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(54) TRAIN DOOR AND PLATFORM DOOR JOINT CONTROL METHOD AND SYSTEM APPLIED TO HIGH SPEED RAIL

(57) Disclosed is a method for joint control of vehicle doors and platform doors applied to a high-speed railway. The method includes: sending, by a vehicle-mounted device, an open-or-close-vehicle-doors command to a first ground device; determining, by the first ground device, a validity of the open-or-close-vehicle-doors command and performing a processing operation depending on the determination; converting, by a second ground device, the open-or-close-platform-doors command received from the first ground device into a platform-doors-relay-driving command recognizable by a platform doors system and sending the platform-doors-relay-driving command to the platform doors system; performing, by the platform doors system, an open-or-close-platform-doors action; capturing, by the second ground device, platform-doors-relay-state information, converting the platform-doors-relay-state information into first platform doors state information and sending the first platform doors state information to the first ground device; and converting, by the first ground device, the first platform doors state information into second platform doors state information and determining whether to return the second platform doors state information to the vehicle-mounted device. Thus, the stability and reliability of the vehicle doors/platform doors joint control system are improved, improving the efficiency of operation.

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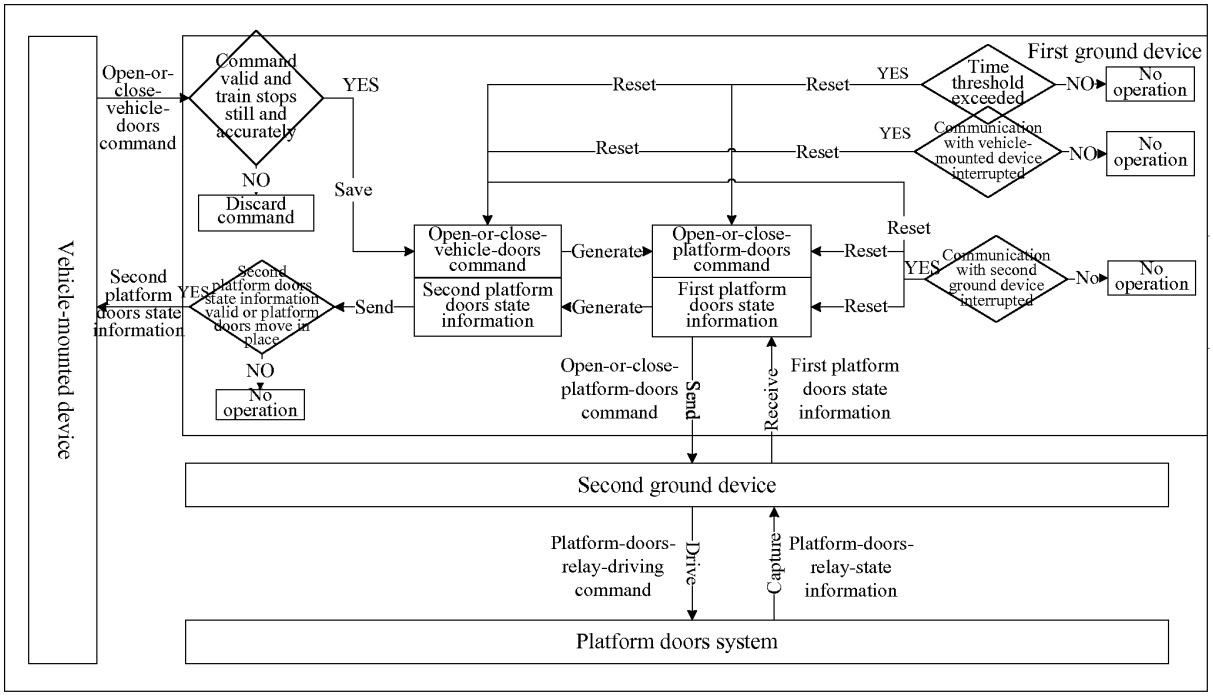
Vehicle-mounted device
First ground device
Open-or-close-vehicle-doors command
Command valid and train stops still and accurately
YES
NO
Discard command
Save
Reset
Reset
YES
Time threshold exceeded
NO
No operation
Reset
Reset
YES
Communication with vehicle-mounted device interrupted
NO
No operation
Open-or-close-vehicle-doors command
Generate
Open-or-close-platform-doors command
Reset
Reset
YES
Communication with second ground device interrupted
No
No operation
Second platform doors state information
YES
Second platform doors state information valid or platform doors move in place
Send
Second platform doors state information
Generate
First platform doors state information
Reset
NO
No operation
Open-or-close-platform-doors command
Send
Receive
First platform doors state information
Second ground device
Platform-doors-relay-driving command
Drive
Capture
Platform-doors-relay-state information
Platform doors system

FIG. 1

Description

[0001] This application claims the priority of China patent application No. 201910507577.4 filed on June 12, 2019 with the China National Intellectual Property Administration, disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present invention belongs to the technical field of rail transport, and more particularly relates to a method and system for joint control of vehicle doors and platform doors applied to high-speed railway.

BACKGROUND

[0003] With the development of rail transport, high-speed railway has become one of the most important means of transportation in people's daily life. Which is, however, accompanied by safety accidents that often occur between the platform and the track. Therefore, installing platform doors systems on high-speed railway platforms is the trend. Platform doors are mostly built in a platform area between a train entrance and a train exit for separating the platform space from the train running space. After a train arrives and stops in the platform area, platform doors are opened allowing passengers to get on and off the train, and then are closed before the train is started. Thus, platform doors can provide a safer ride for passengers. Due to actual operation needs, various types of trains would stop at the station every day with each type of train corresponding to a different requirement for opening and closing the platform doors. Furthermore, situations of asymmetric forward and backward rides may arise, which require the accurate determination of the side of platform doors that need to be opened or closed according to the direction in which the station track receives the train. Therefore, there is an urgent need for a platform doors control solution that is compatible with a variety of train types and that can satisfy a variety of train operation schemes.

[0004] In an existing high-speed railway platform doors control system (hereinafter platform doors system), a ground device acquires train entrance and stopping accuracy information through microwave carrier waves, and autonomously controls the opening and closing of corresponding platform doors when determining that the related conditions are met. While this solution is compatible with various types of trains and satisfies various train operation schemes, it poses high requirements for the accuracy of determination of the platform doors system itself. In particular, this solution requires that the platform doors system can accurately determine a train's operation state and the door side information of train doors to be opened or closed, and determine the timing for controlling the platform doors to act, according to the speed and location of the train. Once the platform doors system makes an erroneous judgement, the platform doors may be mistakenly opened or closed, affecting the operation order and efficiency. Therefore, there is a need to improve the stability and reliability of the platform doors system, thereby improving the operation efficiency.

SUMMARY

[0005] In view of the above problems, the present invention provides a method and system for joint control of vehicle doors and platform doors applied to high-speed railway.

[0006] There is provided a method for joint control of vehicle doors and platform doors applied to high-speed railway. The method includes the following operations.

[0007] A vehicle-mounted device sends an open-or-close-vehicle-doors command to a first ground device.

[0008] The first ground device determines a validity of the open-or-close-vehicle-doors command, and performs a processing operation depending on the determination. The processing operation includes the following operations.

[0009] If the open-or-close-vehicle-doors command is valid, the first ground device correctly generates an open-or-close-platform-doors command according to the open-or-close-vehicle-doors command, and the first ground device further decides whether to send the open-or-close-platform-doors command to a second ground device depending on a monitored timing of the open-or-close-platform-doors command.

[0010] If the open-or-close-vehicle-doors command is invalid, the open-or-close-vehicle-doors command is discarded and subsequent processing actions are terminated.

[0011] The second ground device converts the open-or-close-platform-doors command received from the first ground device into a platform-doors-relay-driving command recognizable by a platform doors system, and sends the platform-doors-relay-driving command to the platform doors system.

[0012] After the recognizable platform-doors-relay-driving command is received, the platform doors system performs an open-or-close-platform-doors action.

[0013] The second ground device captures platform-doors-relay-state information, converts the platform-doors-relay-state information into first platform doors state information recognizable by the first ground device, and sends the first

platform doors state information to the first ground device.

[0014] The first ground device converts the first platform doors state information into second platform doors state information recognizable by the vehicle-mounted device, determines a validity of the second platform doors state information, and decides whether to return the second platform doors state information to the vehicle-mounted device depending on the determination. The first ground device may further decide whether to return the second platform doors state information to the vehicle-mounted device depending on a monitored timing for returning the second platform doors state information.

