

TITLE OF THE INVENTION

ELEVATOR DOOR MONITORING DEVICE AND ELEVATOR DOOR
MONITORING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001]

The present invention relates to an elevator door monitoring device and an elevator door monitoring system.

2. Description of the Related Art

[0002]

There is known an elevator door control method for comprehending how an elevator is used based on operating rates of an overload reversing device and a safety shoe which are safety devices, and controlling opening and closing operations of the door. For example, JP 2017-145082 A describes that "if a user often hits a car door, as door control, the door time is set relatively long to allow more time for getting on and off, and moreover, the door speed is decreased to make it slow. Thus, the risk of hitting the car door can be reduced. Impatient users are expected to quickly get on and off, and frequently take actions such as busily pressing the close button. Under door control in such a case, the door time is set relatively short to allow less time for getting on and off,

and the door speed is set relatively fast, so that the number of times the close button is operated can be reduced" (paragraph 0028).

SUMMARY OF THE INVENTION

[0004]

The elevator door control method described in the above JP 2017-145082 A is on the premise that the operating state of the door can be comprehended by a signal from the overload reversing device or the like mounted on the elevator. However, when the need for monitoring the operating state of the door newly arises after the elevator is installed, there may be cases where a signal from the overload reversing device or the like is not available.

[0005]

An object of the present invention is to provide a door monitoring device and a door monitoring system that achieve highly convenient control according to an operating state of a door even when a signal from a door safety device mounted on an elevator is not available.

[0006]

In order to solve the above problems, in an elevator door monitoring device that is coupled via a communication line to a maintenance staff terminal carried by a maintenance staff of an elevator and monitors a door of the

elevator, a current detector is provided on a motor that opens and closes a car door, and when a number of times a current detected by the current detector exceeds a threshold satisfies a predetermined condition, information prompting to change an operation of the car door is transmitted to the maintenance staff terminal.

[0007]

According to the present invention, it is possible to provide a door monitoring device and a door monitoring system that achieve highly convenient control according to an operating state of a door even when a signal from a door safety device mounted on an elevator is not available.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is an overall diagram of an elevator door monitoring system according to an embodiment of the present invention;

Fig. 2 is a front view representing a structure of a car door of the present embodiment;

Fig. 3 is a graph illustrating measured waveforms when the car door normally opens and closes;

Fig. 4 is a graph illustrating measured waveforms when a user or the like collides with a landing door;

Fig. 5 is a graph illustrating measured waveforms

when a user or the like collides with a car door;

Fig. 6 is a flowchart illustrating a method of monitoring a status of collision with a door; and

Fig. 7 is a diagram illustrating a screen displayed on a display unit of a maintenance staff terminal.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009]

Hereinafter, an embodiment of the present invention will be described using the drawings. Fig. 1 is an overall diagram of an elevator door monitoring system according to the present embodiment. As illustrated in Fig. 1, the elevator door monitoring system according to the present embodiment includes a door monitoring device 3 installed in an elevator 100, a maintenance staff terminal 101 carried by a maintenance staff of the elevator, and a maintenance server 201 located at a maintenance center for performing management and the like of maintenance and maintenance staffs for each elevator, which are coupled via a communication line or the like.

[0010]

<Elevator>

Here, the elevator 100 has a car 5 in addition to the door monitoring device 3. Then, by rotating a hoist around which a main rope attached at one end to the car 5

and attached at the other end to a counterweight is wound, the car moves up and down in a hoistway.

[0011]

Next, a structure of a car door of the elevator to be monitored will be described with reference to Fig. 2. Note that in the following, a sliding telescopic door with two panels that opens on one side will be described as an example, but a center-opening telescopic door with four panels or another door may be used.

