

TITLE OF THE INVENTION

CONTROL APPARATUS AND CONTROL METHOD

TECHNICAL FIELD

5 [0001]

The present disclosure relates to a control apparatus and the like.

BACKGROUND ART

10 [0002]

According to a conventional technique, an opening and closing speed and a thrust of a door of a railway vehicle are controlled based on operation information of the railway vehicle (for example, see PTL 1).

Citation List

Patent Literature

[0003]

20 [PTL 1] Japanese Laid-Open Patent Publication No. 2012-76596

SUMMARY OF THE INVENTION

[0004]

25 However, it is desirable that the operation of the door of the railway vehicle can be controlled more appropriately in accordance with various conditions in view of not only the opening and closing speed and the thrust of the door but also
30 other parameters such as the closing timing of the door.

[0005]

It is therefore an object of the present invention to provide a technique capable of more
35 appropriately controlling the operation of a door of a railway vehicle in accordance with various conditions.

[0006]

In order to achieve the above object, one aspect of the present disclose provides:

5 a control apparatus for controlling an operation of a door of a railway vehicle,

wherein the door of the railway vehicle stopped at a station starts to be closed based on at least one of: information about a situation of an inside of the railway vehicle; and information about a situation of a platform of the station at which the railway vehicle is stopped.

[0007]

Furthermore, another aspect of the present disclosure provides:

15 a control method executed by a control apparatus configured to control an operation of a door of a railway vehicle, the control method including:

starting to close the door of the railway vehicle stopped at a station, based on at least one of: information about a situation of an inside of the railway vehicle; and information about a situation of a platform of the station at which the railway vehicle is stopped.

25 [0008]

According to the above-described aspects, the operation of the door of the railway vehicle can be controlled more appropriately in accordance with various situations.

30

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a diagram illustrating an example of a configuration of a vehicle operation support system.
35 FIG. 2 is a sequence diagram illustrating an example of operation of the vehicle operation support system for opening a door of a railway vehicle and a

platform door upon arrival at a station of the railway vehicle.

FIG. 3 is a sequence diagram illustrating another example of operation of the vehicle operation support system for opening a door of a railway vehicle and a platform door upon arrival at a station of the railway vehicle.

FIG. 4 is a sequence diagram illustrating yet another example of operation of the vehicle operation support system for opening a door of a railway vehicle and a platform door upon arrival at a station of the railway vehicle.

FIG. 5 is a sequence diagram illustrating a first example of operation of the vehicle operation support system for closing a door of a railway vehicle and a platform door upon departure of a railway vehicle from a station.

FIG. 6 is a sequence diagram illustrating a second example of operation of the vehicle operation support system for closing a door of a railway vehicle and a platform door upon departure of a railway vehicle from a station.

FIG. 7 is a sequence diagram illustrating a third example of operation of the vehicle operation support system for closing a door of a railway vehicle and a platform door upon departure of a railway vehicle from a station.

FIG. 8 is a sequence diagram illustrating a fourth example of operation of the vehicle operation support system for closing a door of a railway vehicle and a platform door upon departure of a railway vehicle from a station.

FIG. 9 is a sequence diagram illustrating a fifth example of operation of the vehicle operation support system for closing a door of a railway vehicle and a platform door upon departure of a railway vehicle from a station.

DESCRIPTION OF EMBODIMENTS

[0010]

5 An embodiment is described below with reference to the drawings.

[0011]

[Configuration of vehicle operation support system]

10 A configuration of a vehicle operation support system 1 is explained with reference to FIG. 1.

[0012]

FIG. 1 is a diagram illustrating an example of a configuration of the vehicle operation support system 1.

15 [0013]

As illustrated in FIG. 1, the vehicle operation support system 1 includes an operation management apparatus 100, a station 200, and a railway vehicle 300.

20 [0014]

In the following description, it is assumed that communication between the station 200 and the railway vehicle 300 occurs when the railway vehicle 300 stops at the station 200 or immediately before arriving at and stopping at the station 200. Further, in the description, for the sake of convenience, it is assumed that the "forward" direction of the railway vehicle 300 corresponds to the traveling direction of the railway vehicle 300, and "left" and "right" directions of the railway vehicle 300 correspond to the left and right directions, respectively, in a state where the passenger on the railway vehicle 300 faces forward, i.e., the traveling direction of the railway vehicle 300.

35

[0015]

The vehicle operation support system 1 supports

an operation of the railway vehicle 300.

[0016]

The railway vehicle 300 may be constituted by one vehicle 300B (e.g. one railcar) or may be a
5 train in which multiple vehicles 300B (e.g. multiple railcars) are connected. Hereinafter, a case where the railway vehicle 300 is a train in which multiple railway vehicles 300B are connected is mainly explained.

10 [0017]

The operation management apparatus 100 is communicatively connected to the station 200 and the railway vehicle 300 through a predetermined communication network, and manages the operation of
15 the railway vehicle 300 as a host apparatus in the vehicle operation support system 1. The operation management apparatus 100 is provided, for example, in a dispatch room for issuing a command concerning operations of the multiple railway vehicles 300 to
20 the station 200 or the railway vehicle 300.

[0018]

The operation management apparatus 100 transmits, to the station 200, a signal (hereinafter referred to as a "departure permission signal")
25 indicating that departure from the station 200 at which the railway vehicle 300 is stopped is possible in accordance with, for example, the schedule of the railway vehicle 300 and the operation conditions of other railway vehicles 300 before and after the
30 railway vehicle 300.

[0019]

The station 200 is a stop at which the railway vehicle 300 stops. There are multiple stations 200 on a line on which the railway vehicle 300 runs.

35 [0020]

The station 200 includes a camera 202, an image analysis apparatus 204, an image transmission

apparatus 206, a display apparatus 208, a
communication apparatus 210, an integrated control
apparatus 212, a display apparatus 214, a
communication apparatus 216, a platform door control
5 panel 218, a command apparatus 220, and a vehicle
detection apparatus 222. The station 200 also
includes a platform door system 230.

[0021]

The camera 202 (an example of a first camera
10 and a third camera) is installed on the platform of
the station 200 in such a manner as to be able to
capture an image of the railway vehicle 300 which
enters and stops at the platform of the station 200
and a portion of the track adjacent to the platform
15 of the station 200. Hereinafter, the camera 202
obtains image information (an example of information
related to a situation of a platform of a station at
which the railway vehicle stops) including the
platform of the station 200 and the railway vehicle
20 300 in the portion of the track adjacent to the
platform. Hereinafter, for the sake of convenience,
the railway vehicle 300 entering the portion of the
track adjacent to the platform of the station 200 or
stopping on the portion of the track is expressed as
25 "entering the platform of the station 200" or
"stopping at the platform of the station 200". For
example, a single camera 202 may be configured to be
able to capture an image of the entire platform, or
the image-capturing range may be divided in the
30 longitudinal direction (length direction) of the
platform so that multiple cameras 202 can capture an
image of the entire platform. For example, when
there are multiple platforms on which the railway
vehicle 300 can stop at the station 200, one or more
35 cameras 202 are installed for each platform. The
output (image information) of the camera 202 is
received by the image analysis apparatus 204 through

a dedicated communication line or a local area network (LAN). Hereinafter, the constituent elements of the station 200 are described based on the assumption that information and data are

5 exchanged through a dedicated communication line or a local network in the same manner as between the camera 202 and the image analysis apparatus 204.

[0022]

The longitudinal direction (length direction) of the platform of the station 200 corresponds to the longitudinal direction of the railway vehicle 300 which enters and stops at the platform.

[0023]

The image analysis apparatus 204 receives image information of the camera 202 and analyzes the image by using a conventional image processing technique, image recognition technique, and the like. The image analysis apparatus 204 transmits image information of the camera 202 to the display apparatus 208 through the image transmission apparatus 206, and transmits the image information to the railway vehicle 300 through the image transmission apparatus 206 and the communication apparatus 210.

25 [0024]

The functions of the image analysis apparatus 204 may be achieved by any hardware or any combination of hardware and software. For example, the image analysis apparatus 204 is mainly constituted by a computer including a central processing unit (CPU), a memory device, an auxiliary storage device, a high-speed computing device, an interface device, and the like. The memory device is, for example, an SRAM (Static Random Access Memory) or a DRAM (Dynamic Random Access Memory). The auxiliary storage device may be, for example, an HDD (Hard Disk Drive), SSD (Solid State Drive),

flash memory, EEPROM (Electrically Erasable Programmable Read-Only Memory), or the like. Examples of the high-speed computing devices include a GPU (Graphics Processing Unit), an FPGA (Field-
5 Programmable Gate Array), an ASIC (Application Specific Integrated Circuit), and the like. The interface device includes a communication interface for communicating with other constituent elements of the station 200, such as, for example, the
10 integrated control apparatus 212. Examples of the interface devices include an external interface for connecting to a recording medium. Thus, for example, the image analysis apparatus 204 can acquire various programs from the recording medium through the
15 external interface and install them in the auxiliary storage device.

[0025]

The image analysis apparatus 204 determines, for example, presence or absence of a passenger who
20 is about to get on or get off through the door 320 of the railway vehicle 300 stopping at the platform of the station 200 based on the image information of the camera 202. Hereinafter, the phrase "passenger" is meant to include a person who is riding on the
25 railway vehicle 300, a person who is about to ride on the railway vehicle 300, a person who got off the railway vehicle 300, and the like.

[0026]

Furthermore, the image analysis apparatus 204
30 determines, for example, whether there is a specific target person (hereinafter referred to as a "support-required person") who needs support for getting on or getting off the railway vehicle 300 in the vicinity of the door 320 of the railway vehicle
35 300 stopped at the platform of the station 200, based on the image information of the camera 202. The support-required person includes, for example, a

physically disabled person, a person with an infant,
a pregnant woman, an elderly person, and the like.
[0027]

Further, the image analysis apparatus 204
5 outputs, to the image transmission apparatus 206,
image information obtained by combining the image of
the camera 202 with the determination result of the
presence or absence of a passenger who is about to
get on or get off through the door 320 and the
10 presence or absence of a support-required person.
Specifically, when there is a passenger who is about
to get on or get off through the door 320 in the
image-capturing range of the specific camera 202,
the image analysis apparatus 204 may superimpose
15 character information for calling attention on the
image of the target camera 202 or superimpose a
frame surrounding the target passenger. This is
also applicable to a case where there is a support-
required person. Thus, the display apparatus 208
20 can emphasize and display the presence of a
passenger or a support-required person who is about
to get on or off through the door 320 based on the
image information in which the character information
for calling attention and the frame surrounding the
25 target passenger or the support-required person are
combined.
[0028]

The image transmission apparatus 206 transmits
the image of the camera 202 that is output from the
30 image analysis apparatus 204 to the display
apparatus 208 and the communication apparatus 210.
The image transmission apparatus 206 may also
transmit image information of a camera (a passenger
information acquisition apparatus 308 to be
35 described later) inside the railway vehicle 300,
which is received from the railway vehicle 300,
through the communication apparatus 210 to the

display apparatus 208 and the image analysis apparatus 204.

[0029]

5 The display apparatus 208 is installed on the platform of the station 200 and displays an image of the camera 202 received from the image transmission apparatus 206. Thus, a station employee on the platform of the station 200 can perform his/her duty while ascertaining the situation of the platform by
10 viewing the image of the camera 202. The display apparatus 208 may display image information of the camera (the passenger information acquisition apparatus 308) in the railway vehicle 300 received from the image transmission apparatus 206. As a
15 result, the station employee on the platform of the station 200 can perform his/her duties while ascertaining the situation of the inside of the railway vehicle 300 from the image of the camera (the passenger information acquisition apparatus
20 308). For example, a single display apparatus 208 may be provided on the platform of the station 200, or multiple display apparatuses 208 may be provided in a dispersed manner in the longitudinal direction of the platform of the station 200. For example, in
25 a case where the station 200 includes multiple platforms on which the railway vehicle 300 can stop, one or multiple display apparatuses 208 may be provided for each platform.

[0030]

30 The communication apparatus 210 communicates with a communication apparatus 302 of the railway vehicle 300 through a predetermined communication network. The predetermined communication network is, for example, a communication network of local 5G
35 (5th Generation), and in this case, the communication apparatus 210 corresponds to 5G. The communication apparatus 210 transmits the image of

the camera 202 transmitted from the image transmission apparatus 206 to the railway vehicle 300.