[0015] Furthermore, the first ground device determines that the open-or-close-vehicle-doors command is valid when following conditions are all simultaneously met.

[0016] A train stops still and accurately.

[0017] There are platform doors on a station track where the train stops.

[0018] The first ground device determines a platform doors side corresponding to train doors according to the open-or-close-vehicle-doors command. This operation includes the following conditions.

[0019] When the open-or-close-vehicle-doors command is directed to the train doors on the left side, it is determined there is set up platform doors on the platform side corresponding to the train doors on the left side.

[0020] When the open-or-close-vehicle-doors command is directed to the train doors on the right side, it is determined that there is set up platform doors on the platform side corresponding to the train doors on the right side.

[0021] When the open-or-close-vehicle-doors command is directed to the train doors on both sides, it is determined that there is set up platform doors on both sides of a platform of the station track where the train is located The open-or-close-vehicle-doors command is directed to opening or closing trains doors on at least one side. This step includes following conditions.

[0022] The train doors on the left side are command-free, and the train doors on the right side are opened or closed.

[0023] The train doors on the left side are opened or closed, and the train doors on the right side are command-free.

[0024] The train doors on the left side are opened or closed, and the train doors on the right side are opened or closed.

[0025] Further, the operation of determining the platform doors side corresponding to the train doors includes the following operations.

[0026] If the direction in which the station track receives the train is a forward direction, the sides of the platform doors are consistent with the sides of the train doors.

[0027] If of the direction in which the station track receives the train is a backward direction, the sides of the platform doors are opposite to the sides of the train doors.

[0028] Where the forward direction is a forward direction of a line, and the backward direction is a backward direction of the line.

[0029] Further, the operation of correctly generating the open-or-close-platform-doors command according to the open-or-close-vehicle-doors command includes the following operations.

[0030] According to the open-or-close-platform-doors command in conjunction with a platform doors database stored by the first ground device, the first ground device generates a corresponding open-or-close-platform-doors command.

[0031] Further, the open-or-close-vehicle-doors command includes the following fields:
a train carriages grouping type field, a vehicle station track receiving vehicle direction field, a turnback flag field, and an open-or-close-doors command field.

[0032] Further, the turn-back mark is generated by the vehicle- mounted device determining whether the train turns back.

[0033] If the train turns back, the vehicle-mounted device generates an immediately-turn-back flag.

[0034] If the train does not turn back, the vehicle-mounted device generates a not-immediately-turn-back flag.

[0035] Further, the vehicle-mounted device determines whether the train turns back according to mode changes of a currently servicing end and a non-currently servicing end, which specifically includes the following.

[0036] When the currently servicing end switches from a non-sleep mode to a sleep mode so that it descends to the non-currently servicing end, the non-currently servicing end is switches from the sleep mode to the non-sleep mode so that it ascends to the currently servicing end, then the vehicle-mounted device determines that the train turns back.

[0037] When modes of the currently servicing end and/or the non-currently servicing end are not changed, then the vehicle-mounted device determines that the train does not turn back.

[0038] Further, the operation that the first ground device decides whether to send the open-or-close-platform-doors command to the second ground device depending on the monitored timing for sending the open-or-close-platform-doors command includes the following operations.

[0039] Keeping sending the open-or-close-platform-doors command to the second ground device, for a period of time.

[0040] When the period of time exceeds a preset time threshold set by a time threshold timer, the first ground device sends a message to the second ground device indicating that there is no command directed to the corresponding platform doors, and then resets the time threshold timer.

[0041] Each time the first ground device receives the open-or-close-vehicle-doors command and determines that the

open-or-close-vehicle-doors command is valid, the first ground device sends the open-or-close-platform-doors command to the second ground device and restarts the timing.

[0042] When the first ground device determines that its communication with the vehicle-mounted device is interrupted, the first ground device regards a command for controlling platform doors of the station track where the train is located as no command, and resets the time threshold timer.

[0043] When the first ground device determines that its communication with the second ground device is interrupted, the first ground device sets states of all platform doors of a station corresponding to the second ground device to unknown states, sets a platform doors control command to no command, and resets the time threshold timer.

[0044] Further, the operation the first ground device converts the first platform doors state information into the second platform doors state information recognizable by the vehicle-mounted device includes the following.

[0045] The first ground device generates second platform doors state information corresponding to the open-or-close-vehicle-doors command based on the first platform doors state information, the open-or-close-vehicle-doors command, and the platform doors database stored by the first ground device.

[0046] Further, the operation of deciding whether to return the second platform doors state information to the vehicle-mounted device depending on the determination includes the following.

[0047] When it is determined that the second platform doors state information is valid, the first ground device immediately returns the second platform doors state information to the vehicle-mounted device as an acknowledgement of the open-or-close-vehicle-doors command.

[0048] When it is determined that the second platform doors state information is invalid, the first ground device does not return information to the vehicle-mounted device.

[0049] Further, the operation that the first ground device determines the validity of the second platform doors state information includes the following.

[0050] When the open-or-close-vehicle-doors command is directed to the train doors on the left side while the train doors on the right side are command-free, it is determined that the second platform doors state information is valid when the platform doors corresponding to the train doors on the left side are in an open or closed state;

[0051] When the train doors on the left side are command-free while the open-or-close-vehicle-doors command is directed to the train doors on the right side, it is determined that the second platform doors state information is valid when the platform doors corresponding to the train doors on the right side are in an open or closed state.

[0052] When the open-or-close-vehicle-doors command is directed to the train doors on both sides, it is determined that the second platform doors state information is valid when the platform doors corresponding to the train doors on the left side are in an open or closed state and the platform doors corresponding to the train doors on the right side are in an open or closed state.

[0053] Further, the operation that the first ground device further decides whether to return the second platform doors state information to the vehicle-mounted device depending on the monitored timing for returning the second platform doors state information includes the following operations.

[0054] Keeping sending, by the first ground device, the open-or-close-platform-doors command to the second ground device, for a period of time.

[0055] Within the period of time, if it is determined that platform doors move in place, the first ground device immediately returns the second platform doors state information to the vehicle-mounted device as a feedback to the open-or-close-vehicle-doors command.

[0056] When the period of time is exceeded, the first ground device does not return information to the vehicle-mounted device.

[0057] If the first ground device determines that its communication with the second ground device is interrupted, the states of the platform doors are reset to unknown states.

[0058] Further, the operation of determining that the platform doors move in place includes the following conditions.

[0059] When the open-or-close-vehicle-doors command is directed to opening the train doors on the left side while the train doors on the right side are command-free, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in an open state.

[0060] When the open-or-close-vehicle-doors command is directed to closing the train doors on the left side while the train doors on the right side are command-free, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in a closed state.

[0061] When the train doors on the left side are command-free while the open-or-close-vehicle-doors command is directed to opening the train doors on the right side, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the right side are in an open state.

[0062] When the train doors on the left side are command-free while the open-or-close-vehicle-doors command is directed to closing the train doors on the right side, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the right side are in a closed state.

[0063] When the open-or-close-vehicle-doors command is directed to opening the train doors on the left side and

opening the train doors on the right side, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in an open state and the platform doors corresponding to the train doors on the right side are in an open state.

[0064] When the open-or-close-vehicle-doors command is directed to opening the train doors on the left side and closing the train doors on the right side, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in an open state and the platform doors corresponding to the train doors on the right side are in closed state.

[0065] When the open-or-close-vehicle-doors command is directed to closing the train doors on the left side and opening the train doors on the right side, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in closed state and the platform doors corresponding to the train doors on the right side are in an open state.

[0066] When the open-or-close-vehicle-doors command is directed to closing the train doors on the left side and closing the train doors on the right side, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in a closed state and the platform doors corresponding to the train doors on the right side are in a closed state.

[0067] There is further provided a system for joint control of vehicle doors and platform doors applied to high-speed railway. The system includes a vehicle-mounted device, a first ground device, a second ground device, and a platform doors system.

[0068] The vehicle-mounted device is configured to send an open-or-close-vehicle-doors command to the first ground device.

[0069] The first ground device is configured to determine a validity of the open-or-close-vehicle-doors command and decide a subsequent processing action depending on the validity of the open-or-close-vehicle-doors command, and is further configured to convert first platform doors state information into second platform doors state information recognizable by the vehicle-mounted device and decide whether to return the second platform doors state information to the vehicle-mounted device.

[0070] The first ground device being configured to determine the validity of the open-or-close-vehicle-doors command and decide the subsequent processing action depending on the validity of the open-or-close-vehicle-doors command comprises the following.

