

TITLE OF THE INVENTION

ELEVATOR CAR POSITION IDENTIFYING APPARATUS AND ELEVATOR
CAR POSITION IDENTIFYING METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an elevator car position identifying apparatus and an elevator car position identifying method for an elevator.

2. Description of the Related Art

A remote monitoring system that measures an abnormality of an elevator generally measures an abnormality of a position of and a speed of the elevator car, a confinement failure, and the like using information of a control apparatus that controls the elevator, and notifies a monitoring center of the elevator and an operator who performs maintenance of the measured state. However, there is a case where it is difficult to use the information of the control apparatus of the elevator depending on the elevator, and a method of detecting the position of an elevator car based on information obtained from an external sensor in such a case has been proposed.

In addition, a technique using an atmospheric pressure sensor as the external sensor has also been proposed. For example, a technique described in JP 2009-

131043 A creates a floor data table in advance by associating atmospheric pressure data with floor information, and identifies a floor corresponding to the measured atmospheric pressure data. Further, JP 2009-131043 A also discloses that the atmospheric pressure data stored in the floor data table is corrected based on data of the atmospheric pressure sensor output when the elevator car arrives at a reference floor since the atmospheric pressure varies depending on the climate.

SUMMARY OF THE INVENTION

A system using the conventional atmospheric pressure sensor assumes that the presence or absence of stop of an elevator car is determined based on acceleration data output from an acceleration sensor. However, when there is a user in the elevator car, there is a possibility that the acceleration of the elevator car changes due to a motion of the user in the elevator car so that an acceleration signal reflecting an operation status of the elevator car is hidden. Therefore, the accurate correction of the atmospheric pressure data can be performed only when there is no user in the elevator car, which affects the accuracy of identifying the position of the elevator car.

An object of the present invention is to provide an elevator car position identifying apparatus with improved

accuracy in identifying a position of an elevator car.

In order to solve the above problem, the present invention provides an elevator car position identifying apparatus including a control module that identifies a position of an elevator car based on a detection signal in a sensor module provided in the elevator car of an elevator. The sensor module includes a magnetic sensor and an atmospheric pressure sensor. The control module corrects the atmospheric pressure sensor when detecting an opening/closing operation of a door while the elevator car is stopped based on a detection signal of the magnetic sensor, and estimates a stop position of the elevator car using a sensor value of the atmospheric pressure sensor after the correction.

According to the present invention, it is possible to provide the elevator car position identifying apparatus with the improved accuracy in identifying the position of the elevator car.

BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 2 is a block diagram illustrating a configuration of an elevator car position identifying

apparatus according to the embodiment of the present invention;

Fig. 3 is a graph illustrating an example of transition of a magnetic signal detected by a magnetic sensor;

Fig. 4 is a flowchart illustrating a method of estimating an elevator car position;

Fig. 5 is a flowchart illustrating a method of updating an atmospheric pressure value stored in an atmospheric pressure value storage unit;

Fig. 6 is a graph illustrating the transition of the magnetic signal detected by the magnetic sensor;

Fig. 7 is a graph illustrating transition of an elevator car height output by an atmospheric pressure sensor when the atmospheric pressure value has not been corrected;

Fig. 8 is a graph illustrating the transition of the elevator car height output by the atmospheric pressure sensor when the atmospheric pressure value has been corrected according to the present embodiment; and

Fig. 9 is a graph illustrating an example of transition of an acceleration signal detected when an acceleration sensor is provided in an elevator car as a comparative example.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, an embodiment of the present invention will be described with reference to the drawings.

Fig. 1 is an overall configuration diagram of an elevator monitoring system according to the present embodiment. As illustrated in Fig. 1, the elevator monitoring system according to the present embodiment includes a sensor module 1, a control module 2, a communication line 3, a monitoring server 4, a monitoring device 5, and a terminal device 6. The sensor module 1 and the control module 2 form an elevator car position identifying apparatus 7.

Although not illustrated, an elevator includes an elevator car, a counterweight, a main rope, and a hoisting machine. The main rope suspends the elevator car and the counterweight and is driven by the hoisting machine, so that the elevator car and the counterweight move in the hoistway.

In addition, the sensor module 1 is installed in the upper portion of the elevator car of the elevator, and includes a magnetic sensor 8 and an atmospheric pressure sensor 9. The atmospheric pressure sensor 9 outputs a detected atmospheric pressure signal to the control module 2 in order to detect a change in height accompanying the ascent and descent of the elevator car. The magnetic

sensor 8 outputs a detected magnetic signal to the control module 2 in order to detect an opening/closing operation of an elevator car door and the number of passing floors.