[0031]

5 The integrated control apparatus 212 (an example of a control apparatus) controls the opening and closing of the platform door 232 and the operation of the railway vehicle 300 as a host apparatus of the platform door system 230 and the
10 railway vehicle 300.

[0032]

 The functions of the integrated control apparatus 212 may be achieved by any hardware or any combination of hardware and software. For example,
15 the integrated control apparatus 212 is mainly constituted by a computer including a CPU, a memory device, an auxiliary storage device, an interface device, and the like. The memory device is, for example, an SRAM or a DRAM. The auxiliary storage
20 device may be, for example, an HDD, SSD, flash memory, EEPROM, or the like. The interface device includes a communication interface for communicating with other constituent elements of the station 200, such as, for example, the image analysis apparatus
25 204. Examples of the interface devices include an external interface for connecting to a recording medium. Thus, the integrated control apparatus 212 can acquire various programs from the recording medium through the external interface, for example,
30 and install them in the auxiliary storage device.

[0033]

 For example, the integrated control apparatus 212 controls the opening operation of the platform door 232 and the closing operation of the door 320
35 of the railway vehicle 300 based on signals received from the operation management apparatus 100 and the analysis results of the image analysis apparatus 204.

[0034]

The display apparatus 214 is provided on the platform of the station 200 and displays the contents of a signal (command) received from the operation management apparatus 100. As a result, the station employee on the platform of the station 200 can execute the duties while ascertaining the command from the operation management apparatus 100.

[0035]

The communication apparatus 216 communicates with the communication apparatus 306 of the railway vehicle 300 through a predetermined communication network. The communication apparatus 216 is, for example, a ground element of a transponder apparatus functioning in combination with the communication apparatus 306.

[0036]

The functions of the communication apparatuses 210, 216 may be integrated into one communication apparatus.

[0037]

The platform door control panel 218 controls the platform door system 230.

[0038]

The functions of the platform door control panel 218 may be achieved by any hardware or any combination of hardware and software. For example, the platform door control panel 218 is mainly constituted by a computer including a CPU, a memory device, an auxiliary storage device, an interface device, and the like. The memory device is, for example, an SRAM. The auxiliary storage device may be, for example, a flash memory, EEPROM, or the like. The interface device includes a communication interface for communicating with other constituent elements of the station 200, such as, for example, the integrated control apparatus 212. Examples of

the interface devices include an external interface for connecting to a recording medium. Thus, the platform door control panel 218 can acquire various programs from the recording medium through the
5 external interface, for example, and install them in the auxiliary storage device.
[0039]

The command apparatus 220 is provided on the platform of the station 200 and is operated by a
10 station employee of the station 200, the conductor of the railway vehicle 300, or the like. The command apparatus 220 outputs a command for opening the platform door 232 (hereinafter referred to as an "open command") and a command for closing the
15 platform door 232 (hereinafter referred to as a "close command") to the platform door control panel 218 by the operation of a station employee, the conductor, or the like. Thus, the platform door control panel 218 can achieve opening and closing of
20 the platform door 232 in response to the operation of the command apparatus 220 by relaying the command from the command apparatus 220 to the platform door system 230.

[0040]
25 The vehicle detection apparatus 222 detects the railway vehicle 300 entering and stopping on the platform of the station 200. The multiple vehicle detection apparatuses 222 are provided in a dispersed manner in the longitudinal direction of
30 the platform of the station 200, and their output signals are received by the platform door control panel 218. Thus, the platform door control panel 218 and the like can determine the stop range, in the longitudinal direction of the platform, of the
35 railway vehicle 300 that has arrived at and stopped at the station 200, the relationship in position between the railway vehicle 300 and the platform

door 232, or the like, in accordance with the signals of the detection results of the multiple vehicle detection apparatuses 222.

[0041]

5 The image analysis apparatus 204 may determine, from the image of the camera 202, the stopping range, in the longitudinal direction of the platform, of the railway vehicle 300 arriving at and stopping at the station 200, the relationship in position with
10 the platform door 232 of the railway vehicle 300, and the like. In this case, the determination result is received by the platform door control panel 218 through the integrated control apparatus 212.

15 [0042]

 The platform door system 230 includes multiple platform doors 232 and multiple control apparatuses 234 corresponding to the respective platform doors.

[0043]

20 For example, multiple platform door systems 230 may be provided such that each is provided in a corresponding section of multiple sections into which the platform of the station 200 is divided in the longitudinal direction (for example, a section
25 corresponding to a single vehicle 300B of the railway vehicle 300).

[0044]

 The platform door 232 is provided so that the position of the platform in the longitudinal
30 direction matches the position of the door 320 of the door of the railway vehicle 300 when the railway vehicle 300 entering the platform of the station 200 stops within a predetermined range of the stopping position.

35 [0045]

 As described above, the control apparatus 234 is provided for a corresponding platform door 232,

and outputs a control command to the actuator (for example, an electric motor, and the like) of the corresponding platform door 232 to directly control the opening and closing operation of the platform door 232.

[0046]

The functions of the control apparatus 234 may be achieved by any hardware or any combination of hardware and software. For example, the control apparatus 234 is mainly constituted by a computer including a CPU, a memory device, an auxiliary storage device, an interface device, and the like. The memory device is, for example, an SRAM. The auxiliary storage device may be, for example, a flash memory, EEPROM, or the like. The interface apparatus includes, for example, a communication interface for communicating with the platform door control panel 218 and the platform door 232. Examples of the interface devices include an external interface for connecting to a recording medium. Thus, the control apparatus 234 can acquire various programs from the recording medium through the external interface, for example, and install them in the auxiliary storage device.

[0047]

The railway vehicle 300 includes a communication apparatus 302, a display apparatus 304, a communication apparatus 306, a passenger information acquisition apparatus 308, a platform detection apparatus 310, a command apparatus 312, a transmission apparatus 314, a notification apparatus 316, a transmission apparatus 318, a door 320, and a control apparatus 322.

[0048]

The communication apparatus 302 communicates with the communication apparatus 210 of the station 200 through a predetermined communication network.

The image of the camera 202 received from the station 200 through the communication apparatus 302 is received by the display apparatus 304 through a dedicated communication line, a local network, or
5 the like.

[0049]

The display apparatus 304 is provided, for example, in the driver's console 300A provided on a head vehicle 300B and a tail vehicle 300B of the
10 railway vehicles 300 (train). The display apparatus 304 displays an image of the camera 202 received from the station 200 (the communication apparatus 210) by the communication apparatus 302. Thus, the operator or the conductor of the railway vehicle 300
15 can ascertain, through the display apparatus 304, the situation of the platform of the station 200 at which the railway vehicle 300 stops.

[0050]

The communication apparatus 306 communicates
20 with the communication apparatus 216 of the station 200 through a predetermined communication network. The communication apparatus 306 is communicatively connected to the transmission apparatus 314 through a dedicated communication line or a local network,
25 and transmits a signal from the transmission apparatus 314 to the station 200 (the communication apparatus 216) or outputs a signal received from the station 200 (the communication apparatus 216) to the transmission apparatus 314.

30 [0051]

When the communication apparatuses 210, 216 of the station 200 are integrated into one communication apparatus as described above, it is to be understood that the communication apparatuses 302,
35 306 are to be integrated into one communication apparatus.

[0052]

The passenger information acquisition apparatus 308 obtains information about the situation of the passengers in the railway vehicle 300 (an example of information about the situation inside the railway vehicle). The information about the passengers in the railway vehicle 300 includes, for example, information about the congestion situation of passengers in the railway vehicle 300 (hereinafter referred to as "congestion situation information").

10 The information about the situation of passengers in the railway vehicle 300 includes, for example, information about a disembarkation situation of passengers in the railway vehicle 300 such as whether there is a passenger who gets off through the door 320 in the railway vehicle 300 while the railway vehicle 300 is at a stop (hereinafter referred to as "disembarkation situation information").

15 The information about the situation of passengers in the railway vehicle 300 includes, for example, information about the situation of passengers in the railway vehicle 300 such as whether there is a passenger who gets on the railway vehicle 300 through the door 320 while the railway vehicle 300 is at a stop (hereinafter referred to as "embarkation situation information").

20 [0053]

The passenger information acquisition apparatus 308 includes, for example, a weight detection apparatus that detects the weight of each vehicle 300B of the railway vehicle 300 and obtains detection information (measurement information) about the weight of the vehicle 300B. The detection information (the measurement information) about the weight of the vehicle 300B corresponds to the congestion situation information. This is because the number of passengers in the vehicle 300B can be estimated depending on the weight of the vehicle

30

35

300B.

[0054]

The passenger information acquisition apparatus 308 includes, for example, a camera (an example of a
5 second camera) installed near the door 320 inside the railway vehicle 300 (the vehicle 300B). The image information of the camera corresponds to, for example, congestion situation information. This is because the congestion situation of the railway
10 vehicles 300 (the respective vehicles 300B) can be recognized from the image information of the camera. Furthermore, the image information of the camera corresponds to, for example, the disembarkation situation information. This is because the presence
15 or absence of a passenger who is about to get off can be recognized from the situation of the inside of the railway vehicle 300 (the vehicle 300B) in the vicinity of the door 320 that is shown in the image information of the camera. The image information of
20 the camera corresponds to, for example, embarkation situation information. This is because the presence or absence of a passenger who is about to get on the railway vehicle 300 can be recognized from the situation of the platform behind the opening portion
25 of the door 320 that is shown in the image information of the camera.

[0055]

Further, the passenger information acquisition apparatus 308 may include an information processing
30 apparatus (a computer) for specifically determining, from the obtained passenger information, the congestion situation of passengers, the presence or absence of a passenger who is about to get on or get off through the door 320, and the like.

35 [0056]

The platform detection apparatus 310 detects presence of a platform of the station 200 adjacent

to the left side surface or the right side surface
of the railway vehicle 300. The detection
information of the platform detection apparatus 310
is received by the transmission apparatus 314 and
5 transmitted to the driver's console 300A or the like.
[0057]

The command apparatus 312 is provided in the
driver's console 300A and is operated by the
conductor or the like. The command apparatus 312
10 outputs an open command for opening the door 320 and
a close command for closing the door to the control
apparatus 322 through the transmission apparatus 314
according to the operation of the conductor or the
like. Thus, the control apparatus 322 can open and
15 close the door 320 in response to the operation of
the command apparatus 312.
[0058]

The command apparatus 312 may be configured to
output only an open command and a close command of
20 the door 320, or to output only a close command.
[0059]

The transmission apparatus 314 receives various
kinds of information (data and signals) and
transmits them to a specified destination apparatus
25 (group) through a communication network inside the
railway vehicle 300.
[0060]

For example, the transmission apparatus 314
relays a signal of a command for the operation of
30 the door 320 from the integrated control apparatus
212 received by the communication apparatus 306 and
transmits it to the control apparatus 322 through
the transmission apparatus 318 of each vehicle 300B.
[0061]

35 For example, the transmission apparatus 314
relays the open command and the close command from
the command apparatus 312 and transmits them to the

control apparatus 322 through the transmission apparatus 318.

[0062]

For example, the transmission apparatus 314
5 relays a signal (hereinafter referred to as a "full
close completion signal") received from the control
apparatus 322 through the transmission apparatus 318,
indicating that the closing operation of the door
320 is completed, and transmits the signal to the
10 notification apparatus 316.

[0063]

In addition to the relaying function of various
types of information (data and signals), the
transmission apparatus 314 may perform necessary
15 processing based on various types of received
information, and transmit information (data and
signals) corresponding to the result of the
processing or the like to an apparatus at a
predetermined destination.

20 [0064]

The notification apparatus 316 is provided on
the driver's console 300A and notifies various kinds
of information to the driver, the conductor, or the
like of the railway vehicle 300.

25 [0065]

The notification apparatus 316 is, for example,
a display apparatus or a lighting apparatus for
visually notifying information to the driver, the
conductor or the like. The notification apparatus
30 316 is, for example, a sound output apparatus for
audibly notifying information to the driver, the
conductor or the like. The sound output apparatus
is, for example, a speaker, an alarm, a buzzer, or
the like.

35 [0066]

For example, the notification apparatus 316
displays the open-and-close state of the doors of

the railway vehicle 300 that is stopped at the station 200 based on the presence or absence of the full close completion signal of the doors 320 received from the control apparatus 322 through the transmission apparatuses 318, 314.

[0067]

The transmission apparatus 318 is provided in each vehicle 300B and relays information (signals, data, and the like) received from the transmission apparatus 314 for transmission to the control apparatus 322, or relays information (signals, data, and the like) received from the control apparatus 322 for transmission to the transmission apparatus 314.