[0071] If the open-or-close-vehicle-doors command is valid, the first ground device correctly generates an open-or-close-platform-doors command is according to the open-or-close-vehicle-doors command, and the first ground device further decides whether to send the open-or-close-platform-doors command to the second ground device depending on a monitored timing for sending the open-or-close-platform-doors command.

[0072] If the open-or-close-vehicle-doors command is invalid, the first ground device discards the open-or-close-vehicle-doors command and terminates subsequent processing actions.

[0073] The first ground device being further configured to convert the first platform doors state information into the second platform doors state information recognizable by the vehicle-mounted device and decide whether to return the second platform doors state information to the vehicle-mounted device includes the following.

[0074] The first ground device decides whether to return the second platform doors state information to the vehicle-mounted device depending on the validity of the second platform doors state information, and can further be configured to decide whether to return the second platform doors state information to the vehicle-mounted device depending on a monitored timing for returning the second platform doors state information.

[0075] The second ground device is configured to convert the open-or-close-platform-doors command into a platform-doors-relay-driving command recognizable by the platform doors system and send the platform-doors-relay-driving command to the platform doors system, and is further configured to capture and convert the platform-doors-relay-state information into the first platform doors state information and send the first platform doors state information to the first ground device.

[0076] The platform doors system is configured to perform an open-or-close-platform-doors action.

[0077] Further, the vehicle-mounted device is connected to the first ground device in a wireless transmission manner.

[0078] The first ground device is connected to the second ground device in a wired communication manner.

[0079] The second ground device is connected to the platform doors system in a wired manner.

[0080] Further, the first ground device includes an open-or-close-vehicle-doors command verifying and storing module, an open-or-close-platform-doors command generating module, an open-or-close-platform-doors command sending module, and an open-or-close-platform-doors command sending timing monitoring module.

[0081] The open-or-close-vehicle-doors command verifying and storing module is configured to determine the validity of the open-or-close-vehicle-doors command and store the open-or-close-vehicle-doors command.

[0082] The open-or-close-platform-doors command generating module is configured to convert the open-or-close-vehicle-doors command into the open-or-close-platform-doors command.

[0083] The open-or-close-platform-doors command sending timing monitoring module is configured to determine the

timing for sending the open-or-close-platform-doors command.

[0084] The open-or-close-platform-doors command sending module is configured to send the open-or-close-platform-doors command to the second ground device when the open-or-close-platform-doors command sending timing monitoring module determines that the open-or-close-platform-doors command needs to be sent.

[0085] Further, the first ground device includes a platform doors state receiving and storing module, a platform doors state converting module, a platform doors state sending module, and a platform doors state feedback timing monitoring module.

[0086] The platform doors state receiving and storing module is configured to receive and store the first platform doors state information sent by the second ground device.

[0087] The platform doors state converting module is configured to convert the first platform doors state information into second platform doors state information corresponding to the open-or-close-vehicle-doors command.

[0088] The platform doors state feedback timing monitoring module is configured to determine the validity of the second platform doors state information and monitor the timing for returning the second platform doors state information to the vehicle-mounted device.

[0089] The platform doors state sending module is configured to return the second platform doors state information to the vehicle-mounted device when the platform doors state feedback timing monitoring module determines that the second platform doors state information needs to be fed back.

[0090] The present invention improves the stability and reliability of the vehicle doors and platform doors joint control system, thereby improving the efficiency of operation. Additional features and advantages of the preset invention will be set forth in the description below, and in part will be apparent from the description, or may be understood by implementing the present invention. The objects and other advantages of the present invention may be implemented and obtained through structures set forth in the description, claims and drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0091] To better illustrate the technical solutions reflected in the embodiments of the present invention or the technical solutions in the related art, drawings used in description of the embodiments or the related art will be briefly described below. Apparently, the drawings described below illustrate part of the embodiments of the present invention, and those skilled in the art may obtain other drawings based on the drawings described below on the premise that no creative work is done.

FIG. 1 is a data flow diagram of a method for joint control of vehicle doors and platform doors according to the present invention.

FIG. 2 is a block diagram illustrating an overall structure of a system according to the present invention.

FIG. 3 is a block diagram illustrating the internal modules of a first ground device of the system according to the present invention.

DETAILED DESCRIPTION

[0092] To better illustrate the object, technical solutions and advantages of embodiments of the present invention, the technical solutions in the embodiments of the present invention will be described clearly and completely in conjunction with drawings in the embodiments of the present invention. Apparently, the embodiments described below are part, not all, of the embodiments of the present invention. Based on the embodiments of the present invention, all other embodiments obtained by those skilled in the art without creative work shall all fall in the scope of the present invention.

[0093] The present invention provides a method for joint control of vehicle doors and platform doors applied to high-speed railway. The method includes the following operations.

[0094] A vehicle-mounted device sends an open-or-close-vehicle-doors command to a first ground device.

[0095] The first ground device determines a validity of the open-or-close-vehicle-doors command, and performs a processing operation depending on the determination. The processing operation includes the following.

[0096] If the open-or-close-vehicle-doors command is valid, an open-or-close-platform-doors command is correctly generated according to the open-or-close-vehicle-doors command, and the first ground device decides whether to send the open-or-close-platform-doors command to a second ground device depending on a monitored timing for sending the open-or-close-platform-doors command.

[0097] If the open-or-close-vehicle-doors command is invalid, the open-or-close-vehicle-doors command is discarded and subsequent processing actions are terminated.

[0098] The second ground device converts the open-or-close-platform-doors command received from the first ground

device into a platform-doors-relay-driving command recognizable by a platform doors system, and sends the platform-doors-relay-driving command to the platform doors system.

[0099] After the recognizable platform-doors-relay-driving command is received, the platform doors system performs an open-or-close-platform-doors action.

[0100] The second ground device captures platform-doors-relay-state information, converts the platform-doors-relay-state information into first platform doors state information recognizable by the first ground device, and sends the first platform doors state information to the first ground device.

[0101] The first ground device converts the first platform doors state information into second platform doors state information recognizable by the vehicle-mounted device, determines a validity of the second platform doors state information, and decides whether to return the second platform doors state information to the vehicle-mounted device depending on the determination, and the first ground device can further decide whether to return the second platform doors state information to the vehicle-mounted device depending on a monitored timing for returning the second platform doors state information.

[0102] Embodiments of the present invention will be described in detail with reference to FIG. 1. FIG. 1 is a data flow diagram of a method for joint control of vehicle doors and platform doors according to the present invention. As shown in FIG. 1, the method is described as follows.

[0103] The vehicle-mounted device sends an open-or-close-vehicle-doors command to the first ground device.

[0104] The first ground device determines a platform doors side corresponding to train doors according to the open-or-close-vehicle-doors command. This step includes following steps. The first ground device verifies that the open-or-close-vehicle-doors command is valid, then stores this command and performs the subsequent processing, otherwise, the first ground device discards this command and terminates the subsequent processing, so as to improve safety of an action of the platform doors. Specifically, the open-or-close-vehicle-doors command is determined to be valid only when following conditions are met simultaneously.

1. A train stops still and accurately.

2. There are platform doors on a station track where the train stops.

3. A platform doors side corresponding to train doors is determined according to the open-or-close-vehicle-doors command. This step includes following steps.

[0105] When the open-or-close-vehicle-doors command is directed to the train doors on the left side, it is determined that there is set up platform doors on the platform side corresponding to the train doors on the left side.

[0106] When the open-or-close-vehicle-doors command is directed to the train doors on the right side, it is determined that there is set up platform doors on the platform side corresponding to the train doors on the right side.

[0107] When the open-or-close-vehicle-doors command is directed to the train doors on both sides, it is determined there is set up platform doors on both sides of a platform of the station track where the train is located.

[0108] 4. The open-or-close-vehicle-doors command is directed to opening or closing trains doors on at least one side. The step includes following scenarios.

[0109] The train doors on the left side are command-free, and the train doors on the right side are open or closed.

[0110] The train doors on the left side are open or closed, and the train doors on the right side are command-free.

[0111] The train doors on the left side are open or closed, and the train doors on the right side are opened or closed.

[0112] All of above conditions must be satisfied, otherwise it is determined that the open-or-close-vehicle-doors command is invalid, and the first ground device does not covert or send the open-or-close-vehicle-doors command.

[0113] Furthermore, the step of determining the platform doors side corresponding to the train doors includes following steps.

[0114] If the direction in which the station track receives the train is a forward direction, the sides of the platform doors are consistent with the sides of the train doors.

