

ELEVATOR DOOR SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to an elevator door system and an elevator including the same elevator door system.

There has been known a technology of adjusting a door open time of an elevator car (hereinafter called "car") according to signals from two sensors provided inside the car and at a landing (JP-A-2006-347686). There has been known another technology of detecting a user's posture and his or her moving speed by a camera provided inside a car so that the car door open time is changed based thereon (JP-A-2005-335875). Still another technology in which when a user in a hurry is detected, the car door open time is extended has been also known (JP-A-2005-10 162434). Furthermore, a technology in which when a user's approach is detected by a sensor provided at an elevator hall, an operation of a door closing button inside the car is invalidated has been also known (JP-U-6-73051).

SUMMARY OF THE INVENTION

15 According to conventional technologies, when a user's approach is detected, a car door open time is extended. As a result, a user can be protected from coming into contact with a door which is being closed. However, each time when a user is detected, the car door open time is extended, so that a period that the car stops at a landing is prolonged thereby reducing the operating efficiency of the elevator. Providing a sensor inside a car and at a landing each or
20 arrangement of a plurality of sensors at a landing leads to complication of the system structure and increases of the production cost.

Accordingly, an object of the present invention is to provide an elevator door system and the elevator with the elevator door system capable of preventing a user from contacting a door while improving the availability.

25 To achieve the above-described object, the present invention provides an elevator door system including a camera for taking a video of a predetermined range set in the vicinity of a car landing entrance, and a control unit that generates a predetermined control signal based on video information from the camera and transmits the predetermined control signal to a door drive unit so as to control an opening/closing state of the door. The control unit detects a
30 presence/absence of a moving object by analyzing the video information from the camera. When the moving object is detected, the control unit specifies a position and a velocity of the

moving object based on an opening/closing state of the door and the position and the velocity of the moving object, and determines whether the moving object is able to get on the car. When it is determined that the moving object is able to get on the car, the control unit lowers the closing velocity of the door relative to a current velocity. When it is determined that the moving object is
5 unable to get on, the control unit executes a predetermined operation.

When the moving object is not detected, the control unit may start the car after waiting for a predetermined time set shorter than a normal waiting time.

According to the present invention, by taking a video of the predetermined range in the vicinity of the door of the car by the camera, whether the moving object is able to get on
10 the car can be determined. Then, if it is determined that the moving object is able to get on the car, a closing velocity of the door is lowered relative to a current velocity, thereby preventing the moving object such as a user from contacting the door.

When the camera does not detect any moving object, the car is allowed to start after waiting for a predetermined time shorter than a usual waiting time, thereby reducing the
15 waiting time and improving the operating efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG 1 is an explanatory diagram showing a structure of an elevator;

FIG 2 is an explanatory diagram showing a relation between a door and a user;

20 FIG 3 is a flow chart showing opening/closing control of a door;

FIG 4 is a flow chart showing opening/closing control of a door according to a second embodiment;

FIG 5 is a flow chart showing opening/closing control of a door according to a third embodiment; and

25 FIG 6 is a graph showing a state in which the door opening velocity is changed in a step-like fashion.

DESCRIPTION OF THE EMBODIMENTS

Hereinafter, embodiments of the present invention will be described with
30 reference to the accompanying drawings. According to the present embodiment, as described in detail below, a control unit takes a video of a predetermined range in the vicinity of a landing entrance of a car by a camera and detects a presence/absence of a moving object such as a user, pet or baggage based on the taken video information. When detecting any moving object, the control unit specifies a position and a velocity of the moving object. The control unit

determines whether a moving object can get on the car based on an opening/closing state of the door and a position/velocity of the moving object. If it is determined that the moving object is able to get on the car, the door closing velocity is lowered relative to a current velocity. If it is determined that the moving object is unable to get on the car, the control unit executes a
5 predetermined operation such as reversing a door motion to open the door or starting the car without waiting.

1. First embodiment

A first embodiment will be described with reference to Figs. 1 to 3. The elevator
1 having an elevator door system of the present example 1 includes a car 3 which moves up and
10 down in a hoistway 2 to arrive at each landing 4 and a control unit 10 which controls an operation of the car 3. Here, description about call assignment to the car is omitted and mainly control on a door 5 of the car 3 will be described.

