

DESCRIPTION

PASSENGER CONVEYOR SYSTEM AND MOVING BODY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of and priority to Japanese Patent Application No. 2022-098707 filed on June 20, 2022, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

An embodiment of the present invention relates to a passenger conveyor system and a moving body used for the same.

2. Description of Related Art

In passenger conveyors such as an escalator and a moving walkway, a balustrade, on which a handrail belt moves, is provided with a lamp for illuminating the balustrade. This lamp is an LED fluorescent lamp or a fluorescent lamp of a straight tube type. A large number of such lamps are attached to the balustrade from one landing to another landing.

SUMMARY OF THE INVENTION

While the large number of lamps are attached to the balustrade of the passenger conveyor as described above, one or some of these lamps may not be light up properly, that is, so-called "dark illumination" may occur. However, there has been no conventional function to detect such dark illumination, and the dark illumination is detected only through a report from a passenger or during maintenance work for which the passenger conveyor is stopped.

In view of the above problem, an embodiment of the invention has a purpose of providing a passenger conveyor system and a moving body capable of detecting an illumination state of a lamp that is attached to a balustrade of a passenger conveyor.

An embodiment of the invention is a passenger conveyor system including a passenger conveyor and a moving body. The passenger conveyor has: a right and left pair of balustrades on each of which a handrail belt runs; a step that moves between the right and left pair of the balustrades in a front-rear direction from one landing to another landing; a lamp that is provided along the front-rear direction in an upper portion of each of the balustrades; and a main control section that moves the step. The moving body has: a body of the moving body that moves on the step; a sensor that is provided to the body of the moving body and detects illuminance from the lamp; and a

moving body control section that stores illumination information in a chronological order, the illumination information indicating an illumination state of the lamp at each position on each of the balustrades on the basis of the illuminance detected by the sensor.

In addition, an embodiment of the invention is a moving body having: a body of the moving body that moves on a step of a passenger conveyor; a sensor that is provided to the body of the moving body and detects illuminance from a lamp provided in a front-rear direction along an upper portion of a balustrade of the passenger conveyor; and a moving body control section that stores illumination information in a chronological order, the illumination information indicating an illumination state of the lamp at each position on the balustrade on the basis of the illuminance detected by the sensor.

According to the embodiment of the invention, it is possible to inspect the illumination state of the lamp, which is attached to the balustrade, only by placing the moving body on the step and moving the moving body.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an explanatory view of an escalator illustrating an embodiment of the invention, and is an enlarged vertical cross-sectional view of a portion

including a left lamp cover;

FIG. 2 is a view of a moving body placed on a step and an upper portion of a balustrade in a state seen from a lower floor;

FIG. 3 is a schematic view for illustrating binarized illuminance in a manner to correspond to an illumination state of an LED that is attached to the balustrade;

FIG. 4 is a block diagram of the escalator and the moving body; and

FIG. 5 is a flowchart for inspection of a left LED and a right LED.

DESCRIPTION OF EMBODIMENTS

A description will be made on an escalator 10 and a moving body 100 in a passenger conveyor system in an embodiment of the invention with reference to FIGS. 1 to 5.

(1) Escalator 10

A description will be made on an overall structure of the escalator 10 with reference to FIG. 1. FIG. 1 is an explanatory view in which the escalator 10 is seen from a left side. Here, in order to facilitate understanding of an internal structure of the escalator 10, members on a right side of the escalator 10 are not illustrated. In a description of a front-rear direction of the escalator 10, an upper floor is set as a front side, and a lower floor is

set as a rear side when the upper floor is looked up from the lower floor.

A truss 12 as a framework of the escalator 10 is supported in the front-rear direction by using support angles 2, 3 across an upper floor and a lower floor of a building 1. A camera 5 for monitoring the escalator 10 is installed above the escalator 10, that is, on a ceiling 4 of the building 1. This camera 5 has a function that enables to capture a 360° image of an area below, and can capture an image of an area from a landing on the lower floor side to a landing on the upper floor side of the escalator 10. Instead of providing the single camera 5, plural cameras 5 may be provided so as to be able to capture images of the area from the landing on the lower floor side to the landing on the upper floor side of the escalator 10.