Here, when the sensor module 1 is installed at a position within 20 cm from a door drive device, not only workability at the time of installing the sensor module 1 is improved, but also the detection accuracy of the opening/closing operation of the elevator car door by the magnetic sensor 8 is improved. In addition, by installing the sensor module 1 on a hall side of the elevator car door, it is possible to further enhance the detection accuracy of the opening/closing operation of the elevator car door while preventing direct touch of the user.

The control module 2 estimates a position of the elevator car based on the atmospheric pressure signal and the magnetic signal detected by the sensor module 1, and transmits the estimated position of the elevator car to the monitoring server 4, the monitoring device 5, or the terminal device 6 when the estimated position of the elevator car is not at a position corresponding to any floor. In addition, when the control module 2 detects the opening/closing operation of the elevator car door while the elevator car is stopped based on the detection signal of the magnetic sensor 8, the control module 2 corrects (calibrates) the atmospheric pressure sensor 9. The

control module 2 may be installed on the upper portion of the elevator car by being integrated with the sensor module 1, or may be installed at a location different from the sensor module 1. A specific method of correcting the atmospheric pressure sensor 9 will be described later.

The monitoring server 4 is connected to the control module 2 (the elevator car position identifying apparatus 7) via the communication line 3, and is installed in a monitoring center or the like which is a base for remotely monitoring a state of the elevator car. The monitoring server 4 has a database for identifying an elevator based on a warning issued from the elevator car position identifying apparatus 7. The database stores building information of a building in which the elevator under the maintenance contract is installed, elevator information, and the like. Therefore, when receiving the issued warning such as abnormal stop from the control module 2, the monitoring server 4 transmits the building information, the elevator information, and abnormality notification content to a display device of an office that manages the identified elevator. An administrator of the office confirms the content displayed on the display device and gives an instruction to a maintenance worker of the elevator for which the warning has been issued.

The monitoring device 5 is installed in a management

room or the like of the building in which the elevator is installed, and is connected to the control module 2 via the communication line 3 similarly to the monitoring server 4, and thus, can receive the issued warning on the abnormality of the elevator. The terminal device 6 is a device carried by the maintenance worker who performs maintenance and inspection of the elevator, and is connected to the control module via the communication line 3 so that the maintenance worker can confirm position information of the elevator car.

Fig. 2 is a block diagram illustrating a configuration of the elevator car position identifying apparatus 7 according to the present embodiment. Here, a function of the control module 2 in the elevator car position identifying apparatus 7 will be described in detail. As illustrated in Fig. 2, the control module 2 according to the present embodiment includes a door opening/closing detection unit 21, a moving floor number detection unit 22, an atmospheric pressure value storage unit 23, a movement direction determination unit 24, a drift amount calculation unit 25, an atmospheric pressure value correction unit 26, an elevator car position estimation unit 27, an abnormality diagnosis unit 28, and a communication unit 29.

The door opening/closing detection unit 21 detects

an opening operation or a closing operation of the door of the elevator car based on the magnetic signal detected by the magnetic sensor 8. The moving floor number detection unit 22 detects the number of floors where the elevator car has moved based on the magnetic signal detected by the magnetic sensor 8. The atmospheric pressure value storage unit 23 stores the atmospheric pressure value detected by the atmospheric pressure sensor 9 while the elevator car is stopped. The movement direction determination unit 24 determines a movement direction (ascent or descent) of the elevator car by comparing detection signals of the atmospheric pressure sensor 9 before and after the movement of the elevator car. The drift amount calculation unit 25 calculates a drift amount of the atmospheric pressure sensor 9 based on the detection signals of the atmospheric pressure sensor 9 before and after the movement of the elevator car. The atmospheric pressure value correction unit 26 corrects the atmospheric pressure sensor 9 by subtracting the drift amount calculated by the drift amount calculation unit 25 from the detection signal of the atmospheric pressure sensor 9 of the elevator car after the movement. The elevator car position estimation unit 27 estimates a stop position of the elevator car using a sensor value of the atmospheric pressure sensor 9 after the correction. The abnormality diagnosis unit 28 diagnoses

that the elevator car has abnormally stopped when the estimated stop position of the elevator car does not satisfy a predetermined condition. The communication unit 29 issues a warning to the monitoring server 4 or the like via the communication line 3 when the abnormality diagnosis unit 28 diagnoses the elevator car as the abnormal stop state.