[0068]

The door 320 is provided on a right side surface or a left side surface of the railway vehicle 300 (the vehicle 300B). For example, for each vehicle 300B, multiple doors 320 (for example, four or six) are provided at substantially the same positions in the longitudinal direction on each of the right side surface and the left side surface.

[0069]

The control apparatus 322 is provided for each door 320, outputs a control command to an actuator (for example, an electric motor or an electromagnetic solenoid) of the target door 320, and directly controls the opening and closing operation of the door 320.

[0070]

For example, the control apparatus 322 opens the door 320 when the door 320 to be controlled is on a platform side of the station 200 from among the right and left sides of the railway vehicle 300 and when an open command is received from the command apparatus 312.

[0071]

Note that, for example, the control apparatus 322 determines whether the door 320 to be controlled is situated on the platform side of the railway vehicle 300, depending on whether the control apparatus 322 has received a signal (hereinafter referred to as an "open permission signal") indicating that the door 320 is allowed to be opened at the next station 200. The open permission signal is output, for example, in response to an operation for turning ON two switches corresponding to the doors 320 on the left and right sides of the railway vehicle 300, which are provided on the head vehicle 300B and the tail vehicle 300B of the railway vehicle 300. Specifically, when the switch corresponding to the door 320 on the left side of the railway vehicle 300 is turned on, an open permission signal is input to the control apparatus 322 corresponding to the door 320 on the left side. In contrast, when the switch corresponding to the door 320 on the right side of the railway vehicle 300 is turned on, an open permission signal is input to the control apparatus 322 corresponding to the door 320 on the right side. The driver, the conductor, or the like turns ON one of the two switches depending on whether the platform of the station at which the railway vehicle 300 stops next is the right side or the left side of the railway vehicle 300.

[0072]

For example, after opening the door 320 to be controlled, the control apparatus 322 closes the door 320 when the control apparatus 322 receives a close command from the integrated control apparatus 212 of the station 200. Further, the control apparatus 322 may close the door 320 when both a close command from the integrated control apparatus 212 of the station 200 and a close command from the

command apparatus 312 are received after opening the door 320 to be controlled.

[0073]

5 [Control method for opening operation of door and platform door]

Next, a control method for opening the door 320 and the platform door 232 will be described with reference to FIGs. 2 to 4.

[0074]

10 <Overview of control method>

In this example, the image analysis apparatus 204 analyzes the image information of the camera 202 when the railway vehicle 300 arrives at the station 200, and determines the relationship in position
15 between the platform door 232 of the station 200 and the door 320 of the railway vehicle 300. Specifically, with respect to each platform door 232 or with respect to each group of two or more platform doors 232, the image analysis apparatus 204
20 determines whether the door 320 of the railway vehicle 300 is at the position corresponding to the platform door 232. In this example, the image information of the camera 202 corresponds to information about the relationship in position
25 between the platform door 232 and the door 320 of the railway vehicle 300. The platform door group includes two or more doors 320 arranged adjacently in the longitudinal direction of the platform. The platform door group includes, for example, a
30 platform door 232 for each platform door system 230. The platform door group includes, for example, platform doors 232 included in the image-capturing range of each camera 202 distributed in the longitudinal direction of the platform. The
35 position corresponding to the platform door 232 means, for example, a state in which the amount of deviation between the center of the platform door

232 in the opening and closing direction and the center of the door 320 in the opening and closing direction is within a predetermined reference level, with reference to a state in which the center of the platform door 232 in the opening and closing direction is aligned with the center of the door 320 in the opening and closing direction.
[0075]

When the railway vehicle 300 is present in front of the platform door 232 and the door 320 is located at the position corresponding to the platform door 232, the image analysis apparatus 204 determines that the door 320 of the railway vehicle 300 is present at the position corresponding to the platform door 232. In contrast, when the railway vehicle 300 is present in front of the platform door 232 and the door 320 is not at the position corresponding to the platform door 232, the image analysis apparatus 204 determines that the door 320 of the railway vehicle 300 is not at the position corresponding to the platform door 232. In addition, even when the railway vehicle 300 is not in front of the platform door 232, the image analysis apparatus 204 determines that the door 320 of the railway vehicle 300 is not at the position corresponding to the platform door 232.
[0076]

When the image analysis apparatus 204 determines that the door 320 is at the position corresponding to the platform door 232, the image analysis apparatus 204 specifies the platform door 232 or the platform door 232 of the platform door group to be determined, and outputs a signal for allowing the opening of the platform door 232 (an opening permission signal).
[0077]

When the integrated control apparatus 212

receives an opening permission signal from the image analysis apparatus 204 and receives an open command of the platform door 232 from the outside, the integrated control apparatus 212 outputs an open
5 command to the platform door control panel 218 and opens the platform door 232 via the platform door control panel 218 and the control apparatus 234. The open command of the platform door 232 may be, for example, an open command from the command
10 apparatus 220 or an open command received from the railway vehicle 300 through the communication apparatus 216 in conjunction with the close command of the door 320 of the railway vehicle 300. The integrated control apparatus 212 may output an open
15 command to the platform door control panel 218 when the integrated control apparatus 212 receives an open permission signal from the image analysis apparatus 204 and receives both of the two open commands. Thus, the integrated control apparatus
20 212 can open the platform door 232 at the position corresponding to the door 320 of the railway vehicle 300, for example, while keeping the platform door 232 which is not in front of the railway vehicle 300 closed. Furthermore, the integrated control
25 apparatus 212 can prevent the platform door 232 from being opened when, for example, the stopped position of the railway vehicle 300 is greatly shifted from the predetermined position.

[0078]

30 <Specific operation of operation support system>

FIG. 2 is a sequence diagram illustrating an example of operation of the vehicle operation support system 1 for opening the door 320 of the
35 railway vehicle 300 and the platform door 232 upon arrival of the railway vehicle 300 at the station 200. Specifically, FIG. 2 is a sequence diagram

illustrating the operation of the vehicle operation support system 1 when the railway vehicle 300 stops within the predetermined position range and the railway vehicle 300 is present in front of all the platform doors 232.

[0079]

As illustrated in FIG. 2, the command apparatus 312 outputs an open command to the transmission apparatus 314 in response to the conductor's operation that is performed when the railway vehicle 300 stops at the station 200 (step S102).

[0080]

The transmission apparatus 314 relays the open command from the command apparatus 312 and transmits the open command to the station 200 (the integrated control apparatus 212) through the communication apparatus 306 (step S104).

[0081]

The image analysis apparatus 204 outputs an open permission signal to the integrated control apparatus 212 for all the platform doors 232 based on the analysis result of the image information of the camera 202 when the railway vehicle 300 stops at the station 200 (step S106).

[0082]

When the integrated control apparatus 212 receives the open permission signal from the image analysis apparatus 204 and then receives the open command from the railway vehicle 300 through the communication apparatus 216, the integrated control apparatus 212 outputs the open command for all the platform doors 232 to the platform door control panel 218 (step S108).

[0083]

When the platform door control panel 218 receives the open command from the integrated control apparatus 212, the platform door control

panel 218 outputs the open command to all the control apparatuses 234 (step S110).

[0084]

When the control apparatus 234 receives the open command from the platform door control panel 218, the control apparatus 234 outputs the control command to the actuator of the platform door 232 to be controlled, and opens the platform door 232 (step S112).

10 [0085]

The transmission apparatus 314 transmits the open command to the transmission apparatus 318 (step S114). In this example, the transmission apparatus 314 transmits the open command to the station 200 (the integrated control apparatus 212) through the communication apparatus 306, and then transmits the open command to the transmission apparatus 318.

[0086]

The transmission apparatus 318 relays the open command from the transmission apparatus 314 and transmits the open command to all the control apparatuses 322 (step S116).

[0087]

When the control apparatus 322 receives the opening permission signal and the control apparatus 322 receives the opening command from the transmission apparatus 318, the control apparatus 322 outputs the control command to the actuator of the door 320 to be controlled and opens the door 320 (step S118). Specifically, the door 320 is opened at a point in time later than the timing for opening the platform door 232.

[0088]

Thus, in the present embodiment, the integrated control apparatus 212 ascertains that, with respect to all the platform doors 232, the door 320 of the railway vehicle 300 is at the position corresponding

to the platform door 232 by receiving the open permission signal, so that all the platform doors 232 can be opened appropriately.

[0089]

5 Next, FIG. 3 is a sequence diagram illustrating another example of operation of the vehicle operation support system 1 for opening the door 320 of the railway vehicle 300 and the platform door 232 upon arrival at the station 200 of the railway
10 vehicle 300. Specifically, FIG. 3 is a sequence diagram illustrating the operation of the vehicle operation support system 1 when the railway vehicle 300 stops at a position outside the predetermined position range.

15 [0090]

As illustrated in FIG. 3, the steps S202 and S204 are the same as the steps S102 and S104, respectively, of FIG. 2, and accordingly, the description thereof is omitted.

20 [0091]

As in the case of FIG. 2, the image analysis apparatus 204 analyzes image information of the camera 202 when the railway vehicle 300 stops at the station 200. However, in this example, the railway
25 vehicle 300 stops at a position beyond the predetermined position range, and accordingly, the image analysis apparatus 204 determines that the door 320 of the railway vehicle 300 is not at the position corresponding to the platform door 232, and
30 does not output the open permission signal (a broken line arrow in the figure). Therefore, the integrated control apparatus 212 maintains all the platform doors 232 in a closed state even when receiving an open command from the railway vehicle
35 300.

[0092]

The steps S206 to S210 are the same as the

steps S114 to S118, respectively, of FIG. 2, and accordingly, the description thereof is omitted.
[0093]

Thus, in this example, the integrated control
5 apparatus 212 ascertains that, with respect to all
the platform doors 232, the door 320 of the railway
vehicle 300 is not at the position corresponding to
the platform door 232 by not receiving the open
permission signal, and can maintain the platform
10 door 232 in a closed state.
[0094]

Next, FIG. 4 is a sequence diagram illustrating
yet another example of operation of the vehicle
operation support system 1 for opening the door 320
15 of the railway vehicle 300 and the platform door 232
upon arrival at the station 200 of the railway
vehicle 300. Specifically, FIG. 4 is a sequence
diagram illustrating the operation of the vehicle
operation support system 1 when the railway vehicle
20 300 stops at a position within the predetermined
position range and the railway vehicle 300 is
present in front of only some of the platform doors,
i.e., a platform door 232-1. In this example, for
the sake of convenience, the platform doors 232 are
25 distinguished from each other and referred to as
platform doors 232-1, 232-2, and for the sake of
convenience, the control apparatuses 234
corresponding to the platform doors 232-1, 232-2 are
distinguished from each other and referred to as
30 control apparatus 234-1, 234-2, respectively.
[0095]

As illustrated in FIG. 4, the steps S302 and
S304 are the same as the steps S202 and S204,
respectively, of FIG. 2, and accordingly, the
35 description thereof is omitted.
[0096]

As in the case of FIG. 2 and the like, the

image analysis apparatus 204 analyzes image information of the camera 202 when the railway vehicle 300 stops at the station 200. In this example, the railway vehicle 300 is present in front
5 of only some of the platform doors, i.e., the platform door 232-1, and the doors of the railway vehicle 300 are not present at the positions corresponding to the other platform door 232-2. Therefore, the image analysis apparatus 204 outputs
10 an open permission signal to the integrated control apparatus 212 by specifying the platform door 232-1 (step S306).

[0097]

When the integrated control apparatus 212
15 receives the open permission signal from the image analysis apparatus 204 and then receives the open command from the railway vehicle 300 through the communication apparatus 216, the integrated control apparatus 212 outputs, to the platform door control
20 panel 218, an open command for some of the platform doors, i.e., the platform door 232-1 (step S308).

[0098]

When the platform door control panel 218 receives the open command from the integrated
25 control apparatus 212, the platform door control panel 218 outputs the open command to the control apparatus 234-1 corresponding to the specified platform doors 232-1 (step S310).

[0099]

30 When the control apparatus 234-1 receives the open command from the platform door control panel 218, the control apparatus 234-1 outputs a control command to the actuator of the platform door 232-1 to be controlled, and opens the platform door 232-1
35 (step S312).

[0100]

The platform door control panel 218 does not

output the open command to the control apparatus 234-2 corresponding to the other platform door 232-2 (a broken line in the figure). Therefore, the platform door 232-2, in front of which the railway vehicle 300 is not present, can be maintained in a closed state.