A drive unit 18, a right and left pair of step sprockets 24, 24, and a right and left pair of belt sprockets, which are not illustrated, for running a step 30 are provided in a machine room 14 on the upper floor side that is located in an upper end portion of the truss 12. This drive unit 18 has: a motor 20; a decelerator 21; a small drive sprocket 19 that is attached to an output shaft of this decelerator 21; and an electromagnetic brake 23 of a disc type that stops rotation of the motor 20 and keeps a stopped state thereof. A large drive sprocket 17 is

coaxially attached to each of the right and left pair of the step sprockets 24, 24, and an endless drive chain 22 is hung between the large drive sprocket 17 and the small drive sprocket 19. In addition, a controller 50 as a main control section that controls the motor 20, the electromagnetic brake 23, and the like is provided in the machine room 14 on the upper floor side.

A right and left pair of driven sprockets 26, 26 is provided in a machine room 16 on the lower floor side that is located in a lower end portion of the truss 12. A right and left pair of endless step chains 28, 28 is respectively hung between the right and left pair of the step sprockets 24, 24 on the upper floor side and the right and left pair of the driven sprockets 26, 26 on the lower floor side. A right and left pair of first wheels 301, 301 in each of the plural steps 30 is respectively coupled to the right and left pair of the step chains 28, 28 at equally-spaced intervals. When the motor 20 rotates, the first wheel 301 of the step 30 runs on a guide rail, which is not illustrated, is fixed to the truss 12, and is dedicated to the first wheel, and a second wheel 302 of the step 30 runs on a guide rail 25, which is fixed to the truss 12 and is dedicated to the second wheel.

A right and left pair of balustrades 36, 36 is vertically provided on both right and left sides on top of

the truss 12. A handrail 39 is provided on top of this balustrade 36, and an endless handrail belt 38 moves along this handrail 39.

As illustrated in a partially enlarged vertical cross-sectional view in FIG. 1 and in FIG. 2, a tape-shaped LED board on the left side (hereinafter referred to as a "left LED board") 68 that is long in the front-rear direction is arranged at the bottom of an inner side (the step 30 side) of the left handrail 39 in a manner to extend in the front-rear direction. LEDs on the left side (hereinafter referred to as "left LEDs") 70 are attached to this left LED board 68 at equally-spaced intervals from the lower floor side to the upper floor side. A left lamp cover 72 is attached to a lower portion of the left handrail 39 in a manner to cover this left LED board 68 and the plural left LEDs 70.

As illustrated in FIG. 2, a tape-shaped LED board on the right side (hereinafter referred to as a "right LED board") 74 that is long in the front-rear direction is arranged at the bottom of an inner side (the step 30 side) of the right handrail 39 in a manner to extend in the front-rear direction. LEDs on the right side (hereinafter referred to as "right LEDs") 76 are attached to this right LED board 74 at equally-spaced intervals from the lower floor side to the upper floor side. A right lamp cover 78 is attached to a lower portion of the right handrail 39 in

a manner to cover this right LED board 74 and the plural right LEDs 76.

In this embodiment, the left LED 70 and the right LED 76 each correspond to a lamp.

A front skirt guard 40 on the upper floor side is provided to a lower front portion on the upper floor side of each of the right and left pair of the balustrades 36, 36. A front skirt guard 42 on the lower floor side is provided to a lower front portion on the lower floor side thereof. Inlets 46, 48 as entry/exit points of the handrail belt 38 are projected from the front skirt guards 40, 42, respectively. A skirt guard 44 is provided to a lower lateral portion of each of the right and left pair of the balustrades 36, 36, and the step 30 runs between the right and left pair of the skirt guards 44, 44.

The handrail belt 38 synchronously moves with the step 30 due to co-rotation of the belt sprocket, which is not illustrated, and the step sprocket 24.

A landing board 32 on the upper floor side is horizontally provided on a ceiling surface of the machine room 14. The ceiling surface of the machine room 14 serves as the landing between the right and left pair of the skirt guards 44, 44 on the upper floor side. A landing board 34 on the lower floor side is horizontally provided on a ceiling surface of the machine room 16. The ceiling surface

of the machine room 16 serves as the landing between the right and left pair of the skirt guards 44, 44 on the lower floor side. A comb 60 with teeth is provided at a tip of the landing board 32 on the upper floor side, and the step 30 advances and enters from this comb 60. In addition, a comb 62 with teeth is provided at a tip of the landing board 34 on the lower floor side.

(2) Moving Body 100

Next, a description will be made on the moving body 100 for inspecting the right LEDs 76 and the left LEDs 70 on the right and left pair of the balustrades 36, 36 of the escalator 10 with reference to FIG. 2. This moving body 100 is a robot that can travel autonomously, and a purpose thereof is unmanned inspection of the escalator 10.