Fig. 3 is a graph illustrating an example of transition of a magnetic signal detected by the magnetic sensor 8. When a downwardly convex magnetic signal is detected, the door opening/closing detection unit 21 detects that the door has been opened or closed. Here, the downwardly convex magnetic signal refers to a magnetic signal having a large groove shape as a whole with a small groove-shaped portion sandwiched between the front and back of a flat portion (for example, a time zone of 40 ms to 55 ms in Fig. 3). It is considered that such a convex downwardly magnetic signal is generated since a metal component moves in accordance with the opening/closing operation of the door.

In addition, when a spike-like magnetic signal is detected, the moving floor number detection unit 22 detects that the elevator car has moved among the floors by the number of spikes. For example, since there are two spikes in a time zone of 60 ms to 70 ms in Fig. 3, the moving

floor number detection unit 22 considers that the elevator car has passed two floors (moved from the third floor to the first floor in the example of Fig. 3). Here, the spike-like magnetic signal refers to a magnetic signal that changes by a certain level or more within a predetermined time. Further, the number of moving floors is identified by the number of spike-like magnetic signals between detection of the closing operation of the door by the downwardly convex magnetic signal and detection of the opening operation of the door by the next downwardly convex magnetic signal. It is considered that the spike-like magnetic signal is generated when the vehicle passes a hall door on each floor.

Fig. 4 is a flowchart illustrating a method of estimating an elevator car position. As illustrated in Fig. 4, first, the door opening/closing detection unit 21 of the control module 2 detects opening/closing of an elevator car door (here, a door closing operation before start of movement) based on a detection signal of the magnetic sensor 8 in a state where an elevator car has stopped (Step S101). Next, after the movement of the elevator car is detected by generation of a spike-like magnetic signal (Step S102), the door opening/closing detection unit 21 detects opening/closing of the elevator car door (here, a door opening operation after the start of

movement) again (Step S103).

Thereafter, if the atmospheric pressure sensor 9 acquires the latest atmospheric pressure value (Step S104), the movement direction determination unit 24 of the control module 2 determines a movement direction of the elevator car based on the previous (pre-movement) atmospheric pressure value stored in the atmospheric pressure value storage unit 23 before the movement of the elevator car and the latest (post-movement) atmospheric pressure value (Step S105). Further, the elevator car position estimation unit 27 of the control module 2 estimates a floor position of the elevator car using the determined movement direction, the number of moving floors (specifically, the number of spikes) detected by the moving floor number detection unit 22, and a pre-movement floor position defined from the atmospheric pressure value before the movement (Step S106).

On the other hand, if the atmospheric pressure sensor acquires the latest atmospheric pressure value in Step S104 described above, the drift amount calculation unit 25 calculates a drift amount of the atmospheric pressure sensor 9 by, for example, a linear function based on the previous atmospheric pressure value and the latest atmospheric pressure value (Step S107). Next, the atmospheric pressure value correction unit 26 subtracts the drift amount calculated by the drift amount calculation

unit 25 from the latest atmospheric pressure value to correct the atmospheric pressure sensor 9 (Step S108). Thereafter, whether or not a weather flag has been set is determined (Step S109). This weather flag is set to OFF, for example, when a change in atmospheric pressure is large due to the influence of weather accompanying the passage of a front or a low atmospheric pressure so as to prevent estimation of a detailed position of the elevator car performed by the atmospheric pressure sensor 9. When the weather flag is set to ON in Step S109, the elevator car position estimation unit 27 estimates the detailed position of the elevator car using the atmospheric pressure value of the atmospheric pressure sensor 9 corrected by the atmospheric pressure value correction unit 26 (Step S110).

At this time, the elevator car position estimation unit 27 converts the corrected sensor value of the atmospheric pressure sensor 9 into a height of the elevator car on the hoistway. For example, assuming that an atmospheric pressure immediately before the elevator car starts to move after door closing is P_0 , an atmospheric pressure immediately after the door opens after the movement of the elevator car is P , and an air temperature during the movement of the elevator car is T , a change h in height caused by the movement of the elevator car is estimated as the following (Formula 1).