[0115] If the direction in which the station track receives the train is a backward direction, the sides of the platform doors side are opposite to the sides of the train doors.

[0116] The forward direction is a forward direction of a line, and the backward direction is a backward direction of the line. The open-or-close-vehicle-doors command sent by the vehicle-mounted device contains the direction in which the station track receives the train, and the first ground device directly accepts the information. The vehicle-mounted device knows whether the current train operates in the forward direction or in the backward direction according to a train orientation of a cab activated by the vehicle-mounted device with respect to a Last Related Balise Group (LRBG) direction.

[0117] The first ground device verifies that the open-or-close-vehicle-doors command is valid, then stores this command, and generates a corresponding open-or-close-platform-doors command according to the open-or-close-vehicle-doors command in conjunction with a platform doors database stored by the first ground device. The open-or-close-

vehicle-doors command includes a train carriages grouping type field, a vehicle station track receiving vehicle direction field, a turnback flag field, and an open-or-close-doors command field. According to actual operation needs, the train grouping includes various types, such as 8 carriages grouping, 16 carriages grouping, and 18 carriages grouping, but it is not limited to that. When platform doors are set in the station, it will consider all current possible operation scenarios. Therefore, the first ground device accurately generates the corresponding open-or-close-platform-doors command (positions and the number of platform doors, and platform doors are closely arranged) according to the actual grouping type of the train, so as to ensure the safety of the system and order of the operation. Exemplarily, the train grouping is described using 8 carriages grouping, 16 carriages grouping and 18 carriages grouping as an example, and the specific solution is shown in the following table.

Table 1 Open-or-close-platform-doors command generation Table

No.	Received open-or-close-vehicle-doors command				Generated open-or -c lose-platform-doors command
	Station track receiving vehicle direction	Train grouping type	Turn-back flag	Open/ close door	
1	Forward	8 carriages grouping	Not immediately turn-back	Open	Station track forward first 8 carriages doors open command
2	Backward	8 carriages grouping	Immediately turn-back	Open	Station track forward first 8 carriages doors open command
3	Forward	8 carriages grouping	Not immediately turn-back	Close	Station track forward first 8 carriages doors close command
4	Backward	8 carriages grouping	Immediately turn-back	Close	Station track forward first 8 carriages doors close command
5	Backward	8 carriages grouping	Not immediately turn-back	Open	Station track forward last 8 carriages doors open command
6	Forward	8 carriages grouping	Immediately turn-back	Open	Station track forward last 8 carriages doors open command
7	Backward	8 carriages grouping	Not immediately turn-back	Close	Station track forward last 8 carriages doors close command
8	Forward	8 carriages grouping	Immediately turn-back	Close	Station track forward last 8 carriages doors close command
9	Forward	16 carriages grouping	Not immediately turn-back	Open	Station track forward first 16 carriages doors open command
10	Backward	16 carriages grouping	Immediately turn-back	Open	Station track forward first 16 carriages doors open command
11	Forward	16 carriages grouping	Not immediately turn-back	Close	Station track forward first 16 carriages doors close command
12	Backward	16 carriages grouping	Immediately turn-back	Close	Station track forward first 16 carriages doors close command
13	Backward	16 carriages grouping	Not immediately turn-back	Open	Station track forward last 16 carriages doors open command
14	Forward	16 carriages grouping	Immediately turn-back	Open	Station track forward last 16 carriages doors open command
15	Backward	16 carriages grouping	Not immediately turn-back	Close	Station track forward last 16 carriages doors close command
16	Forward	16 carriages grouping	Immediately turn-back	Close	Station track forward last 16 carriages doors close command
17	Forward	18 carriages grouping	Not immediately turn-back	Open	18 carriages doors open command

(continued)

No.	Received open-or-close-vehicle-doors command				Generated open-or -c lose-platform-doors command
	Station track receiving vehicle direction	Train grouping type	Turn-back flag	Open/ close door	
18	Backward	18 carriages grouping	Not immediately turn-back	Open	18 carriages doors open command
19	Forward	18 carriages grouping	Immediately turn-back	Open	18 carriages doors open command
20	Backward	18 carriages grouping	Immediately turn-back	Open	18 carriages doors open command
21	Forward	18 carriages grouping	Not immediately turn-back	Close	18 carriages doors close command
22	Backward	18 carriages grouping	Not immediately turn-back	Close	18 carriages doors close command
23	Forward	18 carriages grouping	Immediately turn-back	Close	18 carriages doors close command
24	Backward	18 carriages grouping	Immediately turn-back	Close	18 carriages doors close command

[0118] It is to be noted that the solution of the present invention in which the open-or-close-platform-doors command is generated according to the open-or-close-vehicle-doors command has stronger flexibility, and in addition to situations listed in the table, supports expansion of more train grouping types. The vehicle-mounted device needs to determine whether the current train is turned back to generate the turn-back flag in the table. The turn-back flag includes an immediately-turn-back flag and a not-immediately-turn-back flag. The determining method is to set a currently servicing end (in a non-sleep mode) at one end of the train and set a non-currently servicing end (in a sleep mode) at the other end of the train. In fact, the currently servicing end and the non-currently servicing end are two working states of vehicle-mounted devices on two train heads. Exemplarily, using the Beijing-Shanghai high-speed railway as an example, when the train drives from Beijing to Shanghai, the vehicle-mounted device on the train head 1 is the currently servicing end and is in the non-sleep mode, and it works normally to monitor the safe operation of the train, while the vehicle-mounted device on the train head 2 is the non-currently servicing end and is in the sleep mode, and it does not execute any train safety protection function. When the train is driven from Shanghai to Beijing, the train turns back, and the currently servicing end and the non-currently servicing end are switched. That is, the vehicle-mounted end on the train head 2 becomes the currently servicing end and is in in the non-sleep mode, and it works normally to monitor the safe operation of the train, while the vehicle-mounted device on the train head 1 becomes the non-currently servicing end and is in the sleep mode, and it does not execute any train safety protection function.

[0119] When following conditions are simultaneously satisfied, the vehicle-mounted device determines that the train turns back and the turn-back mark is generated.

[0120] The original currently servicing end switches to the sleep mode and descends to the non-currently servicing end.

[0121] The original non-currently servicing end switches out of the sleep mode and ascends to the currently servicing end.

[0122] Otherwise, it is determined that the train does not turn back, and the not-immediately-turn-back flag is generated.

[0123] Problems that the communication network is interrupted or the communication data is lost may exist, and the action of the platform doors system needs time. Therefore, in order to improve the reliability and safety of the system, before the first ground device sends the open-or-close-platform-doors command to the second ground device, the first ground device needs to monitor the timing for sending the open-or-close-platform-doors command. The specific steps of monitoring the timing for sending the open-or-close-platform-doors command are as follows.

1. The first ground device keeps sending the open-or-close-platform-doors command to the second ground device, for a period of time. Exemplarily, the period of time for sending is set to T.

2. When a preset time threshold T set by a time threshold timer is exceeded, the first ground device sends a message to the second ground device indicating that there is no command directed to the corresponding platform doors and

resets the time threshold timer.

3. Each time the first ground device receives the open-or-close-vehicle-doors command and determines that the open-or-close-vehicle-doors command is valid, the first ground device sends the open-or-close-platform-doors command to the second ground device and restarts the timing T.

4. If the first ground device determines that its communication with the vehicle-mounted device is interrupted, for the sake of safety, the first ground device regards a command for controlling platform doors of the station track where the train is located as no command, and resets the time threshold timer.

5. If the first ground device determines that its communication with the second ground device is interrupted, for the sake of safety, the first ground device sets states of all platform doors of a station corresponding to the second ground device to unknown states, a platform door control command is set to no command, and the time threshold timer is reset.

[0124] When the open-or-close-platform-doors command meets the sending timing, the first ground device sends the open-or-close-platform-doors command to the second ground device. The second ground device converts the open-or-close-platform-doors command into the platform-doors-relay-driving command recognizable by the platform doors system, and sends the platform-doors-relay-driving command to the platform doors system. The platform doors system specifically executes the doors open/close action.

[0125] The second ground device keeps collecting a platform doors relay state, and converts the platform-doors-relay-state information into first platform doors state information and sends the first platform doors state information to the first ground device. The first ground device generates second platform doors state information according to the first platform doors state information, the open-or-close-vehicle-doors command and the platform doors database stored by the first ground device, and sends the second platform doors state information to the vehicle-mounted device. Before the first ground device feeds back the second platform doors state information to the vehicle-mounted device, the validity of the second platform doors state information needs to be determined, or the timing for returning the second platform doors state information is monitored.