[0101]

The steps S314 to S318 are the same as the steps S114 to S118, respectively, of FIG. 2, and accordingly, the description thereof is omitted.

[0102]

Thus, in this example, by receiving an open permission signal for some of the platform doors, i.e., the platform door 232-1, the integrated control apparatus 212 can open only the platform door 232-1 in front of which the railway vehicle 300 is present, while maintaining the platform door 232-2, in front of which the railway vehicle 300 is not present, in a closed state.

[0103]

[First example of control method for closing operation of door and platform door]

Next, the first example of the control method for closing operation of the door 320 and the platform door 232 is explained with reference to FIG. 5.

[0104]

<Overview of control method>

In this example, the image analysis apparatus 204 analyzes the image information of the camera 202 sequentially obtained while the railway vehicle 300 is stopped at the station 200, and determines the situation of passengers who get on and get off through the door 320. More specifically, the image analysis apparatus 204 determines the presence or absence of a passenger who is about to get on or get off through the door 320 with respect to each door

320 or with respect to each group of two or more doors 320 (hereinafter referred to as a "door group"). In this example, the door group includes two or more doors 320 arranged adjacent to each other in the longitudinal direction on the platform side of the railway vehicle 300. The door group includes, for example, a door 320 on the platform side of each vehicle 300B. The door group includes, for example, doors 320 included in the image-capturing range of each of the cameras 202 distributed in the longitudinal direction of the platform.

[0105]

When the image analysis apparatus 204 determines that there are no passengers who get on or get off through the door 320 with respect to all the doors 320 or door groups to be determined, the image analysis apparatus 204 outputs a signal (hereinafter referred to as an "embarkation and disembarkation completion signal") indicating the completion of embarkation or disembarkation of passengers of the railway vehicle 300 to the integrated control apparatus 212.

[0106]

In addition to the image information of the camera 202, the image information of the camera (the passenger information acquisition apparatus 308) installed near the door 320 inside the railway vehicle 300 (the vehicle 300B) may be used to determine presence or absence of a passenger who is about to get on or get off the railway vehicle 300 through the door 320. In this case, the image information of the camera of the railway vehicle 300 is transmitted to the station 200 (the communication apparatus 210) through the communication apparatus 302, for example, and is received by the image analysis apparatus 204. Further, the image

information of the camera of the railway vehicle 300 may be analyzed in the passenger information acquisition apparatus 308, and the determination result may be transmitted to the station 200 (the

5 communication apparatus 210) through the communication apparatus 302, and then received by the integrated control apparatus 212.

[0107]

When the integrated control apparatus 212

10 receives the departure permission signal from the operation management apparatus 100 and receives the embarkation and disembarkation completion signal from the image analysis apparatus 204, the integrated control apparatus 212 transmits, through

15 the communication apparatus 216, a close command for all the doors 320 of the railway vehicle 300 to the railway vehicle 300. Thus, the close command received by the communication apparatus 306 of the railway vehicle 300 is relayed through the

20 transmission apparatus 314 and the transmission apparatus 318 and transmitted to the control apparatus 322. Therefore, the control apparatus 322 can close the doors 320 in response to the close command from the integrated control apparatus 212

25 corresponding to the completion of embarkation and disembarkation of passengers through all the doors 320.

[0108]

<Specific operation of operation support

30 system>

FIG. 5 is a sequence diagram illustrating a first example of operation of the vehicle operation support system 1 for closing the door 320 of the railway vehicle 300 and the platform door 232 upon

35 departure of the railway vehicle 300 from the station 200.

[0109]

As illustrated in FIG. 5, the operation management apparatus 100 transmits a departure permission signal to the station 200 (the integrated control apparatus 212) when the operation management apparatus 100 determines that the target railway vehicle 300 is ready to depart in accordance with information about the timetable of the target railway vehicle 300, operation information about other railway vehicles 300, and the like (step S402).

10 [0110]

The image analysis apparatus 204 analyzes the image information about the camera 202, and when the image analysis apparatus 204 determines that there is no passenger who gets on or gets off through the door 320 with respect to all the doors 320 or door groups, the image analysis apparatus 204 outputs an embarkation and disembarkation completion signal to the integrated control apparatus 212 (step S404).

15 [0111]

When the integrated control apparatus 212 receives a departure permission signal from the operation management apparatus 100 and the embarkation and disembarkation completion signal from the image analysis apparatus 204, the integrated control apparatus 212 transmits a close command of the doors 320 to the railway vehicle 300 through the communication apparatus 216 (step S406).

20 [0112]

When the transmission apparatus 314 receives the close command of the doors 320 from the station 200 (the integrated control apparatus 212) through the communication apparatus 306, the transmission apparatus 314 relays the close command and transmits it to the transmission apparatuses 318 of all the vehicles 300B (step S408).

25 [0113]

When the transmission apparatus 318 receives

the close command from the transmission apparatus 318, the transmission apparatus 318 relays the close command and transmits it to the control apparatus 322 (step S410).

5 [0114]

When receiving the close command from the transmission apparatus 318, the control apparatus 322 outputs a control command to the actuator of the door 320 to be controlled, and closes the door 320 (step S412).

10 (step S412).

[0115]

When the closing operation of the door 320 is completed and the door 320 is in the fully closed state, the control apparatus 322 outputs the full close completion signal to the transmission apparatus 318 (step S414). The full close completion signal may include information specifying the target door 320.

15 close completion signal to the transmission

apparatus 318 (step S414). The full close

completion signal may include information specifying the target door 320.

[0116]

When the transmission apparatus 318 receives the full close completion signal from the control apparatus 322, the transmission apparatus 318 relays the full close completion signal and transmits it to the transmission apparatus 314 (step S416).

20 When the transmission apparatus 318 receives

the full close completion signal from the control

apparatus 322, the transmission apparatus 318 relays

the full close completion signal and transmits it to

the transmission apparatus 314 (step S416).

25 [0117]

When the transmission apparatus 314 receives the full close completion signal from the transmission apparatus 318, the transmission apparatus 314 relays the full close completion signal and transmits it to the station 200 (the integrated control apparatus 212) through the communication apparatus 306 (step S418).

30 signal and transmits it to the station 200 (the

integrated control apparatus 212) through the

communication apparatus 306 (step S418).

[0118]

The transmission apparatus 314 transmits the full close completion signal not only to the station 200 (the integrated control apparatus 212) but also to the notification apparatus 316. This is also

35 full close completion signal not only to the station

200 (the integrated control apparatus 212) but also

to the notification apparatus 316. This is also

applicable to the second example (FIG. 6) to the fifth example (FIG. 9) described later.

[0119]

When the integrated control apparatus 212
5 receives the full close completion signals for all the doors 320 from the railway vehicle 300 (the transmission apparatus 314) through the communication apparatus 216, the integrated control apparatus 212 outputs a close command for closing
10 the platform door 232 to the platform door control panel 218 (step S420).

[0120]

When the platform door control panel 218 receives the close command from the integrated
15 control apparatus 212, the platform door control panel 218 outputs an open command to all the control apparatuses 234 (step S422).

[0121]

When the control apparatus 234 receives the
20 close command from the platform door control panel 218, the control apparatus 234 outputs a control command to the actuator of the platform door 232 to be controlled, and closes the platform door 232 (step S424).

25 [0122]

Thus, in this example, the integrated control apparatus 212 can confirm the completion of embarkation and disembarkation of the passengers of the railway vehicle 300 by receiving the embarkation and disembarkation completion signal, and can
30 properly close the door 320 of the railway vehicle 300. That is, the integrated control apparatus 212 can adjust the timing for starting to close the door 320 of the railway vehicle 300 in accordance with
35 the timing of the embarkation and disembarkation completion signal, and as a result, the proper operation of the railway vehicle 300 can be achieved

while securing the proper embarkation and disembarkation of the railway vehicle 300.

[0123]

5 [Second example of control method for closing operation of door and platform door]

Next, the second example of the control method for closing operation of the door 320 and the platform door 232 is explained with reference to FIG. 6.

10 [0124]

<Overview of control method>

In this example, similarly to the case of the first example described above, the image analysis apparatus 204 determines presence or absence of a passenger who is about to get on or get off through the door 320 for each door 320 or for each group of two or more doors 320 (hereinafter referred to as a "door group").

[0125]

20 When the image analysis apparatus 204 determines that there is no passenger who gets on or gets off through the door 320 for each door 320 or the door group to be determined, the image analysis apparatus 204 outputs a signal (hereinafter referred to as an "embarkation and disembarkation completion signal") indicating the completion of passengers getting on or getting off the railway vehicle 300 to the integrated control apparatus 212. That is, the image analysis apparatus 204 first outputs the
30 embarkation and disembarkation completion signal with respect to the door 320 or the door group through which embarkation of passengers through the door 320 is completed, from among all the doors 320 or the door groups to be determined. The
35 embarkation and disembarkation completion signal includes information specifying a target door 320 or door group.

[0126]

When the integrated control apparatus 212 receives the departure permission signal from the operation management apparatus 100 and the
5 embarkation and disembarkation completion signal, the integrated control apparatus 212 transmits, through the communication apparatus 216, to the railway vehicle 300 a close command with respect to the door 320 or the door group specified by the
10 embarkation and disembarkation completion signal. As a result, the close command received by the communication apparatus 306 of the railway vehicle 300 is relayed through the transmission apparatus 314 and the transmission apparatus 318 and
15 transmitted to the control apparatus 322 corresponding to the target door 320 or the door 320 included in the door group. Therefore, the control apparatus 322 can close the door 320 in response to a close command from the integrated control
20 apparatus 212 corresponding to the completion of embarkation and disembarkation of passengers from the door 320 to be controlled.

[0127]

25 <Specific operation of operation support system>

FIG. 6 is a sequence diagram illustrating a second example of operation of the vehicle operation support system 1 for closing the door 320 of the railway vehicle 300 and the platform door 232 upon
30 departure of the railway vehicle 300 from station 200. In this example, for the sake of convenience, the doors 320 of the same vehicle 300B are distinguished from each other and referred to as doors 320-1, 320-2, and for the sake of convenience,
35 the control apparatuses 322 corresponding to the doors 320-1, 320-2 are distinguished from each other and referred to as control apparatuses 322-1, 322-2.

[0128]

As illustrated in FIG. 6, the step S502 is the same as the step S402 of FIG. 5, and accordingly, the description thereof is omitted.

5 [0129]

The image analysis apparatus 204 analyzes the image information of the camera 202 and determines that there is no passenger who gets on or gets off through the door 320-1 with respect to the door 320-1 or the door group including the door 320-1. Then, the image analysis apparatus 204 outputs an embarkation and disembarkation completion signal specifying the door 320-1 or the door group including the door 320-1 to the integrated control apparatus 212 (step S504).

15 [0130]

When the integrated control apparatus 212 receives the departure permission signal from the operation management apparatus 100 and thereafter receives the embarkation and disembarkation completion signal from the image analysis apparatus 204, the integrated control apparatus 212 transmits, through the communication apparatus 216, a close command specifying the door 320-1 or the door group including the door 320-1 to the railway vehicle 300 (step S506).

25 [0131]

The transmission apparatus 314 receives, through the communication apparatus 306, a close command from the station 200 (the integrated control apparatus 212) specifying the door group including the door 320-1 or the door 320-1. Then, the transmission apparatus 314 relays the close command and transmits the close command to the transmission apparatus 318 of the vehicle 300B corresponding to the control apparatus 322-1 which controls the door 320-1 specified by the close command (step S508).

35

[0132]

When the transmission apparatus 318 receives the close command from the transmission apparatus 314, the transmission apparatus 318 relays the close
5 command and transmits the close command to the control apparatus 322-1 corresponding to the door 320-1 specified by the close command (step S510).

[0133]

When the control apparatus 322-1 receives the
10 close command from the transmission apparatus 318, the control apparatus 322-1 outputs a control command to the actuator of the door 320-1 to be controlled, and closes the door 320-1 (step S512).

[0134]

15 The image analysis apparatus 204 analyzes the image information of the camera 202 after the output of the embarkation and disembarkation completion signal in step S504. Then, the image analysis apparatus 204 determines that there is no passenger
20 who gets on or gets off through the door 320-2 with respect to the door group including the door 320-2 or the door 320-2. Then, the image analysis apparatus 204 outputs an embarkation and disembarkation completion signal specifying the door
25 group including the door 320-2 or the door 320-2 to the integrated control apparatus 212 (step S514).