[0012]

Fig. 2 is a front view illustrating a structure of a car door of the present embodiment. As illustrated in Fig. 2, the car door of the present embodiment includes a car door 6 having a first panel 6a and a second panel 6b that opens and closes in conjunction with the first panel 6a, a door hanger 7 provided above the car door 6 and suspending the car door, an endless door opening-closing belt 8 coupled to the door hanger 7 of the first panel 6a, door pulleys 9 fixed to the car 5 and supporting the door opening-closing belt 8, a car door motor 10 provided above the car 5, an endless transmission belt 11 that is wound around the car door motor 10 and the door pulleys 9 and transmits rotation of the car door motor 10 to the door pulleys 9, a door sill 12 in which a groove guiding movement in an opening and closing direction of the car

door 6 is formed, and an engagement device 13 connecting the car door 6 and a landing door (not illustrated). Note that the landing door is opened and closed in conjunction with the car door 6 by transmitting power of the car door motor 10 via this engagement device 13. Although not illustrated, a safety shoe is provided at a closing end of the car door to open the door and protect a user when the car door retracts due to contact with the user, or the like.

[0013]

Here, the car door motor 10 includes a current detector 2 that detects a motor current, and when the current detected by the current detector 2 has exceeded a certain threshold, it is determined that there is an obstacle on an open-close trajectory of the car door 6 or the landing door, and the opening-closing operation of the door is reversed. For example, when a user or a cargo collides with the car door 6 or the landing door in a closing operation, this overload reversal function operates and reverses the car door 6 and the landing door to the opening direction. Therefore, even if the safety shoe malfunctions, the door is reversed by this overload reversal function, and thus the safety of the user can be ensured.

[0014]

Note that other than when a user or the like collides with the car door 6 or the landing door, the current supplied to the car door motor 10 also increases when dust or the like is clogged in the groove of the door sill 12. However, since the degree of this increase is relatively smaller than that at a time of collision, the threshold at which the overload reversal function operates is not normally reached.

[0015]

<Maintenance staff terminal>

Next, the maintenance staff terminal 101 carried by a maintenance staff will be described. The maintenance staff terminal 101 includes a communication unit 101a, a processing unit 101b, a storage unit 101c, a display unit 101d, and a setting unit 101e. The communication unit 101a is coupled to a network 300, and can transmit and receive data to and from the elevator 100 and the maintenance server 201. Note that the communication unit 101a can also transmit and receive data by directly coupling to the elevator 100 without passing through the network 300. The processing unit 101b controls overall operation of the maintenance staff terminal 101, and is configured by, for example, a CPU, and operates by executing a predetermined OS. The storage unit 101c stores data and stores a work plan and the like obtained from the maintenance server 201.

The display unit 101d displays specific contents of work on a screen to the staff. The setting unit 101e receives an input from the maintenance staff terminal 101.

[0016]

<Maintenance server>

Next, the maintenance server 201 installed in a building different from that of the elevator on which maintenance work is performed will be described. The maintenance server 201 includes a communication unit 201a, a processing unit 201b, and a storage unit 201c. The communication unit 201a is coupled to the network 300, and can transmit and receive data to and from the elevator 100 and the maintenance staff terminal 101. The processing unit 201b controls overall operation of the entire maintenance server 201, and is configured as, for example, a CPU, and operates by executing a predetermined OS. The storage unit 201c stores data and stores a work plan and the like. This work plan is an elevator maintenance work plan including maintenance work contents and a patrol schedule for the elevator. Specifically, a schedule of which elevator and when to perform what kind of maintenance work is stored in the work plan.

[0017]

<Door monitoring device>

Next, the door monitoring device 3 will be

described. The door monitoring device 3 includes a communication unit 3a, a processing unit 3b, and a storage unit 3c. The processing unit 3b determines whether or not the current detected by the current detector 2 of the car door motor 10 has exceeded a threshold. The threshold here is desirably the same as the threshold that is the reference at which the overload reversal function of the car door motor 10 operates. The storage unit 3c counts the number of times the threshold is exceeded. The communication unit 3a transmits information of the number of times counted in the storage unit 3c to the maintenance server 201. Note that if the current detector 2 originally mounted on the car door motor 10 cannot be used, a current detector may be provided separately so as to detect the current of the motor.

[0018]

Further, in the door monitoring device 3 of the present embodiment, as illustrated in Fig. 2, a car door acceleration detector 1 is provided at a lower part of the first panel 6a of the car door 6 and at a position where there occurs no interference with other components. Since the car door acceleration detector 1 is provided at the lower part where a displacement of the car door 6 becomes large, acceleration can be detected with high accuracy.