The moving body 100 has a substantially cubic body 102, which is designed to be large enough to ride on the single step 30. A robot control section 104 as a moving body control section including a computer and the like is provided in the body 102. Four wheels 106 are provided below the body 102, and these four wheels 106 are rotated by a movement motor 108. The robot control section 104 can cause the moving body 100 to travel forward, travel rearward, rotate to the right, or rotate to the left by controlling rotation, a stop, and a rotational direction of the movement motor 108.

As illustrated in FIG. 2, a support column 118 is vertically provided in a perpendicular direction from an upper surface of the body 102 of the moving body 100. A left horizontal section 120 is projected horizontally leftward from an upper end of this support column 118, and a right horizontal section 122 is projected horizontally rightward therefrom. When the moving body 100 is seen from behind, the left horizontal section 120, the right horizontal section 122, and the support column 118 are substantially T-shaped. An illuminance sensor on the left side (hereinafter referred to as a "left sensor") 110 is attached to a tip of the left horizontal section 120. An illuminance sensor on the right side (hereinafter referred to as a "right sensor") 112 is attached to a tip of the right horizontal section 122. Illuminance detected by each of the left sensor 110 and the right sensor 112 is sent to the robot control section 104.

Heights of the right horizontal section 122 and the left horizontal section 120 are set such that, when the moving body 100 is placed on the step 30, as illustrated in FIG. 2, heights of the right sensor 112 and the left sensor 110 are substantially equal to heights of the right LEDs 76 and the left LEDs 70 provided to the right and left pair of the balustrades 36, 36.

(3) Electrical Configurations of Escalator 10 and Moving

Body 100

Next, a description will be made on electrical configurations of the escalator 10 and the moving body 100 with reference to a block diagram in FIG. 4.

To the controller 50 provided in the machine room 14 on the upper floor side, a communication section 64 for communicating with a robot communication section 116 as a moving body communication section of the moving body 100 and a monitoring device 200 at a maintenance center on the outside, a drive circuit 66 for controlling the motor 20 and the electromagnetic brake 23, the left LED board 68, and the right LED board 74 are connected. In addition, the controller 50 receives the image (moving image data) from the camera 5, which is provided on the ceiling 4 of the building 1 as illustrated in Fig. 1. The controller 50 then subjects the moving image data to an image analysis to determine whether the moving body 100 gets on the lowest step 30 on the lower floor side or gets off the highest step 30 on the upper floor side.

The movement motor 108, the left sensor 110, the right sensor 112, a storage section 114, and the robot communication section 116, which communicates with the communication section 64, are connected to the robot control section 104 in the moving body 100.

(4) Inspection Method of Left LEDs 70 and Right LEDs 76 by

Moving Body 100

Next, a description will be made on a method for inspecting the left LEDs 70 and the right LEDs 76 by using the moving body 100.

First, the robot control section 104 uses the movement motor 108 to move the moving body 100 from the landing board 34 on the lower floor side to the lowest step 30. Then, the controller 50 detects a state where the moving body 100 has been moved to the step 30 by using the camera 5, and instructs the robot control section 104 to start inspecting the illumination states of the left LEDs 70 and the right LEDs 76 by using the left sensor 110 and the right sensor 112, respectively. Hereinafter, this inspection start position will be referred to as a "start point".

When the step 30 moves toward the upper floor side, the moving body 100 is moved along therewith. Then, the left sensor 110 and the right sensor 112 respectively detect the illuminance of the left LEDs 70 and the right LEDs 76 at predetermined times (for example, every one second). As illustrated in FIG. 3, the robot control section 104 binarizes the detected illuminance on each of the right and left sides by using a predetermined reference value. Then, the robot control section 104 stores the binarized illuminance in a chronological order by setting the illuminance that is equal to or higher than the reference

value as "1" and the illuminance that is lower than the reference value as "0". The LED with a value of 1 means "bright illumination", and the LED with a value of 0 means "dark illumination". A position of the dark illumination LED is determined by what number (for example, n-th number) the value of 0 is located counting from the start point. Hereafter, this binarized illuminance will be referred to as "illumination information".

When the moving body 100 on the step 30 ascends and arrives at the landing board 32 on the upper floor side from the highest step 30, the controller 50 detects the moving body 100 from the image captured by the camera 5 and instructs the robot control section 104 to terminate the inspection of the left LEDs 70 and the right LEDs 76. Hereinafter, this position will be referred to as an "end point".