[0135]

When the integrated control apparatus 212 receives the embarkation and disembarkation
30 completion signal from the image analysis apparatus 204, the integrated control apparatus 212, having already received the departure enabling signal, transmits, via the communication apparatus 216, to the railway vehicle 300, a close command for
35 specifying the door 320-2 or the door group including the doors 320-2 (step S516).

[0136]

The transmission apparatus 314 receives,
through the communication apparatus 306, a close
command from the station 200 (the integrated control
apparatus 212) specifying the door group including
5 the door 320-2 or the door 320-2. Then, the
transmission apparatus 314 relays the close command
and transmits the close command to the transmission
apparatus 318 of the vehicle 300B corresponding to
the control apparatus 322-2 which controls the door
10 320-2 specified by the close command (step S518).
[0137]

If the control apparatuses 322-1, 322-2 are in
different vehicles 300B, in this step, the
transmission apparatus 314 transmits the close
15 command to another transmission apparatus 318
corresponding to the control apparatus 322-2, which
is different from the transmission apparatus 318
transmitting the close command in step S508.
[0138]

20 When the transmission apparatus 318 receives
the close command from the transmission apparatus
314, the transmission apparatus 318 relays the close
command and transmits the close command to the
control apparatus 322-2 corresponding to the door
25 320-2 specified by the close command (step S520).
[0139]

When the control apparatus 322-2 receives the
close command from the transmission apparatus 318,
the control apparatus 322-2 outputs a control
30 command to the actuator of the door 320-2 to be
controlled, and closes the door 320-2 (step S522).
[0140]

The control apparatus 322-1 completes the
closing operation of the door 320-1 in step S512,
35 and when the door 320 is in the fully closed state,
outputs the full close completion signal to the
transmission apparatus 318 (step S524).

[0141]

When the transmission apparatus 318 receives the full close completion signal specifying the door 320-1 from the control apparatus 322, the
5 transmission apparatus relays the full close completion signal and transmits it to the transmission apparatus 314 (step S526).

[0142]

When the transmission apparatus 314 receives
10 the full close completion signal specifying the door 320-1 from the transmission apparatus 318, the transmission apparatus 314 relays the full close completion signal and transmits it to the station 200 (the integrated control apparatus 212) through
15 the communication apparatus 306 (step S528).

[0143]

When the closing operation of the door 320-2 in step S522 is completed and the door 320-2 is in the fully closed state, the control apparatus 322-2
20 outputs the full close completion signal to the transmission apparatus 318 (step S530).

[0144]

When the transmission apparatus 318 receives the full close completion signal specifying the door
25 320-2 from the control apparatus 322, the transmission apparatus relays the full close completion signal and transmits it to the transmission apparatus 314 (step S532).

[0145]

When the transmission apparatus 314 receives the full close completion signal specifying the door
30 320-2 from the transmission apparatus 318, the transmission apparatus 314 relays the full close completion signal and transmits it to the station
35 200 (the integrated control apparatus 212) through the communication apparatus 306 (step S534).

[0146]

The steps S536 to S540 are the same as the steps S420 to S424, respectively, of FIG. 5, and accordingly, the description thereof is omitted.
[0147]

5 Each time the integrated control apparatus 212 receives the full close completion signal specifying the particular door 320, the integrated control apparatus 212 may sequentially output a close command specifying the platform door 232
10 corresponding to the door 320 to the platform door control panel 218. Hereinafter, this may apply to the third example (FIG. 7) to the fifth example (FIG. 9) described later.
[0148]

15 Thus, in this example, the integrated control apparatus 212 can ascertain the completion of embarkation and disembarkation of passengers of the railway vehicle 300 by receiving the embarkation and disembarkation completion signal for each door 320
20 or for each door group, and can properly close the door 320 of the railway vehicle 300. Therefore, the integrated control apparatus 212 can achieve a proper operation of the railway vehicle 300 while ensuring proper embarkation and disembarkation of
25 the railway vehicle 300 for each door 320 or for each door group.
[0149]

[Third example of control method for closing operation of door and platform door]

30 Next, the third example of the control method for closing operation of the door 320 and the platform door 232 is explained with reference to FIG. 7.
[0150]

35 <Overview of control method>

 In this example, the integrated control apparatus 212 reads out the station feature

information when the railway vehicle 300 arrives at the station 200.

[0151]

5 The station feature information is information
indicating features related to embarkation and
disembarkation of passengers of the railway vehicle
300. The station feature information includes, for
example, information about a frequency of
10 occurrences of rush rides in each of multiple
sections in the longitudinal direction of the
platform of the station 200. Throughout this
specification, an action of a passenger who rushes
into a railway vehicle through a door that has
already started to be closed is referred to as a
15 "rush ride". The station feature information
includes, for example, information about a tendency
of congestion of passengers who get on or get off
through the door 320 for each of multiple sections
in the longitudinal direction of the platform of the
20 station 200 and for each period of time. The
multiple sections may be sections for each door 320
or sections for each vehicle 300B, for example. The
station feature information includes, for example,
information about an entrance to or an exit from the
25 platform, such as a stairway or an elevator of the
station 200.

[0152]

 When the integrated control apparatus 212
receives the departure permission signal from the
30 operation management apparatus 100 and the
embarkation and disembarkation completion signal
from the image analysis apparatus 204, the
integrated control apparatus 212 reflects the
contents of the station feature information and
35 outputs the close signal of the door 320
corresponding to the embarkation and disembarkation
completion signal to the station 200.

[0153]

For example, the integrated control apparatus 212 determines whether the frequency of occurrences of rush rides from the target door 320 is relatively high based on the station feature information. The relatively high frequency of occurrences of rush rides through the door 320 means, for example, a state in which the frequency of occurrences exceeds a predetermined reference level or is equal to or more than a predetermined reference level. In this case, the integrated control apparatus 212 may determine whether the frequency of occurrences of rush rides through the target door 320 is relatively high based on information about the frequency of occurrences of rush rides in each of multiple sections in the longitudinal direction of the platform of the station 200 as the station characteristic information. Furthermore, the integrated control apparatus 212 may determine whether the frequency of occurrences of rush rides through the target door 320 is relatively high based on the information about an entrance to or an exit from the platform, such as a stairway or an elevator of the station 200, as the station characteristic information. This is because it is considered that the possibility that passengers rush to get on the railway vehicle 300 is relatively high through a door 320 that is close to a platform entrance and exit gate of the station 200. When the integrated control apparatus 212 determines that the frequency of occurrences of rush rides through the target door 320 is relatively high, the output timing of the close command is delayed as compared with usual output timing. When the integrated control apparatus 212 determines, based on the station feature information, that the frequency of occurrences of rush rides through the target door

320 is relatively high, the integrated control apparatus may transmit a close command including a command for delaying the timing for starting to close the door 320 (hereinafter referred to as a
5 "close start delay command"). Thus, the control apparatus 322 can respond to a rush ride by delaying the timing for starting to close the target door 320 as compared with usual timing in response to the close command from the integrated control apparatus
10 212.

[0154]

Furthermore, instead of delaying the timing for starting to close the target door 320 as compared with usual timing, the closing speed of the door 320
15 may be reduced as compared with usual timing, and a length of time of the closing operation from the start of closing to the fully closed state (hereinafter referred to as a "close time") may be increased as compared with a usual time.
20 Specifically, the integrated control apparatus 212 may output a close command including a command to increase the close time of the target door 320 as compared with a usual close time (hereinafter referred to as a "close time extension command")
25 when it is determined that the frequency of occurrences of rush rides through the target door 320 is relatively high based on the station feature information. Thus, the control apparatus 322 can respond to a rush ride by reducing the closing speed
30 of the target door 320 as compared with a usual closing speed in response to the close command including the close time extension command from the integrated control apparatus 212.

[0155]

35 In addition to delaying the timing for starting the closing of the target door 320 as compared with usual timing, the closing speed of the door 320 may

be increased and the close time may be reduced as compared with a usual close time. Specifically, the integrated control apparatus 212 may output a close command including a command to shorten the close
5 time of the target door 320 (hereinafter referred to as a "close time shortening command") as compared with a normal time when it is determined that the frequency of occurrences of rush rides through the target door 320 is relatively high based on the
10 station feature information. In this case, as described above, the integrated control apparatus 212 may delay the output timing of the close command as compared with usual output timing, or may output a close command further including a close start
15 delay command. As a result, the control apparatus 322 can delay the timing for starting to close the target door 320 as compared with usual timing in response to the close command from the integrated control apparatus 212, reduce the close time to a
20 time shorter than a usual close time in response to the rush ride, and reduce the operation delay of the railway vehicle 300.

[0156]

The degree (amount) by which the timing for
25 starting of the closing of the target door 320 is delayed as compared with usual timing may be varied in such a manner that, for example, the degree (amount) increases in accordance with an increase in the frequency of occurrences of rush rides through
30 the target door 320. This may be also applicable to the degree (amount) by which the closing speed of the door 320 is reduced and the degree (amount) by which the closing speed is increased.

[0157]

35 For example, the integrated control apparatus 212 determines whether the degree of congestion of passengers who get on or get off through the target

door 320 is relatively high based on the station
feature information. The relatively high degree of
congestion of passengers who get on or get off
through the door 320 means, for example, a state in
5 which the degree of congestion exceeds or is equal
to or more than a predetermined reference level. In
this case, the integrated control apparatus 212 may
determine whether the degree of congestion of
passengers who get on or get off through the target
10 door 320 is relatively high based on information
about the tendency of congestion of passengers who
get on or get off through the door 320 for each of
multiple sections in the longitudinal direction of
the platform of the station 200 as station
15 characteristic information and for each period of
time. When the integrated control apparatus 212
determines that the degree of congestion of
passengers who get on or get off through the target
door 320 is relatively high, the output timing of
20 the close command of the door 320 is delayed as
compared with usual output timing. When the
integrated control apparatus 212 determines that the
degree of congestion of passengers who get on or get
off through the target door 320 is relatively high,
25 the integrated control apparatus 212 may transmit a
close command including a close start delay command
of the door 320. Thus, in response to the close
command from the integrated control apparatus 212,
the control apparatus 322 can delay the timing for
30 starting to close the target door 320 as compared
with usual timing, and can respond to a situation in
which it takes a relatively long time for passengers
to get on and off through the target door 320.
[0158]
35 Further, instead of delaying the timing of the
target door 320 as compared with usual timing, the
closing speed of the door 320 may be reduced as

compared with a usual closing speed and the close time of the door 320 may be increased as compared with a usual closing speed. Specifically, the integrated control apparatus 212 may output a close
5 command including a close time extension command of the target door 320 when the integrated control apparatus 212 determines that the degree of congestion of passengers who get on or get off through the target door 320 is relatively high based
10 on the station feature information. Thus, the control apparatus 322 can reduce the closing speed of the target door 320 to a closing speed lower than a usual closing speed in response to the close command including the close time extension command
15 from the integrated control apparatus 212, and can respond to the congestion situation of passengers exceeding a predetermined reference level.
[0159]

Furthermore, in addition to delaying the timing
20 for starting the closing of the target door 320 as compared with usual timing, the integrated control apparatus 212 may increase the closing speed of the door 320 to a faster closing speed and reduce the close time as compared with a usual close time.
25 Specifically, the integrated control apparatus 212 may output a close command including a close time shortening command for the target door 320 when the integrated control apparatus 212 determines that the degree of congestion of passengers who get on or get
30 off through the target door 320 is relatively high based on the station feature information. In this case, as described above, the integrated control apparatus 212 may delay the output timing of the close command as compared with usual output timing,
35 or may output a close command further including a close start delay command. As a result, in response to the close command from the integrated control

apparatus 212, the control apparatus 322 can delay the timing for starting to close the target door 320 as compared with usual timing, reduce the close time to a close time shorter than a usual close time, and
5 reduce the operation delay of the railway vehicle 300, while responding to the congestion of passengers.

[0160]

The degree (amount) by which the timing for
10 starting of the closing of the target door 320 is delayed as compared with usual timing may be varied in such a manner that, for example, the degree (amount) increases in accordance with an increase in the likelihood of congestion of passengers who get
15 on or get off the target door 320. This may be also applicable to the degree (amount) by which the closing speed of the door 320 is reduced and the degree (amount) by which the closing speed is increased.