[0126] Specifically, the situation in which the validity of the second platform doors state information is determined is as follows.

1. When the open-or-close-vehicle-doors command is directed to the train doors on the left side while the train doors on the right side are command-free, it is determined that the second platform doors state information is valid when the platform doors corresponding to the train doors on the left side are in an open or closed state.

2. When the train doors on the left side are command-free while the open-or-close-vehicle-doors command is directed to the train doors on the right side, it is determined that the second platform doors state information is valid when the platform doors corresponding to the train doors on the right side are in an open or closed state.

3. When the open-or-close-vehicle-doors command is directed to the train doors on both sides, determining that the second platform doors state information is valid when the platform doors corresponding to the train doors on the left side are in an open or closed state and the platform doors corresponding to the train doors on the right side are in an open or closed state.

[0127] The step of monitoring the timing for returning the second platform doors state information is as follows.

[0128] The first ground device keeps sending the open-or-close-platform-doors command to the second ground device, for a period of time. Exemplarily, the period of time for sending is set to T.

[0129] In the time of T, if it is determined that platform doors move in place, the first ground device immediately feeds back the second platform doors state information to the vehicle-mounted device as a feedback of the open-or-close-vehicle-doors command.

[0130] When the time of T is exceeded, the first ground device does not return information to the vehicle-mounted device.

[0131] If the first ground device determines that its communication with the second ground device is interrupted, the states of the platform doors are reset to unknown states.

[0132] Furthermore, it is determined that the platform doors move in place only in following situations.

1. When the open-or-close-vehicle-doors command is directed to opening the train doors on the left side while the train doors on the right side are command-free, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in an open state.

2. When the open-or-close-vehicle-doors command is directed to closing the train doors on the left side while the train doors on the right side are command-free, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in a closed state.

3. When the train doors on the left side are command-free while the open-or-close-vehicle-doors command is directed to opening the train doors on the right side, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the right side are in an open state.

4. When the train doors on the left side are command-free while the open-or-close-vehicle-doors command is directed to closing the train doors on the right side, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the right side are in a closed state.

5. When the open-or-close-vehicle-doors command is directed to opening the train doors on the left side and opening the train doors on the right side, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in an open state and the platform doors corresponding to the train doors on the right side are in an open state.

6. When the open-or-close-vehicle-doors command is directed to opening the train doors on the left side and closing the train doors on the right side, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in an open state and the platform doors corresponding to the train doors on the right side are in closed state.

7. When the open-or-close-vehicle-doors command is directed to closing the train doors on the left side and opening the train doors on the right side, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in closed state and the platform doors corresponding to the train doors on the right side are in an open state.

8. When the open-or-close-vehicle-doors command is directed to closing the train doors on the left side and closing the train doors on the right side, it is determined that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in a closed state and the platform doors corresponding to the train doors on the right side are in a closed state.

[0133] When the second platform doors state information is valid or the second platform doors state information meets the feedback timing, the first ground device feeds back the second platform doors state information to the vehicle-mounted device as an acknowledgement of the open-or-close-vehicle-doors command.

[0134] In FIG. 1, the NOP refers to "no operation", and the "reset" refers to that the open-or-close-vehicle-doors command is reset to no command, the open-or-close-platform-doors command is reset to no command, and the platform door state is reset to the unknown state.

[0135] The present invention provides a system for joint control of vehicle doors and platform doors applied to a high-speed railway. The system includes a vehicle-mounted device, a first ground device, a second ground device, and a platform doors system.

[0136] The vehicle-mounted device is configured to send an open-or-close-vehicle-doors command to the first ground device.

[0137] The first ground device is configured to determine a validity of the open-or-close-vehicle-doors command and decide a subsequent processing action depending on the validity of the open-or-close-vehicle-doors command, and is further configured to convert first platform doors state information into second platform doors state information recognizable by the vehicle-mounted device and decide whether to return the second platform doors state information to the vehicle-mounted device.

[0138] The first ground device being configured to determine the validity of the open-or-close-vehicle-doors command and decide the subsequent processing action depending on the validity of the open-or-close-vehicle-doors command includes the following.

[0139] If the open-or-close-vehicle-doors command is valid, an open-or-close-platform-doors command is correctly generated according to the open-or-close-vehicle-doors command, and the first ground device decides whether to send the open-or-close-platform-doors command to the second ground device depending on a monitored timing for sending the open-or-close-platform-doors command.

[0140] If the open-or-close-vehicle-doors command is invalid, the open-or-close-vehicle-doors command is discarded and subsequent processing actions are terminated.

[0141] The first ground device being further configured to convert the first platform doors state information into the

second platform doors state information recognizable by the vehicle-mounted device and decide whether to return the second platform doors state information to the vehicle-mounted device includes the following.

[0142] The first ground device decides whether to return the second platform doors state information to the vehicle-mounted device depending on the validity of the second platform doors state information, and can further be configured to decide whether to return the second platform doors state information to the vehicle-mounted device depending on the monitored timing for returning the second platform doors state information.

[0143] The second ground device is configured to convert the open-or-close-platform-doors command into a platform-doors-relay-driving command recognizable by the platform doors system and send the platform-doors-relay-driving command to the platform doors system, and is further configured to collect and convert the platform-doors-relay-state information into the first platform doors state information and send the first platform doors state information to the first ground device.

[0144] The platform doors system is configured to perform an open-or-close-platform-doors action.

[0145] In this system, the first ground device bears a key role, and it needs to correctly generate the open-or-close-platform-doors command according to the open-or-close-vehicle-doors command, so as to ensure the correctness of the open-or-close-platform-doors command; it needs to determine the timing for sending the open-or-close-platform-doors command to the second ground device and the platform doors system according to a state of the system for joint control of the vehicle doors and platform doors, so as to implement correct and efficient joint control of the vehicle doors and platform doors; and it needs to decide whether to return the second platform doors state information to the vehicle-mounted device and the feedback timing according to the current state platform doors system, so as to allow the vehicle-mounted device and the train driver to accurately know the condition of the joint control of the vehicle doors and platform doors in time for taking further measures.

[0146] FIG. 2 is a schematic diagram of a system according to the present invention. As shown in FIG. 2, the system is described as follows.

[0147] The vehicle-mounted device communicates with the first ground device in a wireless transmission manner: the vehicle-mounted device sends the open-or-close-vehicle-doors command to the first ground device, and the first ground device feeds back the second platform doors state information to the vehicle-mounted device.

[0148] The first ground device exchanges information with the second ground device in a wired communication manner: the first ground device sends the open-or-close-platform-doors command to the second ground device, and the second ground device sends the first platform doors state information to the first ground device.

[0149] A relay interface is performed between the second ground device and the platform doors system in a wired manner: the second ground device sends the platform-doors-relay-driving command to the platform doors system and collects the platform-doors-relay-state information.

[0150] FIG. 3 is a block diagram illustrating the internal modules of a first ground device of the system according to the present invention. As shown in FIG. 3, the first ground device includes an open-or-close-vehicle-doors command verifying and storing module, an open-or-close-platform-doors command generating module, an open-or-close-platform-doors command sending module, an open-or-close-platform-doors command sending timing monitoring module, a platform doors state receiving and storing module, a platform doors state converting module, a platform doors state sending module and a platform doors state feedback timing monitoring module. Specifically, the open-or-close-vehicle-doors command verifying and storing module verifies the open-or-close-vehicle-doors command after receiving the open-or-close-vehicle-doors command and stores and sends the open-or-close-vehicle-doors command to the open-or-close-platform-doors command generating module after determining that the open-or-close-platform-doors command is valid. The open-or-close-platform-doors command generating module converts the open-or-close-vehicle-doors command into the corresponding open-or-close-platform-doors command and sends the open-or-close-platform-doors command to the open-or-close-platform-doors command sending module. The open-or-close-platform-doors command sending timing monitoring module determines whether the open-or-close-platform-doors command meets the sending timing and sends the open-or-close-platform-doors command to the open-or-close-platform-doors command sending module depending on the determination. The open-or-close-platform-doors command sending module is configured to send the open-or-close-platform-doors command to the second ground device when the open-or-close-platform-doors command sending timing monitoring module determines that the open-or-close-platform-doors command needs to be sent.