The robot control section 104 arranges the illumination information of the left LEDs 70 from the start point to the end point in the chronological order as left continuous illumination information, and arranges the illumination information of the right LEDs 76 from the start point to the end point in the chronological order as right continuous illumination information. Then, the robot control section 104 sends the left continuous illumination information and the right continuous illumination

information to the controller 50.

In the case where the n-th illumination information in the left continuous illumination information in the chronological order is 0, the controller 50 determines that the n-th left LED 70 from the start point is the dark illumination, and reports such a fact to the monitoring device 200 at the maintenance center on the outside. The same processing is executed for the right continuous illumination information.

A description will be made on the inspection method that has been described above with reference to a flowchart in FIG. 5.

In step S1, in the case where the escalator 10 is activated and the steps 30 are operated normally, the processing proceeds to step S2.

In step S2, the number of passengers on the escalator 10 is smaller than a reference number of the passengers (if y), the processing proceeds to step S3. If the number of passengers on the escalator 10 is larger than the reference number of the passengers (if n), the processing in step S2 is repeated. This prevents presence of the moving body 100 from becoming an obstacle when there are many passengers.

Since it is determined that the number of the passengers is small, in step S3, the controller 50 controls the robot control section 104 to place the moving body 100

on the lowest step 30 from the landing board 34 on the lower floor side. Then, the processing proceeds to step S4.

In step S4, when the controller 50 confirms that the moving body 100 has been placed on the lowest step 30 on the basis of the image from the camera 5, the controller 50 determines that the moving body 100 has arrived at the start point, and starts the inspection of the left LEDs 70 and the right LEDs 76. Then, the processing proceeds to step S5.

In step S5, while the moving body 100 on the step 30 moves from the lower floor to the upper floor, the robot control section 104 detects the illumination information of the left LEDs 70 and the right LEDs 76 in the chronological order by using the left sensor 110 and the right sensor 112. Then, the processing proceeds to step S6.

In step S6, when the moving body 100 gets off the highest step 30 to the landing board 32 on the upper floor side, the processing proceeds to step S7.

In step S7, when the controller 50 confirms that the moving body 100 has gotten off the highest step 30 on the basis of the image from the camera 5, the controller 50 determines that the moving body 100 has arrived at the end point, and terminates the inspection of the left LEDs 70 and the right LEDs 76. Then, the processing proceeds to step S8.

In step S8, the robot control section 104 sends the continuous illumination information on both of the right and left sides to the communication section 64 in the controller 50 via the robot communication section 116. Then, the processing proceeds to step S9.

In step S9, the controller 50 determines presence or absence of the left LED 70 or the right LED 76 as the dark illumination from the continuous illumination information on both of the right and left sides. Then, the processing proceeds to step S10.

In step S10, if there is the left LED 70 or the right LED 76 as the dark illumination, such a left LED 70 or right LED 76 is determined to be abnormal. Then, the processing proceeds to step S11. If there is no left LED 70 or right LED 76 as the dark illumination, it is determined that the left LEDs 70 and the right LEDs 76 are normal, and the inspection is then terminated.

In step S11, a position of the left LED 70 or the right LED 76 as the dark illumination is sent to the monitoring device 200 at the maintenance center. Then, the inspection is terminated.

(5) Effects

According to this embodiment, it is possible to inspect the illumination states of the right LEDs 76 and the left LEDs 70 on both of the right and left sides of the

balustrades 36, 36 only by placing the moving body 100 on the step 30 and moving the moving body 100.

In addition, since the inspection is performed when the escalator 10 is operated normally in a state with the few passengers, the inspection can be performed without stopping the escalator 10 and without disturbing the passengers.

Furthermore, also, at the maintenance center, it is possible to determine the presence and the positions of the left LED 70 and/or the right LED 76 as the dark illumination from the controller 50 in the escalator 10. Thus, when a maintenance worker heads for the escalator 10 for the maintenance, a type, number, and the like of a replacement part such as the LED are also determined.

Moreover, the left sensor 110 and the right sensor 112 are respectively provided at the tips of the left horizontal section 120 and the right horizontal section 122, and the illuminance can be detected near the left LEDs 70 and the right LEDs 76. Thus, it is possible to suppress disturbance (for example, light from a lighting device of the building, sunlight, and the like) and to accurately detect the illuminance.

(6) Modified Examples

Next, a description will be made on modified examples of the above embodiment.

In the above embodiment, the LED is used as the lamp for the balustrade 36. However, instead thereof, a fluorescent lamp of a straight tube type may be used.

In the above embodiment, the illuminance sensors as the left sensor 110 and the right sensor 112 only detect the illuminance. However, by detecting chromaticity in addition thereto, not only the dark LED but also the discolored LED can be detected.