20 [0161]

<Specific operation of operation support system>

FIG. 7 is a sequence diagram illustrating a third example of operation of the vehicle operation
25 support system 1 for closing the door 320 of the railway vehicle 300 and the platform door 232 upon departure of the railway vehicle 300 from the station 200. In this example, for the sake of convenience, similarly to the above-described second example (FIG. 6), the doors 320 of the same vehicle
30 300B are distinguished from each other and referred to as doors 320-1, 320-2, and for the sake of convenience, the control apparatuses 322 corresponding to the doors 320-1, 320-2 are
35 distinguished from each other and referred to as control apparatuses 322-1, 322-2.

[0162]

As illustrated in FIG. 7, when the railway vehicle 300 arrives at (stops at) the station 200, the integrated control apparatus 212 reads the station feature information previously stored in the auxiliary storage device to the memory device (step S602). In this example, the integrated control apparatus 212 determines that the frequency of occurrences of rush rides through the particular door 320-2 is relatively high, and determines that the frequency of occurrences of rush rides through the other doors 320-1 is low.

[0163]

The steps S604, S606 are the same as the steps S402, S404, respectively, of FIG. 5, and accordingly, the description thereof is omitted.

[0164]

When the integrated control apparatus 212 receives the departure permission signal from the operation management apparatus 100 and the embarkation and disembarkation completion signal from the image analysis apparatus 204, the integrated control apparatus 212 transmits the close command of the door 320-1 to the railway vehicle 300 through the communication apparatus 216 (step S608).

[0165]

When the transmission apparatus 314 receives the close command of the door 320-1 from the station 200 (the integrated control apparatus 212) through the communication apparatus 306, the transmission apparatus 314 relays the close command and transmits it to the transmission apparatus 318 of the vehicle 300B including the door 320-1 (step S610).

[0166]

Although FIG. 7 illustrates a case where the close command is transmitted to the transmission apparatus 318 of the same vehicle 300B including both of the doors 320-1, 320-2, only the close

command of the door 320-1 is transmitted to the transmission apparatus 318 of the vehicle 300B including only the door 320-1.

[0167]

5 When the transmission apparatus 318 receives the close command of the door 320-1 from the transmission apparatus 314, the transmission apparatus 318 transmits the close command to the control apparatus 322-1 corresponding to the door
10 320-1 (step S612).

[0168]

 When the control apparatus 322-1 receives the close command from the transmission apparatus 318, the control apparatus 322-1 outputs a control
15 command to the actuator of the door 320-1 to be controlled, and closes the door 320-1 at a predetermined normal speed (step S614).

[0169]

 The integrated control apparatus 212 transmits
20 the close command of the door 320-2 including the close time shortening command to the railway vehicle 300 through the communication apparatus 216 at a predetermined timing after the output of the close command of the door 320-1 in step S608 (step S616).

25 [0170]

 When the transmission apparatus 314 receives the close command of the door 320-2 from the station 200 (the integrated control apparatus 212) through the communication apparatus 306, the transmission
30 apparatus 314 relays the close command and transmits it to the transmission apparatus 318 of the vehicle 300B including the door 320-2 (step S618).

[0171]

 When the transmission apparatus 318 receives
35 the close command of the door 320-2 from the transmission apparatus 314, the transmission apparatus 318 relays the close command and transmits

it to the control apparatus 322-2 corresponding to the door 320-2 (step S620).

[0172]

When the control apparatus 322-2 receives the close command from the transmission apparatus 318, the control apparatus 322-2 outputs a control command to the actuator of the door 320-2 to be controlled, and closes the door 320-2 at a speed higher (faster) than the normal speed (step S622).

10 [0173]

The steps S624 to S628, step S630 to S634, and step S636 to S640 are the same as the steps S524 to S528, step S530 to S534, and step S536 to S540, respectively, of FIG. 6, and accordingly, the description thereof is omitted.

15 [0174]

Thus, in the present embodiment, the integrated control apparatus 212 can appropriately close the door 320 of the railway vehicle 300 based on the station feature information in view of the frequency of occurrences of rush rides and the tendency of congestion of passengers who get on or get off through the door 320.

[0175]

25 [Fourth example of control method for closing operation of door and platform door]

Next, the fourth example of the control method for closing operation of the door 320 and the platform door 232 is explained with reference to FIG. 8.

30 [0176]

<Overview of control method>

In this example, the image analysis apparatus 204 analyzes the image information of the camera 202 immediately before the arrival of the railway vehicle 300 at the station 200, and attempts to recognize (detect) the support-required person on

35

the platform where the railway vehicle 300 enters and stops, for each of multiple sections in the longitudinal direction of the platform of the station 200.

5 [0177]

When the image analysis apparatus 204 detects a support-required person in a specific section in the longitudinal direction of the platform of the station 200 until the door 320 of the railway
10 vehicle 300 is closed, the image analysis apparatus 204 outputs a signal indicating detection of the support-required person (hereinafter, a "support-required person detection signal") to the integrated control apparatus 212. The support-required person
15 detection signal includes information specifying a target section or a door 320 corresponding to the target section.

[0178]

When the integrated control apparatus receives
20 the departure permission signal from the operation management apparatus 100 and the embarkation and disembarkation completion signal from the image analysis apparatus 204, the integrated control apparatus 212 transmits the close command of the
25 door 320 to the railway vehicle 300 through the communication apparatus 216. In this case, when the integrated control apparatus 212 receives the support-required person detection signal from the image analysis apparatus 204, the integrated control
30 apparatus 212 delays the output timing of the close command with respect to the door 320 specified by the support-required person detection signal or the door 320 corresponding to the specified section. Further, the integrated control apparatus 212 may
35 output a close command including a close start delay command with respect to the door 320 specified by the support-required person signal or the door 320

corresponding to the specified section. Thus, the control apparatus 322 can respond to the embarkation of the support-required person by delaying the timing for starting to close the target door 320 as compared with usual timing in response to the close command from the integrated control apparatus 212. [0179]

Alternatively to or in addition to delaying the timing for starting to close the target door 320 as compared with usual timing, the closing speed of the target door 320 may be reduced as compared with a normal closing speed and the close time may be increased as compared with a normal close time. Specifically, the integrated control apparatus 212 may output a close command including a close time extension command with respect to the door 320 specified by the support-required person detection signal or the door 320 in the specified section. As a result, the control apparatus 322 can increase the close time of the target door 320 as compared with a usual close time in response to the close command from the integrated control apparatus 212 to respond to embarkation of the support-required person. [0180]

In addition, in order to respond not only to embarkation of the support-required person on the railway vehicle 300 from the platform but also to the disembarkation of the support-required person from the railway vehicle 300, the timing for starting to close the target door 320 may be delayed as compared with usual timing or the close time may be increased as compared with a usual close time. For example, the image information of the camera (the passenger information acquisition apparatus 308) which captures an image of the vicinity of the door 320 inside the railway vehicle 300 (the vehicle 300B) may be analyzed to determine whether there is

a support-required person who is about to get off the railway vehicle 300 upon arrival. In this case, for example, the image analysis apparatus 204 may determine whether there is a support-required person who is about to get off the railway vehicle 300 when the railway vehicle 300 arrives by transmitting the image information of the railway vehicle 300 to the image analysis apparatus 204 of the station 200 through the communication apparatus 302.

Furthermore, image analysis may be performed inside the passenger information acquisition apparatus 308, and the result of the determination may be transmitted to the integrated control apparatus 212 through the communication apparatus 302.

Furthermore, for example, in a situation where a support-required person such as a disabled person who uses a wheelchair or a white cane gets on the railway vehicle 300 with the support of a station employee or the like, information about the vehicle 300B which the support-required person get on and the door 320 through which the support-required person is expected to get off may be obtained in advance. In this case, for example, the integrated control apparatus 212 may determine whether there is a support-required person who is scheduled to get off the railway vehicle 300 when the railway vehicle 300 arrives, by acquiring the support-required person information. The support-required person information may be obtained, for example, from a control apparatus that controls the operation of the railway vehicle 300 on the driver's console 300A through the communication apparatus 306 or may be obtained from the operation management apparatus 100.

[0181]

<Specific operation of operation support system>

FIG. 8 is a sequence diagram illustrating a

fourth example of operation of the vehicle operation support system 1 for closing the door 320 of the railway vehicle 300 and the platform door 232 upon departure of the railway vehicle 300 from the station 200. In this example, for the sake of convenience, similarly to the above-described second example (FIG. 6) and the above-described third example (FIG. 7), the two control apparatuses 322 of the same vehicle 300B are distinguished from each other and referred to as control apparatuses 322-1, 322-2.

[0182]

As illustrated in FIG. 8, the image analysis apparatus 204 analyzes the image information of the camera 202, and when a support-required person is detected in a section in the longitudinal direction of the platform of the station 200, the image analysis apparatus 204 outputs a support-required person detection signal to the integrated control apparatus 212 (step S702). Hereinafter, in this embodiment, the door 320 specified by the support-required person detection signal or the door 320 corresponding to the specified section is referred to as a "door 320-2", and the other door 320 is referred to as a "door 320-1" so that they are distinguished from each other for the sake of convenience.

[0183]

The steps S704, S706 are the same as the steps S402, S404, respectively, of FIG. 5, and accordingly, the description thereof is omitted.

[0184]

When the integrated control apparatus 212 receives the departure permission signal from the operation management apparatus 100 and the embarkation and disembarkation completion signal from the image analysis apparatus 204, the

integrated control apparatus 212 transmits the close command of the door 320-1 to the railway vehicle 300 through the communication apparatus 216 (step S708).
[0185]

5 When the transmission apparatus 314 receives the close command of the door 320-1 from the station 200 (the integrated control apparatus 212) through the communication apparatus 306, the transmission apparatus 314 relays the close command and transmits
10 it to the transmission apparatus 318 of the vehicle 300B including the door 320-1 (step S710).
[0186]

 Although FIG. 8 illustrates a case where the close command is transmitted to the transmission
15 apparatus 318 of the same vehicle 300B including both of the doors 320-1, 320-2, only the close command of the door 320-1 is transmitted to the transmission apparatus 318 of the vehicle 300B including only the door 320-1.
20 [0187]

 When the transmission apparatus 318 receives the close command of the door 320-1 from the transmission apparatus 314, the transmission apparatus 318 transmits the close command to the
25 control apparatus 322-1 corresponding to the door 320-1 (step S712).
[0188]

 When the control apparatus 322-1 receives the close command from the transmission apparatus 318,
30 the control apparatus 322-1 outputs a control command to the actuator of the door 320-1 to be controlled, and closes the door 320-1 at a predetermined normal speed (step S714).
[0189]

35 The integrated control apparatus 212 transmits the close command of the door 320-2 including the close time extension command to the railway vehicle

300 through the communication apparatus 216 at a predetermined timing after the output of the close command of the door 320-1 in step S708 (step S716).
[0190]

5 When the transmission apparatus 314 receives the close command of the door 320-2 from the station 200 (the integrated control apparatus 212) through the communication apparatus 306, the transmission apparatus 314 relays the close command and transmits
10 it to the transmission apparatus 318 of the vehicle 300B including the door 320-2 (step S718).
[0191]

 When the transmission apparatus 318 receives the close command of the door 320-2 from the
15 transmission apparatus 314, the transmission apparatus 318 relays the close command and transmits it to the control apparatus 322-2 corresponding to the door 320-2 (step S720).
[0192]

20 When the control apparatus 322-2 receives the close command from the transmission apparatus 318, the control apparatus 322-2 outputs a control command to the actuator of the door 320-2 to be controlled, and closes the door 320-2 at a speed
25 smaller (slower) than the normal speed (step S722).
[0193]

 The step S724 to S728, step S730 to S734, and step S736 to S740 are the same as the steps S524 to S528, step S530 to S534, and step S536 to S540,
30 respectively, of FIG. 6, and accordingly, the description thereof is omitted.
[0194]

 Thus, in this example, the integrated control apparatus 212 can appropriately close the door 320
35 of the railway vehicle 300 by receiving the support-required person detection signal in view of presence of the support-required person.

[0195]

[Fifth example of control method for closing operation of door and platform door]

Next, the fifth example of the control method
5 for closing operation of the door 320 and the platform door 232 is explained with reference to FIG. 9.