[0151] The platform doors state receiving and storing module receives and stores the first platform doors state information sent from the second ground device and sends the first platform doors state information to the platform doors state converting module. The platform doors state converting module converts the first platform doors state information into second platform doors state information corresponding to the open-or-close-vehicle-doors command. The platform doors state feedback timing monitoring module is configured to determine the validity of the second platform doors state information and whether the second platform doors state information meets the feedback timing and sends the second platform doors state information to the platform doors state sending module. The platform doors state sending module is configured to return the second platform doors state information to the vehicle-mounted device when the platform doors state feedback timing monitoring module determines that the second platform doors state information needs to

be fed back.

[0152] It is to be noted that in the present invention, the first ground device and the second ground device can also be combined as one ground device, and this ground device converts the open-or-close-vehicle-doors command sent by the vehicle-mounted device into the corresponding platform-doors- relay-driving command; and the above functions of the first ground device can also be integrated onto the vehicle-mounted device, and the vehicle-mounted device directly sends the open-or-close-platform-doors command to the second ground device.

[0153] In the present invention, the first ground device fully verifies the validity of the received open-or-close-vehicle-doors command, monitors the timing for sending the open-or-close-platform-doors command, and decides whether to return the platform doors state to the vehicle-mounted device and monitors the feedback time according to the state of the platform doors system, so that the reliability and the safety of the system for joint control of vehicle doors and platform doors are improved, thereby improving the efficiency of operation.

[0154] Although the present invention has been described in detail with reference to the above-mentioned embodiments, it should be understood by those skilled in the art that the technical solutions described in the above-mentioned embodiments may still be modified, or part of the technical features therein may be equivalently substituted. Such modifications or substitutions do not depart from the spirit and scope in nature of the technical solutions in the embodiments of the present invention.

Claims

1. A method for joint control of vehicle doors and platform doors applied to high-speed railway, the method comprising:

   sending, by a vehicle-mounted device, an open-or-close-vehicle-doors command to a first ground device;
   determining, by the first ground device, a validity of the open-or-close-vehicle-doors command, and performing a processing operation depending on the determination, the processing operation comprising:

      in response to determining that the open-or-close-vehicle-doors command is valid, correctly generating an open-or-close-platform-doors command according to the open-or-close-vehicle-doors command, and deciding, by the first ground device, whether to send the open-or-close-platform-doors command to a second ground device depending on a monitored timing for sending the open-or-close-platform-doors command; and
      in response to determining that the open-or-close-vehicle-doors command is invalid, discarding the open-or-close-vehicle-doors command and terminating subsequent processing actions;

   converting, by the second ground device, the open-or-close-platform-doors command received from the first ground device into a platform-doors-relay-driving command recognizable by a platform doors system, and sending the platform-doors-relay-driving command to the platform doors system;
   in response to receiving the recognizable platform-doors-relay-driving command, performing, by the platform doors system, an open-or-close-platform-doors action;
   capturing, by the second ground device, platform-doors-relay-state information, converting the platform-doors-relay-state information into first platform doors state information recognizable by the first ground device, and sending the first platform doors state information to the first ground device; and
   converting, by the first ground device, the first platform doors state information into second platform doors state information recognizable by the vehicle-mounted device, determining a validity of the second platform doors state information, deciding whether to return the second platform doors state information to the vehicle-mounted device depending on the determination, and further deciding whether to return the second platform doors state information to the vehicle-mounted device depending on a monitored timing for returning the second platform doors state information.

2. The method of claim 1, wherein the first ground device determines that the open-or-close-vehicle-doors command is valid when the following conditions are all simultaneously met:

   a train stops still and accurately;
   there are platform doors on a station track where the train stops;
   the first ground device determines a platform doors side corresponding to train doors according to the open-or-close-vehicle-doors command, comprising the following conditions:

      when the open-or-close-vehicle-doors command is directed to the train doors on the left side, there is set

up platform doors on the platform side corresponding to the train doors on the left side;
when the open-or-close-vehicle-doors command is directed to the train doors on the right side, there is set up platform doors on the platform side corresponding to the train doors on the right side; and
when the open-or-close-vehicle-doors command is directed to the train doors on both sides, there is set up platform doors on both sides of a platform of the station track where the train is located; and

the open-or-close-vehicle-doors command is directed to opening or closing trains doors on at least one side, comprising the following conditions:

the train doors on the left side are command-free, and the train doors on the right side are opened or closed;
the train doors on the left side are opened or closed, and the train doors on the right side are command-free; and
the train doors on the left side are opened or closed, and the train doors on the right side are opened or closed.

3. The method of claim 2, wherein the first ground device determining the platform doors side corresponding to the train doors comprises:

when the direction in which the station track receives the train is a forward direction, determining that the sides of the platform doors are consistent with the sides of the train doors; and
when the direction in which the station track receives the train is a backward direction, determining that the sides of the platform doors are opposite to the sides of the train doors;
wherein the forward direction is a forward direction of a line, and the backward direction is a backward direction of the line.

4. The method of claim 1, wherein correctly generating the open-or-close-platform-doors command according to the open-or-close-vehicle-doors command comprises:
generating, by the first ground device, a corresponding open-or-close-platform-doors command according to the open-or-close-vehicle-doors command in conjunction with a platform doors database stored by the first ground device.

5. The method of any one of claims 1 to 4, wherein the open-or-close-vehicle-doors command comprises the following fields:
a train carriages grouping type field, a station track receiving vehicle direction field, a turnback flag field, and an open-or-close-doors command field.

6. The method of claim 5, wherein the turn-back flag is generated by the vehicle-mounted device determining whether the train turns back, comprising:

when the train turns back, generating, by the vehicle-mounted device, an immediately-turn-back flag; and
when the train doesn't turn back, generating, by the vehicle-mounted device, a not-immediately-turn-back flag.

7. The method of claim 6, wherein the vehicle-mounted device determines whether the train turns back according to mode changes of a currently servicing end and a non-currently servicing end, comprising:

in response to the currently servicing end switching from a non-sleep mode to a sleep mode so that it descends to be the non-currently servicing end, and the non-currently servicing end switching from the sleep mode to the non-sleep mode so that it ascends to be the currently servicing end, determining, by the vehicle-mounted device, that the train turns back; and
in response to the modes of the currently servicing end and/or the non-currently servicing end not changing, determining by, the vehicle-mounted device, that the train does not turn back.

8. The method of any one of claims 1 to 4, 6 and 7, wherein deciding by the first ground device whether to send the open-or-close-platform-doors command to the second ground device depending on the monitored timing for sending the open-or-close-platform-doors command comprises:

keeping sending, by the first ground device, the open-or-close-platform-doors command to the second ground device for a period of time;
in response to the period of time exceeding a preset time threshold set by a time threshold timer, sending, by

the first ground device, a message to the second ground device indicating that there is no command directed to the corresponding platform doors, and resetting the time threshold timer;
each time the first ground device receives the open-or-close-vehicle-doors command and determines that the open-or-close-vehicle-doors command is valid, sending, by the first ground device, the open-or-close-platform-doors command to the second ground device, and restarting the timing;
in response to the determining that its communication with the vehicle-mounted device is interrupted, regarding, by the first ground device, a command for controlling platform doors of the station track where the train is located as no command, and resetting the time threshold timer; and
in response to the first ground device determining that its communication with the second ground device is interrupted, setting, by the first ground device, states of all platform doors of a station corresponding to the second ground device to unknown states, setting a platform doors control command to no command, and resetting the time threshold timer.

9. The method of any one of claims 1 to 4, 6 and 7, wherein converting, by the first ground device, the first platform doors state information into the second platform doors state information recognizable by the vehicle-mounted device comprises:
generating, by the first ground device, the second platform doors state information corresponding to the open-or-close-vehicle-doors command based on the first platform doors state information, the open-or-close-vehicle-doors command, and the platform doors database stored by the first ground device.

10. The method of any one of claims 1 to 4, 6 and , wherein deciding whether to return the second platform doors state information to the vehicle-mounted device depending on the determination comprises:

in response to determining that the second platform doors state information is valid, immediately returning, by the first ground device, the second platform doors state information to the vehicle-mounted device as an acknowledgement of the open-or-close-vehicle-doors command; and
in response to determining that the second platform doors state information is invalid, skipping, by the first ground device, the operation of returning information to the vehicle-mounted device.

11. The method of any one of claims 1 to 4, 6 and 7, wherein determining, by the first ground device, the validity of the second platform doors state information comprises:

when the open-or-close-vehicle-doors command is directed to the train doors on the left side while the train doors on the right side are command-free, determining that the second platform doors state information is valid when the platform doors corresponding to the train doors on the left side are in an open or closed state;
when the train doors on the left side are command-free while the open-or-close-vehicle-doors command is directed to the train doors on the right side, determining that the second platform doors state information is valid when the platform doors corresponding to the train doors on the right side are in an open or closed state; and
when the open-or-close-vehicle-doors command is directed to the train doors on both sides, determining that the second platform doors state information is valid when the platform doors corresponding to the train doors on the left side are in an open or closed state and the platform doors corresponding to the train doors on the right side are in an open or closed state.