[Formula 1]

$$h = \frac{\left(\left(\frac{P_0}{P} \right)^{\frac{1}{5.257}} - 1 \right) \times (T + 273.15)}{0.0065}$$

... (Formula 1)

Here, the air temperature T during the movement is acquired by a temperature sensor or the like built in the sensor module 1. Further, regarding the sensor value of the atmospheric pressure sensor 9, the position of the elevator car may be estimated using a table in which the relationship between the sensor value and the floor height is determined in advance, in addition to the conversion formula such as the above (Formula 1).

Fig. 5 is a flowchart illustrating a method of updating an atmospheric pressure value stored in the atmospheric pressure value storage unit 23. As illustrated in Fig. 5, first, it is determined whether or not a stop state of an elevator car has continued for a predetermined time (for example, one minute) from a point of time when an atmospheric pressure value is acquired or corrected last (Step S201). Note that the stop state of the elevator car can be detected when the magnetic sensor 8 detects no spike-like magnetic signal. When the predetermined time has elapsed, the atmospheric pressure sensor acquires an atmospheric pressure value again (Step S202). As the timing for acquiring the atmospheric pressure value again,

for example, it is conceivable to perform the re-acquisition while there is no user (elevator call) and the elevator car stops on a reference floor (floor having the largest number of users such as the first floor) and the door is closed.

Next, it is determined whether or not a difference between the re-acquired atmospheric pressure value and the (previous) atmospheric pressure value stored in the atmospheric pressure value storage unit 23 at the current point in time is larger than a threshold (for example, 0.5 hPa/min) (Step S203). If the difference is smaller than the threshold, the atmospheric pressure value in the atmospheric pressure value storage unit 23 is updated to the re-acquired atmospheric pressure value from the previous atmospheric pressure value after the weather flag is set to ON (Step S204) (Step S206). On the other hand, if the difference is larger than the threshold, the atmospheric pressure value in the atmospheric pressure value storage unit 23 is updated to the re-acquired atmospheric pressure value from the previous atmospheric pressure value after the weather flag is set to OFF (Step S205) (Step S206).

Hereinafter, an effect, obtained by correcting the atmospheric pressure sensor at the timing when the opening/closing operation of the door during the stop of

the elevator car is detected based on the detection signal of the magnetic sensor, will be described using graphs of Figs. 6 to 8 represented by a common time axis. Fig. 6 illustrates transition of a magnetic signal detected by the magnetic sensor, Fig. 7 illustrates transition of an elevator car height output from the atmospheric pressure sensor when correction of an atmospheric pressure value is not performed, and Fig. 8 illustrates transition of an elevator car height output from the atmospheric pressure sensor when the correction of the atmospheric pressure value according to the present embodiment is performed. Note that horizontal lines in the graphs of Figs. 7 and 8 indicate actual heights corresponding to the respective floors of the building.

For example, it can be seen that an atmospheric pressure value of the atmospheric pressure sensor 9 before correction deviates from the actual height of the seventh floor as illustrated in Fig. 7, but an atmospheric pressure value of the atmospheric pressure sensor 9 after correction substantially matches the actual height of the seventh floor as illustrated in Fig. 8. In this manner, the identification accuracy of the position of the elevator car can be improved according to the elevator car identifying apparatus of the present embodiment.

Fig. 9 is a graph illustrating an example of

transition of an acceleration signal detected when an acceleration sensor is provided in an elevator car as a comparative example. As illustrated in Fig. 9, it can be seen that a vibration when a user gets on and off the elevator car or moves in the elevator car is larger than a vibration caused by the operation of the elevator car itself. Therefore, when the user is present in the elevator car, it is difficult to accurately correct the atmospheric pressure sensor only with the acceleration sensor.

Further, the abnormality diagnosis unit 28 according to the present embodiment determines whether the position (height) of the elevator car estimated by the elevator car position estimation unit 27 matches the height corresponding to each floor, and diagnoses the elevator car as the abnormal stop state when there is no correspondence assuming that the elevator car is stopped at a position where the elevator car should not stop. When the abnormality diagnosis unit 28 diagnoses the elevator car as the abnormal stop state, the communication unit 29 issues a warning to the monitoring server 4 or the like via the communication line 3. When there is the issued warning for the abnormality, the monitoring center contacts the office to send the maintenance worker to the target elevator.

As described above, the atmospheric pressure sensor

9 is corrected at the timing when the opening/closing operation of the door of the elevator car is detected by the magnetic sensor in the elevator car position identifying apparatus according to the present embodiment, and thus, the correction can be performed even when the user is present in the elevator car. Therefore, the frequency of the correction of the atmospheric pressure sensor 9 can be increased, the position of the elevator car can be accurately identified, and as a result, erroneous determination of the abnormal stop can be suppressed.