[0196]

<Overview of control method>

10 In this example, the passenger information acquisition apparatus 308 determines the degree of congestion for each vehicle 300B based on congestion information obtained after the departure of the railway vehicle 300 from the station 200 (i.e.,
15 after departing from a station 200 previous to a station 200 at which the railway vehicle 300 subsequently stops). When the passenger information acquisition apparatus 308 determines that the degree of congestion of a certain vehicle 300B is
20 relatively high, the passenger information acquisition apparatus 308 outputs a signal (hereinafter referred to as a "congestion signal") indicating the congested state to the transmission apparatus 314. The relatively high degree of
25 congestion of the vehicle 300B means, for example, a state in which the degree of congestion exceeds or is equal to or more than a predetermined reference level. The congestion signal includes information specifying the target vehicle 300B.

30 [0197]

The passenger information acquisition apparatus 308 may also determine the degree of congestion for each vehicle 300B based on the congestion information obtained by the railway vehicle 300
35 while stopping at the station 200. If the passenger information acquisition apparatus 308 determines that the degree of congestion of a certain vehicle

300B is relatively high, the passenger information acquisition apparatus 308 may output a congestion signal to the transmission apparatus 314.

[0198]

5 When the transmission apparatus 314 receives the congestion signal from the passenger information acquisition apparatus 308, the transmission apparatus 314 outputs a close start delay command of the target door 320 to the transmission apparatus
10 318 including the door 320 of the vehicle 300B specified by the congestion signal. The transmission apparatus 314 may output a close time extension command instead of a close start delay command, or may output a close start delay command
15 and a close time extension command (Hereinafter, a "close start delay and a close time extension command"). Hereinafter, for the sake of convenience, the close start delay command, the close time extension command, or the close start delay and a
20 close time extension command will be referred to as a "close start delay command or the like".

[0199]

 When the transmission apparatus 318 receives a close start delay command or the like from the
25 transmission apparatus 314, the transmission apparatus 318 relays the close start delay command or the like and transmits it to the control apparatus 322 corresponding to the door 320 specified by the close start delay command or the
30 like.

[0200]

 When the control apparatus 322 receives a close start delay command or the like from the transmission apparatus 318 and thereafter receives a
35 close command of the door 320 to be controlled from the station 200 (the integrated control apparatus 212) through the transmission apparatus 318, the

control apparatus 322 reflects the close start delay command or the like and closes the door 320 to be controlled. Specifically, when the control apparatus receives the close command of the door 320 to be controlled from the transmission apparatus 318 in the case where the control apparatus has received the close start delay command from the transmission apparatus 318, the control apparatus 322 starts to close the door 320 after a longer period of time elapses than a usual time from the reception of the close command. When the control apparatus 322 receives a command for extending the opening time from the transmission apparatus 318 and a command for closing the door 320 to be controlled from the transmission apparatus 318, the control apparatus closes the door 320 at a lower (slower) speed than a usual speed and increases the close time as compared with a usual close time. When the control apparatus 322 receives a close start delay and close time extension command from the transmission apparatus 318, the control apparatus 322 receives a close command of the door 320 to be controlled from the transmission apparatus 318 and thereafter starts to close the door 320 after a longer period of time elapses than a usual time from the reception of the close command and closes the door 320 at a lower (slower) speed than a usual speed, thereby increasing the close time to a time longer than a usual close time. As a result, the control apparatus 322 can relatively delay the start of closing the door 320 based on the output timing of the embarkation and disembarkation completion signal from the image analysis apparatus 204. Therefore, the control apparatus 322 can appropriately respond to a situation where the time required for passengers to get on and get off through the door 320 becomes relatively long due to the congestion of

the vehicle 300B including the door 320 to be controlled.

[0201]

5 The degree (amount) by which the timing for
starting of the closing of the target door 320 is
relatively delayed may be varied in such a manner
that, for example, the degree (amount) increases in
accordance with an increase in the degree of
congestion of passengers in the vehicle 300B
10 including the door 320. This may be also applicable
to the degree (amount) by which the closing speed of
the target door 320 is reduced (slowed).

[0202]

15 <Specific operation of operation support
system>

FIG. 9 is a sequence diagram illustrating a
fifth example of operation of the vehicle operation
support system 1 for closing the door 320 of the
railway vehicle 300 and the platform door 232 upon
20 departure of the railway vehicle 300 from the
station 200. In this example, the transmission
apparatus 318 and the control apparatus 322 of two
different vehicles 300B are referred to as
transmission apparatuses 318-1, 318-2 and control
25 apparatuses 322-1, 322-2.

[0203]

As illustrated in FIG. 9, the passenger
information acquisition apparatus 308 obtains
congestion situation information after the railway
30 vehicle 300 departs from the station 200 and before
the railway vehicle 300 arrives at the next station
200, and determines whether the degree of congestion
of the passengers in the vehicle 300B is relatively
high for each vehicle 300B of the railway vehicle
35 300. In this example, the passenger information
acquisition apparatus 308 determines that the degree
of congestion of the vehicle 300B (hereinafter

referred to as a "first vehicle 300B") corresponding to the transmission apparatus 318-1 and the control apparatus 322-1 is relatively low. The passenger information acquisition apparatus 308 determines
5 that the degree of congestion of the vehicle 300B (hereinafter referred to as a "second vehicle 300B") corresponding to the transmission apparatus 318-2 and the control apparatus 322-1 is relatively high. Therefore, the passenger information acquisition
10 apparatus 308 outputs the congestion signal of the second vehicle 300B to the transmission apparatus 314 (step S802).

[0204]

When the transmission apparatus 314 receives
15 the congestion signal of the second vehicle 300B from the passenger information acquisition apparatus 308, the transmission apparatus 314 transmits a close start delay and open time extension command to the transmission apparatus 318-2 corresponding to
20 the second vehicle 300B (step S804).

[0205]

When the transmission apparatus 318-2 receives the close start delay and open time extension command from the transmission apparatus 314, the
25 transmission apparatus 318-2 relays the close start delay and open time extension command and transmits it to the control apparatus 322-2 (step S806).

[0206]

The steps S808 to S812 are the same as the
30 steps S402 to S406, respectively, of FIG. 5, and accordingly, the description thereof is omitted.

[0207]

When the transmission apparatus 314 receives the close command from the station 200 (the
35 integrated control apparatus 212) through the communication apparatus 306, the transmission apparatus 314 relays the close command and transmits

it to the transmission apparatus 318 (the
transmission apparatuses 318-1, 318-2) (step S814).
[0208]

When the transmission apparatus 318 (the
5 transmission apparatuses 318-1, 318-2) receives the
close command from the transmission apparatus 314,
the transmission apparatus 318 relays the close
command and transmits it to the control apparatus
322 (the control apparatus 322-1, 322-2) (step S816).
10 [0209]

When the control apparatus 322-1 receives the
close command from the transmission apparatus 318-1,
the control apparatus 322-1 immediately outputs a
control command to the actuator of the door 320 to
15 be controlled as usual, and closes the door 320 at a
normal closing speed (step S818).
[0210]

When the control apparatus 322-2 receives the
close command from the transmission apparatus 318-2
20 and a predetermined period of time elapses from the
reception, the control apparatus 322-2 outputs a
control command to the actuator of the door 320 to
be controlled and closes the door 320 at a closing
speed smaller than normal (step S820).
25 [0211]

The control apparatus 322-1 completes the
closing operation of the door 320 (the door 320
included in the first vehicle 300B) in step S818,
and when the door 320 is in the fully closed state,
30 the control apparatus 322-1 outputs a full close
completion signal to the transmission apparatus 318
-1 (step S822).
[0212]

When the transmission apparatus 318-1 receives
35 the full close completion signal specifying the door
320 of the first vehicle 300B from the control
apparatus 322-1, the transmission apparatus 318-1

relays the full close completion signal and transmits it to the transmission apparatus 314 (step S824).

[0213]

5 When the transmission apparatus 314 receives from the transmission apparatus 318 a full close completion signal specifying the door 320 of the first vehicle 300B, the transmission apparatus 314 relays the full close completion signal and
10 transmits it to the station 200 (the integrated control apparatus 212) through the communication apparatus 306 (step S826).

[0214]

 The control apparatus 322-2 completes the
15 closing operation of the door 320 (the door 320 included in the second vehicle 300B) in step S820, and when the door 320 is in the fully closed state, outputs a full close completion signal to the transmission apparatus 318 (step S828).

20 [0215]

 When the transmission apparatus 318-2 receives the full close completion signal specifying the door 320 of the second vehicle 300B from the control apparatus 322-2, the transmission apparatus 318-2
25 relays the full close completion signal and transmits it to the transmission apparatus 314 (step S830).

[0216]

 When the transmission apparatus receives from
30 the transmission apparatus 318 a full close completion signal specifying the door 320 of the second vehicle 300B, the transmission apparatus 314 relays the full close completion signal and transmits it to the station 200 (the integrated
35 control apparatus 212) through the communication apparatus 306 (step S832).

[0217]

The steps S834 to S838 are the same as the steps S420 to S424, respectively, of FIG. 5, and accordingly, the description thereof is omitted.
[0218]

5 Thus, in the present embodiment, the control apparatus 322 (the transmission apparatus 314) can appropriately close the door 320 of the railway vehicle 300 in view of the degree of congestion for each vehicle 300B based on presence or absence of
10 the congestion signal.
[0219]

[Other examples of control method for closing operation of door and platform door]

The above-described first example (FIG. 5) to
15 fifth example (FIG. 9) may be combined as appropriate, or may be modified or changed as appropriate.
[0220]

For example, in the above-described second
20 example, a control method relating to the closing operation of the door 320 based on the support-required person detection signal from the image analysis apparatus 204 and the congestion signal from the passenger information acquisition apparatus
25 308 in the above-described fourth example may be employed.
[0221]

Further, for example, the control methods of the third to fifth examples described above may be
30 employed in the railway vehicle 300 in which the door 320 is closed only by a close command from the command apparatus 312 without relying on a close command from the station 200. In this case, upon receiving the close command from the command
35 apparatus 312, the control apparatus 322 may control the closing timing and the closing speed of the door 320 in such a manner as to reflect a close start

delay command, a close time shortening command, a close time extension command, and the like transmitted from the integrated control apparatus 212 to the railway vehicle 300.

5 [0222]

[Actions]

Next, actions of the vehicle operation support system 1 according to the present embodiment are explained.

10 [0223]

In the present embodiment, the control apparatus (for example, the integrated control apparatus 212 or the control apparatus 322) of the vehicle operation support system 1 controls the operation of the door 320 of the railway vehicle 300. Specifically, the control apparatus begins to close the door 320 of the railway vehicle 300 that is stopped at the station 200 based on at least one of the information related to the situation of the inside of the railway vehicle 300 and the information related to the situation of the platform of the station at which the railway vehicle 300 is at a stop (the station 200).

20 [0224]

25 Thus, the control apparatus can start to close the door 320 of the railway vehicle 300 in view of, for example, the time required for passengers on the railway vehicle 300 to get off the railway vehicle 300 and the time required for passengers to get on the railway vehicle 300 from the platform. Therefore, the control apparatus can more appropriately control the operation of the door 320 of the railway vehicle 300 according to various situations.

30 [0225]

Furthermore, in the present embodiment, the control apparatus may vary at least one of the

timing of start of closing and the closing speed of the door 320 of the railway vehicle 300 stopped at the station 200 based on at least one of the information about the situation of the inside of the railway vehicle 300 and the information about the situation of the platform of the station 200.
[0226]

Thereby, the control apparatus can adjust the timing for starting to close the door 320 of the railway vehicle 300 and the closing speed in view of, for example, the time required for passengers on the railway vehicle 300 to get off the railway vehicle 300 and the time required for passengers to get on the railway vehicle 300 from the platform.
[0227]

Furthermore, in the present embodiment, the control apparatus may vary at least one of the timing of start of closing and the closing speed of the door 320 of the railway vehicle 300 stopped at the station 200 for each of multiple open doors 320 of the railway vehicle 300 or for each of multiple door groups into which the multiple doors 320 are grouped and each of which includes adjacent doors 320 of the multiple doors 320, based on at least one of the information of the situation of the inside of the railway vehicle 300 and the information of the situation of the platform of the station 200.
[0228]

Thus, the control apparatus can take into account the difference in the time required for passengers of the railway vehicle 300 to get off the railway vehicle 300 or the time required for passengers to get on the railway vehicle 300 from the platform for each door 320 or each door group that is open at the station 200. Therefore, the control apparatus can more appropriately close the door 320 of the railway vehicle 300 in accordance

with the difference.