The car door 5 is provided at the landing entrance 9 to the car 3 such that it can be opened and closed. The car door 5 is opened and closed by a door drive unit 20. When the
15 car 3 arrives at a landing 4, a coupler (not shown) provided on the car door 5 connects with a landing door 6 and consequently, the landing door 6 is opened and closed following the car door 5. Two door panels are opened from and closed to their center here. Although a so-called center opening door will be taken as an example for description in this specification, the present invention is not restricted to this example, but a so-called side sliding door in which a plurality of
20 doors move synchronously in a same direction may be adopted.

An upper frame 7 which surrounds an upper portion of the landing entrance 9 is provided on the upper side of the car door 5 and a camera 8 is mounted within the upper frame 7. Although the presence of the camera 8 can be hidden from a user by arranging the camera 8 within the upper frame 7, the present embodiment is not restricted to this example but it is
25 permissible to arrange the camera 8 to be exposed on a ceiling portion above the landing entrance of the car 3.

The camera 8 is arranged so that it looks down to a floor of the landing entrance 9 and takes a video of a predetermined range SA set in the vicinity of the floor of the landing entrance. The predetermined range SA is a moving object detection range which allows the
30 moving object to be detected and which is set, for example, such that both the floor of the car 3 and the floor of the landing 4 can be taken into a video across the landing entrance 9.

A detection range L1 on the car 3 side and a detection range L2 on the landing 4 side may be set equal to each other ($L1 = L2$). Alternatively, the detection range L1 on the car side may be set larger ($L1 > L2$) or the detection range L2 on the landing side may be set larger

($L2 > L1$).

In case where the camera 8 is mounted on an electrically-driven camera platform, the shooting direction of the camera 8 may be changed. Thus, depending on the opening/closing operation of the door 5, a relation in terms of length between the detection range
5 L1 on the car side and the detection range L2 on the landing side may be changed appropriately. For example, if the door 5 begins to open while a user is getting on the car 3, the detection range L1 on the car side is set larger ($L1 > L2$). As a result, an exit of a user standing in the car 3 can be detected within a relatively wider range. If a predetermined short time passes after the door 5 is fully opened, the detection range L2 on the landing side is set larger ($L2 > L1$). As a result,
10 a user who is trying to get on the car in a hurry can be detected within a relatively wider range. Furthermore, the shooting direction of the camera 8 can be changed without use of the electrically-driven camera platform. For example, by adjusting an angle of a mirror provided inside or outside the camera, the shooting direction can be changed.

In the meantime, because the camera 8 is only required to be able to detect a
15 position and a velocity of any moving object such as a user, pet or carriage, the present invention is not limited to the optical camera 8 but may employ other types of sensors such as an ultrasonic radar and infrared radar.

A structure of the control unit 10 will be described. The control unit 10 for controlling the opening/closing of the door includes, for example, a moving object detecting unit
20 11, a position/velocity unit 12 for calculating a position and a velocity of the moving object, a getting-on possibility estimating unit 13, a door control unit 14, and a door instruction generating unit 15. The control unit 10 may be configured by a single unit or a plurality of units each containing a microprocessor, a memory and the like. The functions 11 to 15 of the control unit 10 can be achieved by executing a predetermined computer program by a microprocessor or by a
25 specialized control circuit board.

The moving object detecting unit 11 detects a presence/absence of the moving object by analyzing video information from the camera 8. The moving object includes, for example, a user of the elevator, a pet which a user is accompanied by, a carriage which a user is pushing, a trunk which a user is pulling and the like. The moving object to be detected by the
30 moving object detecting unit 11 is an object which is moving to the landing entrance 9 among the objects which can use the elevator. Hereinafter, description of the moving object will be made by taking the user as an example.

The moving object detecting unit 11 stores, for example, a state when the door 5 is opened before the elevator is actuated as an initial image data (initial video information).

The moving object detecting unit 11 determines whether there exists a user within the detection range SA by comparing the image data (a part of the video information) taken during an actuation of the elevator with the initial image data.

The position/velocity calculating unit 12 calculates a position and a moving
5 velocity of the user detected by the moving object detecting unit 11. For example, the position/velocity calculating unit 12 can detect a user's contour from the image data including the figure of the user and calculate the position coordinates of the contour as a position of the user. Furthermore, the position/velocity calculating unit 12 can calculate a moving velocity and a moving direction of the user from changes with a time passage of the user's position
10 information obtained from a plurality of the image data.