12. The method of any one of claims 1 to 4, 6 and 7, wherein further deciding, by the first ground device, whether to return the second platform doors state information to the vehicle-mounted device depending on the monitored timing for returning the second platform doors state information comprises the following operations:

keeping sending, by the first ground device, the open-or-close-platform-doors command to the second ground device for a period of time;
in response to determining that within the period of time the platform doors move in place, immediately returning, by the first ground device, the second platform doors state information to the vehicle-mounted device as a feedback to the open-or-close-vehicle-doors command;
in response to determining that the period of time is exceeded, skipping, by the first ground device, the operation of returning information to the vehicle-mounted device; and
in response to determining that its communication with the second ground device is interrupted, resetting, by the first ground device, the states of the platform doors to unknown states.

13. The method of claim 12, wherein determining that the platform doors move in place comprises:

when the open-or-close-vehicle-doors command is directed to opening the train doors on the left side while the train doors on the right side are command-free, determining that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in an open state;

when the open-or-close-vehicle-doors command is directed to closing the train doors on the left side while the train doors on the right side are command-free, determining that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in a closed state;

when the train doors on the left side are command-free while the open-or-close-vehicle-doors command is directed to opening the train doors on the right side, determining that the platform doors move in place when the platform doors corresponding to the train doors on the right side are in an open state;

when the train doors on the left side are command-free while the open-or-close-vehicle-doors command is directed to closing the train doors on the right side, determining that the platform doors move in place when the platform doors corresponding to the train doors on the right side are in a closed state;

when the open-or-close-vehicle-doors command is directed to opening the train doors on the left side and opening the train doors on the right side, determining that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in an open state and the platform doors corresponding to the train doors on the right side are in an open state;

when the open-or-close-vehicle-doors command is directed to opening the train doors on the left side and closing the train doors on the right side, determining that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in an open state and the platform doors corresponding to the train doors on the right side are in closed state;

when the open-or-close-vehicle-doors command is directed to closing the train doors on the left side and opening the train doors on the right side, determining that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in closed state and the platform doors corresponding to the train doors on the right side are in an open state; and

when the open-or-close-vehicle-doors command is directed to closing the train doors on the left side and closing the train doors on the right side, determining that the platform doors move in place when the platform doors corresponding to the train doors on the left side are in a closed state and the platform doors corresponding to the train doors on the right side are in a closed state.

14. A system for joint control of vehicle doors and platform doors applied to a high-speed railway, the system comprising a vehicle-mounted device, a first ground device, a second ground device, and a platform doors system, wherein

the vehicle-mounted device is configured to send an open-or-close-vehicle-doors command to the first ground device;

the first ground device is configured to determine a validity of the open-or-close-vehicle-doors command and determine a subsequent processing action depending on the validity of the open-or-close-vehicle-doors command;

the first ground device is further configured to convert first platform doors state information into second platform doors state information recognizable by the vehicle-mounted device and decide whether to return the second platform doors state information to the vehicle-mounted device, wherein:

the first ground device being configured to determine the validity of the open-or-close-vehicle-doors command and decide the subsequent processing action depending on the validity of the open-or-close-vehicle-doors command comprises the following:

in response to determining that the open-or-close-vehicle-doors command is valid, the first ground device is configured to correct generate an open-or-close-platform-doors command according to the open-or-close-vehicle-doors command, and the first ground device is further configured to decide whether to send the open-or-close-platform-doors command to the second ground device depending on a monitored timing for sending the open-or-close-platform-doors command; and

in response to determining that the open-or-close-vehicle-doors command is invalid, the first ground device is configured to discard the open-or-close-vehicle-doors command and terminate subsequent processing actions;

wherein the first ground device being further configured to convert the first platform doors state information into the second platform doors state information recognizable by the vehicle-mounted device and decide whether to return the second platform doors state information to the vehicle-mounted device comprises:

the first ground device is configured to decide whether to return the second platform doors state information to the vehicle-mounted device depending on the validity of the second platform doors state information, and the first ground device is further configured to decide whether to return the second platform doors state information to the vehicle-mounted device depending on a monitored timing for returning the second platform doors state

information;

the second ground device is configured to convert the open-or-close-platform-doors command into a platform-doors-relay-driving command recognizable by the platform doors system and send the platform-doors-relay-driving command to the platform doors system; and the second ground device is further configured to collect and convert the platform-doors-relay-state information into the first platform doors state information and send the first platform doors state information to the first ground device; and
the platform doors system is configured to perform an open-or-close-platform-doors action.

15. The system of claim 14, wherein
the vehicle-mounted device is connected to the first ground device by means of wireless transmission;
the first ground device is connected to the second ground device by means of wired communication; and
the second ground device is connected to the platform doors system by means of wired communication.

16. The system of claim 14, wherein the first ground device comprises an open-or-close-vehicle-doors command verifying and storing module, an open-or-close-platform-doors command generating module, an open-or-close-platform-doors command sending module, and an open-or-close-platform-doors command sending timing monitoring module, wherein
the open-or-close-vehicle-doors command verifying and storing module is configured to determine the validity of the open-or-close-vehicle-doors command and store the open-or-close-vehicle-doors command;
the open-or-close-platform-doors command generating module is configured to convert the open-or-close-vehicle-doors command into the open-or-close-platform-doors command;
the open-or-close-platform-doors command sending timing monitoring module is configured to determine a timing for sending the open-or-close-platform-doors command; and
the open-or-close-platform-doors command sending module is configured to send the open-or-close-platform-doors command to the second ground device in response to the open-or-close-platform-doors command sending timing monitoring module determining that the open-or-close-platform-doors command needs to be sent.

17. The system of any one of claims 14 to 16, wherein the first ground device comprises a platform doors state receiving and storing module, a platform doors state converting module, a platform doors state sending module, and a platform doors state feedback timing monitoring module, wherein
the platform doors state receiving and storing module is configured to receive and store the first platform doors state information sent by the second ground device;
the platform doors state converting module is configured to convert the first platform doors state information into second platform doors state information corresponding to the open-or-close-vehicle-doors command;
the platform doors state feedback timing monitoring module is configured to determine the validity of the second platform doors state information and monitor the timing for returning the second platform doors state information to the vehicle-mounted device; and
the platform doors state sending module is configured to return the second platform doors state information to the vehicle-mounted device when the platform doors state feedback timing monitoring module determines that the second platform doors state information needs to be fed back.