[0019]

Here, the car door acceleration detector 1 includes an X-axis direction acceleration detection unit 1a capable of detecting acceleration of the car door 6 in the opening and closing direction, and a Y-axis direction acceleration detection unit 1b capable of detecting acceleration in a direction parallel to the car floor and perpendicular to the door opening and closing direction (direction orthogonal to the door plane). This car door acceleration detector 1 may be composed of one acceleration sensor with two or more axes, or may be composed of two or more acceleration sensors with one axis.

[0020]

<Operation pattern of car door>

Next, referring to Figs. 3 to 5, operation patterns of the car door 6 will be described in a case where the car door 6 opens and closes normally, in a case where a user or the like collides with the landing door, and in a case where a user or the like collides with the car door 6.

[0021]

Fig. 3 is a graph schematically illustrating speeds in two directions (X-axis direction and Y-axis direction) and a current value of the car door motor 10 when the car door 6 normally opens and closes. The horizontal axis represents the same time T , and the vertical axis represents V_X , V_Y , and A_{DM} . V_X illustrates a cumulative

value (time integral) 14 of measurement values of the X-axis direction acceleration detection unit 1a, with the speed at a time of door closing operation being a positive value. V_Y illustrates a cumulative value 15 of measurement values of the Y-axis direction acceleration detection unit 1b, with the direction from the car 5 to a landing place being a positive value. A_{DM} illustrates a measurement value 16 of the current detector 2. Furthermore, a door opening operation is illustrated between T_0 and T_1 , a door opening standby state is illustrated between T_1 and T_2 , and a door closing operation is illustrated between T_2 and T_3 . As illustrated in Fig. 3, when the car door 6 is opening and closing normally, the current value detected by the current detector 2 does not exceed a threshold 17, and the speed of the car door 6 in the Y-axis direction also does not exceed a determination value 18.

[0022]

Fig. 4 is a graph schematically illustrating speeds in the two directions and a current value of the car door motor 10 when a user or the like collides with the landing door and the overload reversal function of the car door motor 10 operates. As illustrated in Fig. 4, although a door closing operation is started from T_2 , the user trying to enter the car 5 from the landing place has collided with the landing door at T_4 , and thus the current value detected

by the current detector 2 exceeds the threshold 17. Then, the overload reversal function of the car door motor 10 operates, and a door opening operation starts. However, since the collision occurred with the landing door, the speed of the car door 6 in the Y-axis direction does not exceed the determination value 18.

[0023]

Fig. 5 is a graph schematically illustrating speeds in the two directions and a current value of the car door motor 10 when a user or the like collides with the car door 6 and the overload reversal function of the car door motor 10 operates. As illustrated in Fig. 5, although a door closing operation started from T2, when the user trying to go out of the car 5 to the landing place collided with the car door 6 at T4, the current value detected by the current detector 2 exceeds the threshold 17. Then, the overload reversal function of the car door motor 10 operates, and a door opening operation starts. At this time, the speed of the car door 6 in the Y-axis direction exceeds the determination value 18.

[0024]

<Method of monitoring door operation state>

Fig. 6 is a flowchart illustrating a method of monitoring a status of collision with a door and prompting a maintenance staff to change specifications of door

opening and closing operations.

[0025]

First, after the door monitoring device 3 is attached, specifications of the door opening and closing operations under normal conditions are registered as initial values (step S1). After the initial value registration, the door monitoring device 3 starts monitoring the door.

[0026]

Next, the processing unit 3b of the door monitoring device 3 determines whether or not the current value of the car door motor 10 has exceeded a predetermined threshold 17 (step S2).

[0027]

When the current value has exceeded the threshold 17, the overload reversal function of the car door motor 10 operates to reverse the door, but at this time, the processing unit 3b also determines whether or not the speed in the Y-axis direction has exceeded the determination value 18 (step S3).