Based on the position and moving velocity of the user calculated by the position/velocity calculating unit 12 and a position and an opening/closing velocity (door opening/closing state) of the door 5 acquired from the door control unit 14, the getting-on possibility estimating unit 13 estimates whether the user is able to get on the car 3 without
15 touching the door. In accordance with an estimation result of the getting-on possibility estimating unit 13, the door instruction generating unit 15 generates a predetermined control signal and transmits the predetermined control signal to the door drive unit 20.

FIG. 2 is an explanatory diagram showing schematically relationships between a user who gets on or off the car 3 and the doors 5 and 6. Case (a) shows a state in which a user
20 U1 is getting on the car in a hurry through the doors 5, 6 being closed. The user U1 is trying to get on through a clearance between the doors 5 and 6 with his or her body oriented oblique with respect thereto. In this case, there is a possibility that the user U1 may touch the doors 5 and 6.

Case (b) shows a state in which a user U2 getting on the car 3 is being caught by the opening door 5. Case (c) shows a state in which a user U3 is getting on the car 3 normally
25 from a landing 4. Every state shown in (a) to (c) of FIG. 2 can be discriminated by analyzing video data supplied from the camera 8.

FIG. 3 is a flowchart showing door opening/closing control processing according to the present embodiment. The control unit 10 acquires video data from the camera 8 (S10). At this time, as described above, the shooting direction may be adjusted depending on an
30 opening/closing state of the door 5 to determine sizes of the detection range L1 on the car side and the detection range L2 on the landing side.

By analyzing video data acquired from the camera 8, the control unit 10 detects a presence/absence of a user, a position of the user (may be a user's contour) and a moving velocity of the user (including moving direction) (S11). As described above, by comparing a

plurality of the image data between one and another, the presence/absence, position and velocity of the user can be detected.

The control unit 10 determines whether a user exists within the detection range SA (S12). If no user exists within the detection range SA set in the vicinity of the landing entrance 9 (S12: NO), the control unit 10 makes the car 3 wait at the landing 4 for a predetermined time and after that, allows the car 3 to start (S13). The car 3 moves to a floor requested by an assigned call (car assignment, landing assignment) or a floor set preliminarily through the hoistway 2.

If a user exists within the detection range SA (S12: YES), the control unit 10 determines whether the user is able to get on without touching the doors 5 and 6 (S14). In other words, the control unit 10 determines whether the user located within the detection range SA is able to get on the car 3 normally (in safety).

If the control unit 10 determines that the user is able to get on without any collision with the doors 5 and 6 (S14: YES), it lowers the closing velocity of the door 5 with respect to a current velocity (S15). In a case that the user is expected to be able to get on without lowering the closing velocity of the door 5 according to the estimation, the closing velocity of the door 5 is still lowered to improve the safety. As a result, the user is able to get on the car 3 more safely.

If it is determined that the user located within the detection range SA is unable to get on without touching the doors 5 and 6 (S14: NO) or a percentage that the user may fail to rush into the car and he or she touches the doors 5 and 6 is higher than a predetermined value, the control unit 10 reverses the opening/closing operation of the door 5 and then opens the door 5 which is being closed (S16). Consequently, the user can be prevented from touching the doors 5 and 6.

According to the present embodiment, as described above, by analyzing video data from the camera 8 provided on an upper portion of the car 3, whether any user is approaching is determined and the opening/closing of the door 5 is controlled. Thus, it is not necessary to provide a plurality of sensors at the landing 4 and consequently, the safety and usability can be improved without an increase of cost on the elevator door system. In addition, according to the present embodiment, only when a user exists in the vicinity of the landing entrance 9, the closing velocity of the door 5 is adjusted and the moving direction of the door 5 is reversed. Thus, a waste time in the case that the car waits with the door 5 kept open like in a conventional technology can be reduced. Accordingly, the present embodiment can improve the safety and reliability without reducing the operating efficiency.

2. Second embodiment

The second embodiment will be described with reference to FIG. 4. According to the present embodiment, if no user exists within the detection range SA, the car starts after a shorter waiting time than normally. Furthermore, according to the present embodiment, if it is
5 determined that a user located within the detection range SA is unable to get on, the door 5 is closed and the car starts without waiting.

FIG. 4 is a flowchart of the door opening/closing control processing according to the present embodiment. This processing includes the steps S10 to S12, S14, and S15 mentioned in FIG. 3. In this processing, step S20 is executed instead of the step S13 mentioned
10 in FIG. 3, and step S21 is executed instead of the step S16 mentioned in FIG. 3. Hereinafter, mainly a difference from the first embodiment will be described.