In the above embodiment, the left LEDs 70 and the right LEDs 76 are continuously provided from the lower floor to the upper floor. However, in the case where there is a joint or the like in the middle, the illumination information is masked in advance to indicate that this position (the m-th position from the starting point) is dark, that is, the controller 50 does not make a determination for the m-th illumination information. In this way, it is possible to prevent erroneous detection.

In the above embodiment, it is detected whether the moving body 100 has been placed on the step 30 or has gotten off the step 30 by using the image captured by the camera 5. However, instead thereof, a sensor that detects getting on/off of the moving body 100 may be provided at the landing of the escalator 10 for the detection.

In the above embodiment, the lamps are inspected while the moving body 100 ascends from the lower floor to the

upper floor. However, instead thereof, the lamps may be inspected while the moving body 100 descends from the upper floor to the lower floor.

The moving body 100 in the above embodiment has the left sensor 110 and the right sensor 112. However, for example, the illuminance sensor may only be provided on one side (for example, the left side), the illumination states of the left LEDs 70 are inspected from the lower floor to the upper floor, and the moving body 100 may be rotated 180° thereafter to move from the upper floor to the lower floor for the inspection of the right LEDs 76.

In the above embodiment, the robot control section 104 is provided in the body 102 of the moving body 100. However, the invention is not limited thereto. The robot control section 104 may be provided in the escalator 10, and the information from the left sensor 110 and the right sensor 112 may be sent to the robot control section 104.

In the above embodiment, the description has been made on the case where the invention is applied to the escalator 10. However, instead thereof, the invention may be applied to the moving walkway. In the moving walkway, flat plates on which the passenger stands or walks are referred to as the "steps".

The above description has been made on the embodiment of the invention. However, this embodiment is merely

provided as the example and thus is not intended to limit the scope of the invention. These novel embodiments can be implemented in any of various other aspects, and various types of elimination, replacement, and changes can be made thereto within the scope that does not depart from the gist of the invention. These embodiments and the modifications thereof are included in the scope and the gist of the invention and are also included in the invention described in the claims and the equivalent scope thereof.

CLAIMS

1. A passenger conveyor system comprising a passenger conveyor and a moving body, wherein

the passenger conveyor has:

a right and left pair of balustrades on each of which a handrail belt runs;

a step that moves between the right and left pair of the balustrades in a front-rear direction from one landing to another landing;

a lamp that is provided along the front-rear direction in an upper portion of each of the balustrades; and

a main control section that moves the step, and

the moving body has:

a body of the moving body that moves on the step;

a sensor that is provided to the body of the moving body and detects illuminance from the lamp; and

a moving body control section that stores illumination information in a chronological order, the illumination information indicating an illumination state of the lamp at each position on each of the balustrades on the basis of the illuminance detected by the sensor.

2. The passenger conveyor system according to claim 1, wherein

the moving body control section

determines that the lamp is bright illumination when the illuminance detected by the sensor is equal to or higher than a reference value, determines that the lamp is dark illumination when the illuminance detected by the sensor is lower than the reference value, and generates the illumination information, and

generates continuous illumination information by arranging the illumination information of the lamp in the chronological order.

3. The passenger conveyor system according to claim 2, wherein

the moving body control section

sets time at which the moving body gets on the step from the one landing as a start point, and sets time at which the moving body gets off the step to the another landing as an end point, and

stores the continuous illumination information from the start point to the end point.

4. The passenger conveyor system according to claim 3, wherein

the moving body control section has a moving body communication section that sends the stored continuous

illumination information to the main control section.

5. The passenger conveyor system according to claim 4, wherein

in the case where the dark illumination is included in the continuous illumination information, the main control section reports such a fact to a monitoring device at a maintenance center on outside.

6. The passenger conveyor system according to claim 1, wherein

the lamp is an LED or a fluorescent lamp of a straight tube type.

7. The passenger conveyor system according to claim 1, wherein

the sensor can detect chromaticity in addition to the illuminance, and the chromaticity is also included in the illumination state.

8. A moving body comprising:

a body of the moving body that moves on a step of a passenger conveyor;

a sensor that is provided to the body of the moving body and detects illuminance from a lamp provided in a

front-rear direction along an upper portion of a balustrade of the passenger conveyor; and

a moving body control section that stores illumination information in a chronological order, the illumination information indicating an illumination state of the lamp at each position on the balustrade on the basis of the illuminance detected by the sensor.