[0028]

If the speed in the Y-axis direction has exceeded the determination value 18, it is assumed that a user or the like has collided with the car door 6, and the processing unit 3b determines whether or not the collision

has occurred during an opening operation of the door (step S14).

[0029]

If it is determined that it is a collision with the door during the opening operation, the processing unit 3b counts the number of occurrences thereof and stores the counted number in the storage unit 3c (S15a). Furthermore, the maintenance server 201 is notified of the counted number of occurrences via the communication unit 3a (S16a). Thereafter, the processing unit 201b of the maintenance server 201 determines whether or not a predetermined condition is satisfied, such as whether or not the number of occurrences reaches a predetermined number (step S17a). If the predetermined condition is satisfied, the processing unit 201b transmits information prompting to increase the door opening speed to the maintenance staff terminal 101 via the communication unit 201a (step S18a).

[0030]

Note that in addition to increasing the door opening speed, discomfort to users who cannot wait in the car 5 may be alleviated by another specification change, such as employing what is called running open that is to start opening the door before landing is completed. Furthermore, the notification to the maintenance server 201 in step S16a may be performed at any time, may be performed periodically

such as once a month, or may be performed every time a certain number of times are reached. Moreover, the door monitoring device 3 itself may make the determination in step S17a, and the door monitoring device 3 itself may perform transmission to the maintenance staff terminal 101 or the maintenance server 201.

[0031]

In step S14, if it is determined that it is not a collision with the door during the opening operation, that is, it is a collision with the door during a closing operation, the processing unit 3b counts the number of occurrences thereof and stores the counted number in the storage unit 3c (S15b). Furthermore, the maintenance server 201 is notified of the counted number of occurrences via the communication unit 3a (S16b). Thereafter, the processing unit 201b of the maintenance server 201 determines whether or not a predetermined condition is satisfied, such as whether or not the number of occurrences reaches a predetermined number (step S17b). If the predetermined condition is satisfied, the processing unit 201b transmits information prompting to extend the door opening time to the maintenance staff terminal 101 via the communication unit 201a (step S18b).

[0032]

On the other hand, if the speed in the Y-axis

direction has not exceeded the determination value 18 in step S3, it is assumed that a user or the like has collided with the landing door, and the processing unit 3b determines whether or not the collision has occurred during an opening operation of the door (step S24).

[0033]

If it is determined that it is a collision with the door during the opening operation, the processing unit 3b counts the number of occurrences thereof for every floor in which the collision has occurred, and stores the counted number in the storage unit 3c (S25a). Furthermore, the maintenance server 201 is notified of the counted number of occurrences for each floor via the communication unit 3a (S26a). Thereafter, the processing unit 201b of the maintenance server 201 determines whether or not a predetermined condition is satisfied, such as whether or not the number of occurrences reaches a predetermined number (step S27a). If the predetermined condition is satisfied, the processing unit 201b transmits information prompting to increase the door opening speed on the relevant floor to the maintenance staff terminal 101 via the communication unit 201a (step S28a).

[0034]

If it is determined in step S24 that it is a collision with the door during a closing operation, the

processing unit 3b counts the number of occurrences for each floor in which the collision has occurred, and stores the counted number in the storage unit 3c (S25b). Further, the maintenance server 201 is notified of the counted number of occurrences for each floor via the communication unit 3a (S26b). Thereafter, the processing unit 201b of the maintenance server 201 determines whether or not a predetermined condition is satisfied (step S27b). If the predetermined condition is satisfied, the processing unit 201b transmits information prompting to increase the door opening time on the relevant floor (for example, a standard floor where there are many users) to the maintenance staff terminal 101 via the communication unit 201a (step S28b).

[0035]

Note that besides extending the door opening time, a user who takes time to get on and off, such as carrying luggage with a trolley, or a user located away from the door may be given more time by another specification change such as lowering the door closing speed. Furthermore, the above-described predetermined condition may be different for every floor, different between a door collision during an opening operation and a door collision during a closing operation, or different depending on whether it is a collision with the car door or a collision with the landing door.