[0229]

Furthermore, in the present embodiment, the control apparatus may vary at least one of the
5 timing of start of closing and the closing speed of the door of the railway vehicle stopped at the station, based on the situation of passengers who get on and get off through the door, which is determined from at least one of the information
10 about the situation of the inside of the railway vehicle 300 and the information about the situation of the platform at the station.

[0230]

Thereby, the control apparatus can adjust the
15 closing timing and the closing speed of the door 320 of the vehicle 300B in accordance with the situation of the passengers who get on and get off through the door 320, such as presence or absence of the passengers who get on and get off through the door
20 320 and the passengers who get on and get off through the door 320. Thus, the control apparatus can more appropriately close the door 320 of the railway vehicle 300 in accordance with the situation of the passengers who get on or get off through the
25 door 320.

[0231]

Further, in the present embodiment, the control apparatus may vary at least one of the timing of start of closing and the closing speed of the door
30 320 of the railway vehicle 300 stopped at the station 200, based on presence or absence of a specific target person in need of support in the vicinity of the door 320, which is determined from at least one of the information about the situation
35 of the inside of the railway vehicle 300 and the information about the situation of the platform of the station 200.

[0232]

Accordingly, the control apparatus can, for example, relatively delay the closing timing of the door 320 or slow the closing speed of the door 320 when a particular subject in need of support is in the vicinity of the door 320. Thus, the control apparatus can more appropriately close the door 320 of the railway vehicle 300 in response to presence or absence of a particular subject in need of support.

[0233]

Furthermore, in the present embodiment, the control apparatus may vary at least one of the timing of start of closing and the closing speed of the door 320 of the railway vehicle 300 stopped at the station 200, based on the degree of possibility of rush rides through the door 320, which is determined from the information about the situation of the platform of the station 200.

[0234]

Thus, for example, when there is a high possibility of rush rides through the door 320, the control apparatus can relatively delay the timing for starting to close the door 320 and increase the closing speed, or can relatively accelerate the timing of start of closing and decrease the closing speed. Thus, the control apparatus can more appropriately close the door 320 of the railway vehicle 300 to match the likelihood of rush state.

[0235]

Furthermore, in the present embodiment, the control apparatus may vary at least one of the timing of start of closing and the closing speed of the door of the railway vehicle 300 stopped at the station 200, based on the congestion situation of the inside of the railway vehicle 300 before or during the stop at the station 200 at which the

railway vehicle 300 is stopped, as determined from the information about the situation of the inside of the railway vehicle 300.

[0236]

5 Thus, for example, when the degree of congestion inside the vehicle 300B is relatively high and it takes time for passengers to get off, the control apparatus can delay the closing timing or reduce the closing speed of the door 320 of the
10 vehicle 300B. Therefore, the control apparatus can secure a relatively long embarkation and disembarkation time for the vehicle 300B with a relatively high degree of congestion, thereby improving convenience for passengers. Furthermore,
15 the control apparatus can reduce the delay of the railway vehicle 300 caused by, for example, a baggage or the like being caught in the closing door 320 caused by a passenger trying to get on the railway vehicle 300 in a hurry, thereby achieving a
20 proper operation of the railway vehicle 300.

[0237]

 Furthermore, in the present embodiment, the information about the external situation of the railway vehicle 300 may include at least one of
25 image information of the camera 202 for capturing images of the platform of the station 200 where the railway vehicle 300 is stopped, information about the tendency of congestion of passengers who get on or get off for each of multiple sections in the
30 longitudinal direction of the platform of the station 200, and information about an entrance to or an exit from the platform of the station 200.

[0238]

 Thus, the control apparatus can appropriately
35 control the closing timing and the closing speed of the door 320 of the railway vehicle 300 in such a manner as to reflect the information.

[0239]

Furthermore, in the present embodiment, the information about the situation of the inside of the railway vehicle 300 may include at least one of
5 measurement information about the weight of the railway vehicle 300 and image information of a camera for capturing images in the railway vehicle 300.

[0240]

10 Thus, the control apparatus can appropriately control the closing timing and closing speed of the door 320 of the railway vehicle 300 in such a manner as to reflect the information.

[0241]

15 Furthermore, in the present embodiment, the control apparatus (the integrated control apparatus 212) may be communicably connected, outside the railway vehicle 300, to the railway vehicle 300, and may close the door 320 of the railway vehicle 300 by
20 transmitting a command to the railway vehicle 300.

[0242]

Thus, the control apparatus (the integrated control apparatus 212) can control the closing operation of the door 320 of the railway vehicle 300
25 from the outside of the railway vehicle 300. Therefore, the control apparatus can easily reflect various information related to the situation of the platform of the station 200, and as a result, the closing operation of the door 320 of the railway
30 vehicle 300 can be controlled more appropriately.

[0243]

In addition, in the present embodiment, according to closing of the door 320, the control apparatus may close the platform door 232 provided
35 on the platform of the station 200 where the railway vehicle 300 is stopped.

[0244]

Thus, the control apparatus can synchronize the closing operation of the door 320 with the closing operation of the platform door 232. Furthermore, for example, the control apparatus can close the platform door 232 without depending on the operation of the command apparatus 220, not only in response to a satisfaction of a condition related to the command from the command apparatus 220 but also in response to a satisfaction of a condition related to synchronization with the closing operation of the door 320. Therefore, the control apparatus can reduce the load on the station employee and the conductor, and can reduce occurrences of closing operations of the platform door 232 at inappropriate timing due to an operation error of the command apparatus 220 caused by failure of confirmation by the conductor.

[0245]

Furthermore, in the present embodiment, when the railway vehicle 300 stops at the station 200, the control apparatus may open the platform door 232 when the control apparatus determines that the door 320 is situated at a position corresponding to the platform door 232 of the station 200 based on information about the relationship in position between the platform door 232 provided at the station 200 and the door 320 of the railway vehicle 300, and the control apparatus may keep the platform door 232 closed when the control apparatus determines that the door 320 is not situated at a position corresponding to the platform door 232 of the station 200.

[0246]

Thus, for example, with the control apparatus, even if the length of the railway vehicle 300 is relatively short (i.e., the number of vehicles 300B is relatively small) and no railway vehicle 300 is

present at a position corresponding to the platform door 232, the platform door 232 at such a position can be prevented from opening. Furthermore, for example, with the control apparatus, even if the position where the railway vehicle 300 stops is inappropriate and there is a deviation beyond a reference level between the position of the platform door 232 and the position of the door 320, the platform door 232 can be prevented from opening.

10 [0247]

Furthermore, in the present embodiment, information about the relationship in position between the platform door 232 of the station 200 and the door 320 of the railway vehicle 300 may include image information of the camera 202 for capturing images of the platform of the station 200 and the railway vehicle 300 stopped at the platform.

[0248]

Thus, the control apparatus can appropriately control the opening operation of the platform door 232 based on the image information of the camera 202.

[0249]

Although the embodiment has been described in detail above, the present disclosure is not limited to the particular embodiment, and various modifications and changes can be made without departing from the scope of the subject matter of the claims.

30 REFERENCE SIGNS LIST

[0250]

- 1 vehicle operation support system
- 100 operation management apparatus
- 200 station
- 35 202 camera (first camera, third camera)
- 204 image analysis apparatus
- 206 image transmission apparatus

208 display apparatus
210 communication apparatus
212 integrated control apparatus (control
apparatus)
5 214 display apparatus
216 communication apparatus
218 platform door control panel
220 command apparatus
222 vehicle detection apparatus
10 230 platform door system
232 platform door
234, 234-1, 234-2 control apparatus
300 railway vehicle
300A driver's console
15 300B vehicle
302 communication apparatus
304 display apparatus
306 communication apparatus
308 passenger information acquisition apparatus
20 310 platform detection apparatus
312 command apparatus
314 transmission apparatus
316 notification apparatus
318, 318-1, 318-2 transmission apparatus
25 320, 320-1, 320-2 door
322, 322-1, 322-2 control apparatus

WHAT IS CLAIMED IS:

1. A control apparatus for controlling an operation of a door of a railway vehicle,
5 wherein the door of the railway vehicle stopped at a station starts to be closed based on at least one of: information about a situation of an inside of the railway vehicle; and information about a situation of a platform of the station at which the
10 railway vehicle is stopped.

2. The control apparatus according to claim 1, wherein at least one of timing of start of closing and a closing speed of the door of the railway
15 vehicle stopped at the station is varied based on at least one of: the information about the situation of the inside of the railway vehicle; and the information about the situation of the platform of the station at which the railway vehicle is stopped.

20 3. The control apparatus according to claim 2, wherein the door includes a plurality of doors, and for each of the plurality of doors that are open or for each of a plurality of door groups into
25 which the plurality of doors are grouped and each of which includes adjacent doors of the plurality of doors, at least one of the timing of the start of closing and the closing speed of each of the plurality of doors or each of the plurality of door
30 groups of the railway vehicle stopped at the station is varied based on at least one of: the information about the situation of the inside of the railway vehicle; and the information about the situation of the platform of the station at which the railway
35 vehicle is stopped.

4. The control apparatus according to claim 2

or 3, wherein the at least one of the timing of
start of closing and the closing speed of the door
of the railway vehicle stopped at the station is
varied based on a situation of passengers who get on
5 and get off through the door, the situation being
determined from at least one of: the information
about the situation of the inside of the railway
vehicle; and the information about the situation of
the platform of the station at which the railway
10 vehicle is stopped.

5. The control apparatus according to any one
of claims 2 to 4, wherein the at least one of the
timing of start of closing and the closing speed of
15 the door of the railway vehicle stopped at the
station is varied based on particular target person
information indicative of whether there is a
particular target person who is in need of support
in proximity to the door, the particular target
20 person information being determined from at least
one of: the information about the situation of the
inside of the railway vehicle; and the information
about the situation of the platform of the station
at which the railway vehicle is stopped.

25
6. The control apparatus according to any one
of claims 2 to 5, wherein the at least one of the
timing of start of closing and the closing speed of
the door of the railway vehicle stopped at the
30 station is varied based on a degree of possibility
of an occurrence of a passenger who rushes into the
railway vehicle through the door that has already
started to be closed, the degree of possibility
being determined from the information about the
35 situation of the platform of the station at which
the railway vehicle is stopped.

7. The control apparatus according to any one of claims 2 to 6, wherein the at least one of the timing of start of closing and the closing speed of the door of the railway vehicle stopped at the station is varied based on a congestion situation of an inside of the railway vehicle before the railway vehicle stops at the station or when the railway vehicle is stopped at the station, the congestion situation being determined from the information about the situation of the inside of the railway vehicle.

8. The control apparatus according to any one of claims 1 to 7, wherein the information about the situation of the inside of the railway vehicle includes at least one of: image information of a first camera configured to capture an image of a platform of the station at which the railway vehicle is stopped; information about a tendency of congestion of passengers who get on or get off for each of a plurality of sections in a longitudinal direction of the platform of the station; and information about an entrance to or an exit from the platform of the station.

9. The control apparatus according to any one of claims 1 to 8, wherein the information about the situation of the inside of the railway vehicle includes at least one of: measurement information about a weight of the railway vehicle and image information of a second camera configured to capture an image in the railway vehicle.

10. The control apparatus according to any one of claims 1 to 9, wherein the control apparatus is communicably connected, outside the railway vehicle, to the railway vehicle, and is configured to close

the door of the railway vehicle by transmitting a command to the railway vehicle.

11. The control apparatus according to any one
5 of claims 1 to 10, wherein the control apparatus closes, according to closing of the door, a platform door provided on the platform of the station at which the railway vehicle is stopped.

10 12. The control apparatus according to any one of claims 1 to 11, wherein when the railway vehicle stops at the station, the control apparatus opens a platform door provided at the station when the control apparatus determines that the door of the
15 railway vehicle is situated at a position corresponding to the platform door of the station based on information about a relationship in position between the platform door of the station and the door of the railway vehicle, and
20 the control apparatus keeps the platform door closed when the control apparatus determines that the door is not situated at the position corresponding to the platform door of the station.

25 13. The control apparatus according to claim 12, wherein the information about the relationship in position between the platform door of the station and the door of the railway vehicle includes image information of a third camera configured to capture
30 an image including: the platform of the station at which the railway vehicle is stopped; and the railway vehicle stopped at the platform.

14. A control method executed by a control
35 apparatus configured to control an operation of a door of a railway vehicle, the control method comprising:

starting to close the door of the railway
vehicle stopped at a station, based on at least one
of: information about a situation of an inside of
the railway vehicle; and information about a
5 situation of a platform of the station at which the
railway vehicle is stopped.