Incidentally, the above embodiment has been described in detail in order to describe the present invention in an easily understandable manner, and is not necessarily limited to one including the entire configuration that has been described above. Further, addition, deletion or substitution of other configurations can be made with respect to some configurations of the embodiment.

For example, the sensor module 1 includes the magnetic sensor 8 and the atmospheric pressure sensor 9 in the above embodiment, but it is not intended to prevent additional provision of an acceleration sensor. When the acceleration sensor is additionally provided as the sensor module 1, it is possible to detect the stop of the elevator car based on a detection signal of the acceleration sensor

even when the magnetic sensor 8 fails. In addition, if the acceleration sensor is used, not only the movement direction of the elevator car can be determined, but also the sudden stop of the elevator car can be detected, so that the accuracy of diagnosing whether the abnormal stop occurs is improved.

Further, the control module 2 may correct the atmospheric pressure sensor 9 when detecting that there is no user in the elevator car by additionally providing a camera or a motion detector as the sensor module 1. If the camera is used, the presence or absence of a button operation performed by the user can also be determined. In this manner, it is possible to further improve the accuracy of the correction by correcting the atmospheric pressure sensor while there is no user and the elevator car is stopped.

What is claimed is:

1. An elevator car position identifying apparatus comprising

a control module that identifies a position of an elevator car based on a detection signal in a sensor module provided in the elevator car of an elevator,

wherein the sensor module includes a magnetic sensor and an atmospheric pressure sensor, and

the control module corrects the atmospheric pressure sensor when detecting an opening/closing operation of a door while the elevator car is stopped based on a detection signal of the magnetic sensor, and estimates a stop position of the elevator car using a sensor value of the atmospheric pressure sensor after the correction.

2. The elevator car position identifying apparatus according to claim 1, wherein

the control module estimates, when the elevator car has moved, a post-movement floor position of the elevator car using a pre-movement floor position defined from a detection signal of the atmospheric pressure sensor before movement, a movement direction, defined from the detection signal of the atmospheric pressure sensor before movement and a detection signal of the atmospheric pressure sensor after movement, and a number of moving floors detected

based on the detection signal of the magnetic sensor.

3. The elevator car position identifying apparatus according to claim 1, wherein

the control module calculates a drift amount of the atmospheric pressure sensor based on detection signals of the atmospheric pressure sensor before and after movement when the elevator car has moved, and subtracts the drift amount from the detection signal of the atmospheric pressure sensor after the movement to correct the atmospheric pressure sensor.

4. The elevator car position identifying apparatus according to claim 1, wherein

the control module converts the sensor value of the atmospheric pressure sensor after the correction into a height of the elevator car in a hoistway.

5. The elevator car position identifying apparatus according to claim 1, wherein

when the estimated stop position of the elevator car does not satisfy a predetermined condition, the control module issues a warning via a communication line assuming an abnormal stop.

6. The elevator car position identifying apparatus according to claim 1, wherein

the sensor module is provided in an upper portion of the elevator car or the door of the elevator car.

7. The elevator car position identifying apparatus according to claim 6, wherein

the sensor module is provided in an upper portion of the elevator car at a location within 20 cm from a door drive device.

8. The elevator car position identifying apparatus according to claim 1, wherein

the sensor module further includes an acceleration sensor, and

the control module detects that the elevator car is being stopped based on a detection signal of the acceleration sensor.

9. The elevator car position identifying apparatus according to claim 8, wherein

the control module detects a movement direction and an abnormal stop of the elevator car based on the detection signal of the acceleration sensor.

10. The elevator car position identifying apparatus according to claim 1, wherein

when a stop state of the elevator car continues for a predetermined time, the control module corrects the atmospheric pressure sensor.

11. The elevator car position identifying apparatus according to claim 1, wherein

the sensor module further includes a camera or a

motion detector, and

the control module corrects the atmospheric pressure sensor when detecting that there is no user in the elevator car.

12. An elevator car position identifying method for identifying a position of an elevator car based on a detection signal from a sensor provided in the elevator car of an elevator, the elevator car position identifying method comprising

correcting an atmospheric pressure sensor when detecting an opening/closing operation of a door while the elevator car is stopped based on a detection signal of a magnetic sensor and estimating a stop position of the elevator car using a sensor value of the atmospheric pressure sensor after the correction.