If the control unit 10 determines that no user exists within the detection range SA (S12: NO), it makes the car 3 wait for a time shorter than a normal time and start (S20). That is, because no user exists within the detection range SA, the control unit 10 allows the car 3 to
15 start without waiting for the normal time.

If a user is detected within the detection range SA (S12: YES) and it is determined that the user is unable to get on (S14: NO), the control unit 10 closes the door 5 fully without waiting for the user and allows the car 3 to start (S21).

The present embodiment having such a configuration exerts the same effect as the
20 first embodiment. Furthermore, according to the present embodiment, if it is confirmed that a user to get off the car 8 or a user to get on the car 8 does not exist within the detection range SA, the car 8 can be started with a waiting time shorter than the normal time. Consequently, a waste waiting time can be reduced thereby improving the operating efficiency.

According to the present embodiment, if it is determined that a user located
25 within the detection range SA is unable to get on the car 3 without touching the doors 5 and 6, the car 3 starts without waiting. Thus, a necessity of waiting for a user to get on by reversing the operation of the door 5 is eliminated thereby further improving the operating efficiency of the elevator.

3. Third embodiment

80 The third embodiment will be described with reference to FIG. 5 and FIG. 6. FIG. 5 is a flow chart of the door opening/closing control processing of the present embodiment. According to the present embodiment, if it is determined that a user located within the detection range SA is able to get on (S14: YES), the control unit 10 closes the door 5 step by step (S22).

FIG. 6 is a graph showing changes in position of the door 5 with a time passage.

The ordinate axis indicates a position of the door, and a bottom of the ordinate axis indicates a fully-closed position and a top of the ordinate axis indicates a fully-open position. The abscissa axis indicates time.

Assume that at time T1 when the door 5 begins to close, a user is detected within the detection range SA and it is determined that the user is able to get on the car 3. The control unit 10 transmits a predetermined control signal from the door instruction generating unit 15 to the door drive unit 20 to close the door 5 in the step-like fashion (step by step). If it is confirmed that a user has gotten on at time T2 by analyzing video data from the camera 8, the control unit 10 closes the door 5 at a normal velocity as usually.

The present embodiment having the above-described configuration exerts the same effect as the first and second embodiments. In addition, according to the present embodiment, if it is determined that a user located within the detection range SA is able to get on, the door 5 is closed step by step. As a result, user's attention can be evoked by the operation of the door 5. Therefore, the present embodiment allows a user to get on the car 3 more safely.

In the meantime, the present invention is not restricted to the above-described embodiments. Those skilled in the art can perform a variety of additions, modifications and the like within the scope of the present invention.

CLAIMS:

1. An elevator door system comprising:
a camera (8) for taking a video of a predetermined range set in the vicinity of a landing entrance of a car (3);
the camera (8) is provided on an upper side of the door (5) of the car (3)
such that the camera (8) can look down to a floor of the landing entrance (9) and;
a control unit (10) that generates a predetermined control signal based on video information from the camera (8) and transmits the predetermined control signal to a door drive unit (20) so as to control an opening/closing of the door,
wherein the control unit (10) detects a presence/absence of a moving object by analyzing the video information from the camera (8),
when the moving object (8) is detected, the control unit specifies a position and a velocity of the moving object and determines whether the moving object is able to get on the car based on an opening/closing state of the door (5) and the position and the velocity of the moving object, and
when it is determined that the moving object is able to get on the car (3), the control unit lowers the closing velocity of the door (5) relative to a current velocity, and
when it is determined that the moving object is unable to get on the car, the control unit executes a predetermined operation.
2. The elevator door system according to claim 1,
wherein, when the moving object is not detected, the control unit (10) starts the car (3) after making the car (3) wait for a predetermined time set shorter than a normal waiting time.
3. The elevator door system according to claim 1 or 2, wherein the predetermined operation is an operation of opening the door (5).
4. The elevator door system according to claim 1 or 2, wherein the predetermined operation is an operation of closing the door (5) and starting the car (3).
5. The elevator door system according to claim 1 or 2,
wherein, when the control unit determines that the moving object is able to get on the car, the control unit (10) causes the car (3) to close the door (5) step by step.
6. An elevator including the elevator door system according to any one of claims 1 to 5.