[0036]

<Specification change by maintenance staff>

Fig. 7 illustrates an example of a screen displayed on the display unit 101d of the maintenance staff terminal 101. As illustrated in Fig. 7, information for specifying an elevator that requires a specification change of the door opening or closing operation, information indicating the contents of specific changes, and the like are displayed on the display unit 101d. The information displayed here may be received from the maintenance server 201 or may be received directly from the door monitoring device 3. Note that when a change by the maintenance staff is completed, a report is sent to the manager of the building where the elevator is installed.

[0037]

According to the present embodiment, when the frequency of collision with a door during a closing operation of the car door is high, it is determined that there are many users or there is a user who takes time to get on and off, and the closing operation of the door can be changed to give more time. On the other hand, when the frequency of collision with a door during an opening operation of the car door is high, it is determined that there are many users who cannot wait, and the opening operation of the door can be changed to reduce the waiting

time.

[0038]

Note that the present invention is not limited to the present embodiment, and includes various modifications. The present embodiment is described in detail to explain the present invention in an easy-to-understand manner, and is not necessarily limited to one having all the described configurations. For example, in the present embodiment, the car door acceleration detector 1 is provided below the car door 6 and the current detector 2 is provided in the car door motor 10, but they may be installed in other places.

CLAIMS

[Claim 1] An elevator door monitoring device,

- (a) wherein the elevator door monitoring device:
 - (i) is coupled via a communication line to a maintenance staff terminal carried by a maintenance staff of an elevator; and
 - (ii) monitors a door of the elevator;
- (b) wherein the elevator door monitoring device comprises:
 - (i) a current detector provided on a motor that opens and closes a car door; and
 - (ii) an acceleration detector that is provided on the car door and detects an acceleration in a direction orthogonal to a plane of the car door;
- (c) wherein, when a number of times a current detected by the current detector exceeds a threshold satisfies a predetermined condition, information prompting to change an operation of the car door is transmitted to the maintenance staff terminal;
- (d) wherein, when the acceleration detected by the acceleration detector does not exceed a determination value when the current detected by the current detector has exceeded the threshold, a number of times thereof is counted for each floor; and
- (e) wherein, when the number of times counted on a certain floor becomes a predetermined condition, information prompting to change an opening speed or an opening time of the door on the floor is transmitted to the maintenance staff terminal.

[Claim 2] The elevator door monitoring device according to claim 1, wherein when the number of times the threshold is exceeded during a closing operation of the car door satisfies a predetermined condition, information prompting to increase an opening time of the car door is transmitted to the maintenance staff terminal.

[Claim 3] The elevator door monitoring device according to claim 1, wherein when the number of times the threshold is exceeded during an opening operation of the car door satisfies a predetermined condition, information prompting to increase an opening speed of the car door is transmitted to the maintenance staff terminal.

[Claim 4] The elevator door monitoring device according to any one of claims 1 to 3, wherein the motor has an overload reversal function that reverses the car door to a closing direction when the threshold is exceeded during an opening operation of the car door, and reverses the car door to an opening direction when the threshold is exceeded during a closing operation of the car door.

[Claim 5] An elevator door monitoring system including an elevator door monitoring device, a maintenance staff terminal carried by a maintenance staff of an elevator, and a maintenance server,

- (a) wherein the elevator door monitoring device:
 - (i) is coupled via a communication line to the maintenance server; and
 - (ii) monitors a door of the elevator;
- (b) wherein the elevator door monitoring device comprises:
 - (i) a current detector provided on a motor that opens and closes a car door; and
 - (ii) an acceleration detector that is provided on the car door and detects an acceleration in a direction orthogonal to a plane of the car door;
- (c) wherein, when a number of times a current detected by the current detector exceeds a threshold satisfies a predetermined condition, information prompting to change an operation of the

car door is transmitted to the maintenance staff terminal by the maintenance server;

(d) wherein, when the acceleration detected by the acceleration detector does not exceed a determination value when the current detected by the current detector has exceeded the threshold, a number of times thereof is counted for each floor; and

(e) wherein, when the number of times counted on a certain floor becomes a predetermined condition, information prompting to change an opening speed or an opening time of the door on the floor is transmitted to the maintenance staff terminal by the maintenance server.