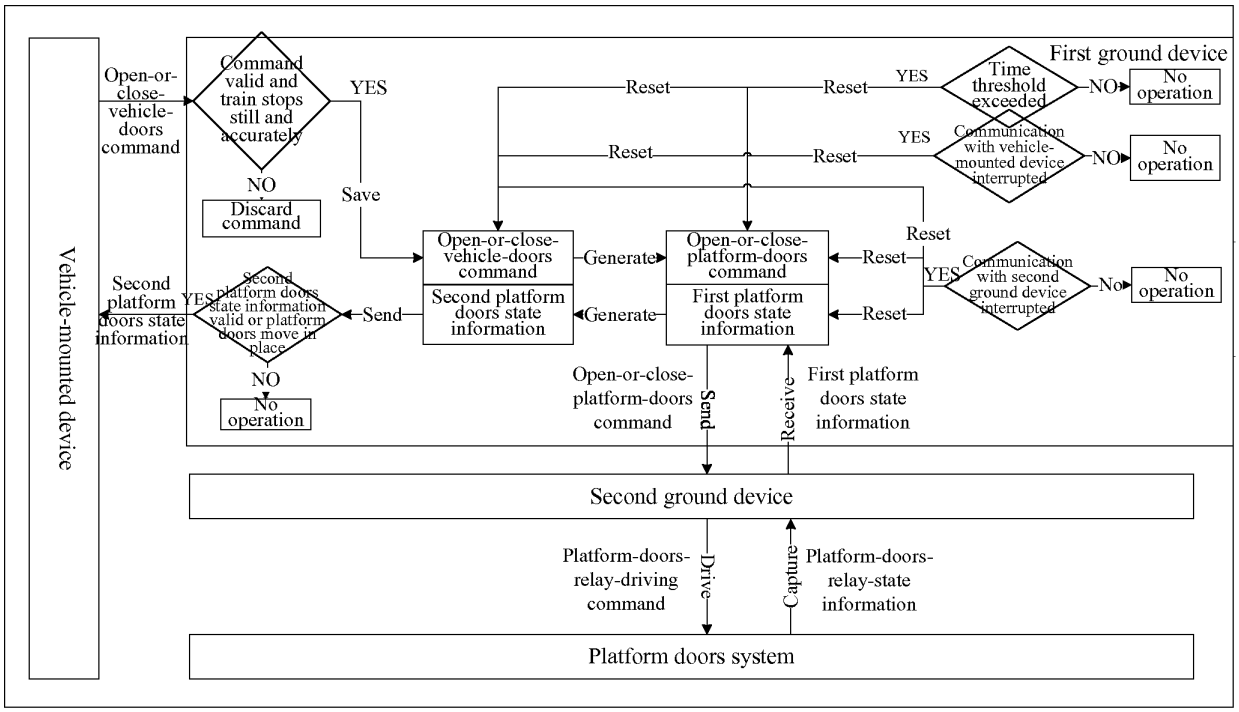
Vehicle-mounted device
Open-or-close-vehicle-doors command
Command valid and train stops still and accurately
YES
NO
Discard command
Save
Second platform doors state information
Second platform doors state information valid or platform doors move in place
YES
NO
No operation
Send
Open-or-close-vehicle-doors command
Second platform doors state information
Generate
Generate
Open-or-close-platform-doors command
First platform doors state information
Reset
Reset
Reset
Reset
Reset
Reset
Reset
YES
Time threshold exceeded
NO
No operation
First ground device
YES
Communication with vehicle-mounted device interrupted
NO
No operation
YES
Communication with second ground device interrupted
No
No operation
Open-or-close-platform-doors command
Send
Receive
First platform doors state information
Second ground device
Platform-doors-relay-driving command
Drive
Capture
Platform-doors-relay-state information
Platform doors system

FIG. 1

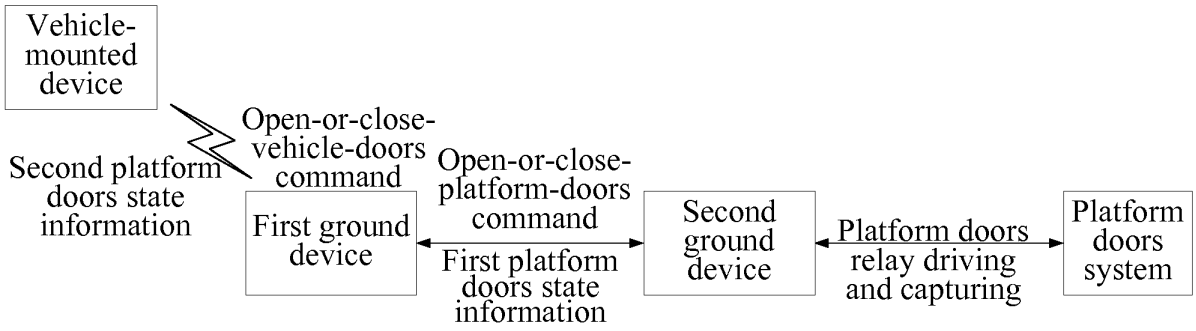
Vehicle-mounted device
Second platform doors state information
Open-or-close-vehicle-doors command
First ground device
Open-or-close-platform-doors command
First platform doors state information
Second ground device
Platform doors relay driving and capturing
Platform doors system

FIG. 2

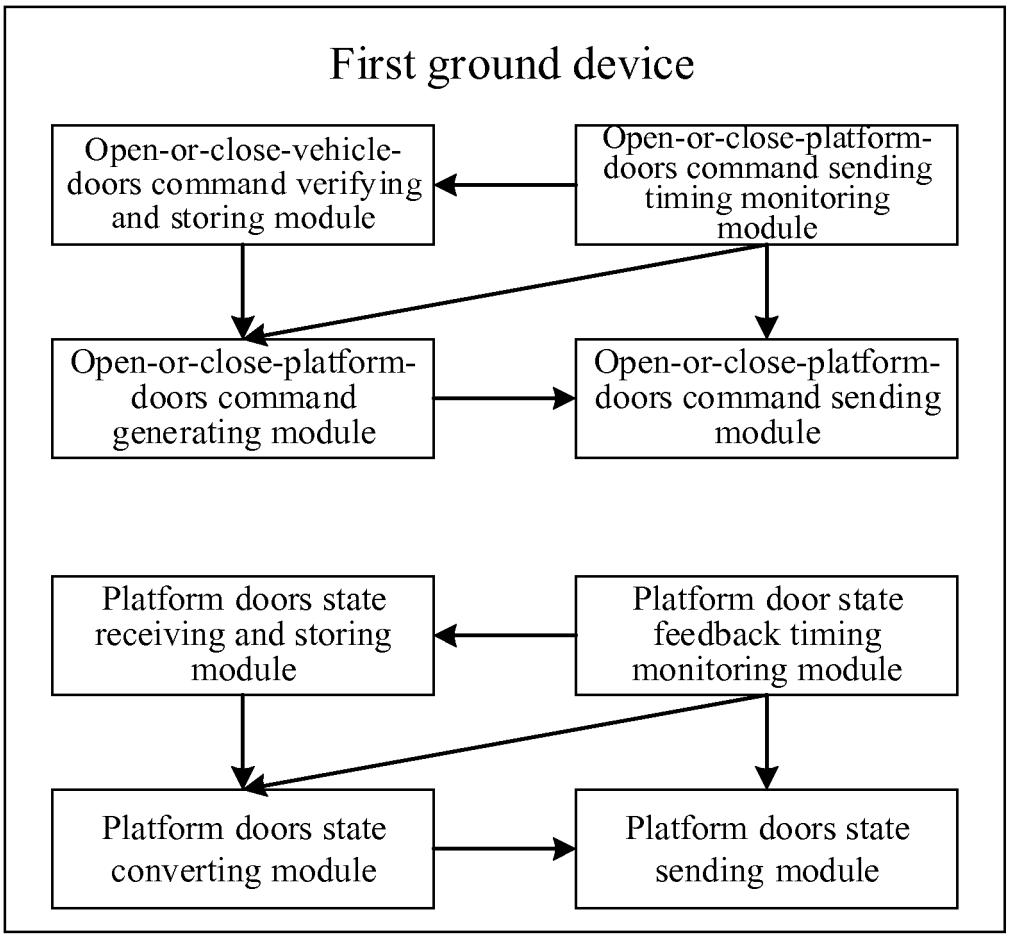
First ground device
Open-or-close-vehicle-doors command verifying and storing module
Open-or-close-platform-doors command sending timing monitoring module
Open-or-close-platform-doors command generating module
Open-or-close-platform-doors command sending module
Platform doors state receiving and storing module
Platform door state feedback timing monitoring module
Platform doors state converting module
Platform doors state sending module

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/104360

A. CLASSIFICATION OF SUBJECT MATTER

E05F 15/70(2015.01)i; B61B 1/02(2006.01)i; B61D 19/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E05F; B61B; B61D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS; CNTXT; CNKI; VEN; USTXT; EPTXT; WOTXT: 地铁, 高铁, 动车, 电车, 站台门, 屏蔽门, 安全门, 联动, 联控, 联合, 反馈, 回执, 有效性, 时机, metro, subway, high-speed rail, tram, platform door, shielding door, linkage, union, joint control, feedback, receipt, effectiveness, opportunity

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 102127998 A (BEIJING JIAOTONG UNIVERSITY) 20 July 2011 (2011-07-20) description, paragraphs [0006]-[0065], and figures 1-5	1-17
Y	CN 109733441 A (CRSC RESEARCH & DESIGN INSTITUTE GROUP CO., LTD.) 10 May 2019 (2019-05-10) description, paragraphs [0070]-[0095]	1-17
A	CN 201062461 Y (COMMUNICATION SIGNALS INSTITUTE, ACADEMY OF RAILWAY SCIENCES et al.) 21 May 2008 (2008-05-21) entire document	1-17
A	JP 2002037056 A (NABCO LTD.) 06 February 2002 (2002-02-06) entire document	1-17

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 February 2020	**10 March 2020**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/104360

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 102127998 A	20 July 2011	CN 102127998 B	21 August 2013
CN 109733441 A	10 May 2019	None	
CN 201062461 Y	21 May 2008	None	
JP 2002037056 A	06 February 2002	None	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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