camera
5 being installed to perform an imaging operation at
least in a predetermined range of a hall; and
a control board installed at the upper portion of
the car, and having a movement detection function of
performing analysis processing on each of images
10 obtained by the imaging operation of the camera to
detect movement of a passenger in the hall who will get
into the car,
wherein:
the camera and the control board are located in
15 respective positions; and
opening/closing of a door of the car is controlled
based on a result of detection of the movement
detection function.
2. The door system of Claim 1, wherein the camera
20 and the control board are installed at a modesty panel
which covers the upper portion of the doorway of the
car.
3. The door system of Claim 2, wherein the camera
is installed at a center portion of the modesty panel
25 in a longitudinal direction thereof, which is located
on a center line of the doorway, and
the control board is installed in vacant space in
the modesty panel so as not to interfere with a
plurality devices installed originally in the modesty
30 panel, and is also located in the closest possible
position with respect to the camera.
4. The door system of Claim 1, wherein
transmission of a signal between the camera and the
control board is carried out with a cable.
- 35 5. The door system of Claim 1, wherein
transmission of a signal between the camera and the
control board is wirelessly carried out.