

DESCRIPTION**TITLE OF THE INVENTION:** INFORMATION DISPLAY DEVICE**TECHNICAL FIELD**

[0001]

The present invention relates to an information display device that provides various categories of information to passengers in a vehicle such as a railroad vehicle.

BACKGROUND ART

[0002]

As services to passengers of railroads or the like, various categories of information such as operating conditions, current location, or the like are provided by using information display devices installed in vehicles. An information display device is installed, for example, in space above an entrance door, the space above a passage, or the like, and displays information by using a display device such as a Light Emitting Diode (LED) or a Liquid Crystal Display (LCD). Display contents and their switching timing are provided separately from a control device installed in a train, and delivered to each information display device.

[0003]

Conventionally, this delivery from the control unit is performed through a network that uses wires. As a result, installation of information display devices in an existing vehicle requires burdensome wiring work. Further, installation of equipment such as network equipment is required also.

[0004]

To simplify installation work in an existing vehicle, for example the system described in Patent reference 1 uses a wireless Local Area Network (LAN). This system simplifies installation by partially using a wireless LAN for delivering information to information display devices.

PRIOR ART REFERENCE

PATENT REFERENCE

[0005]

PATENT REFERENCE 1: Japanese Patent Publication No. 5480771 (Paragraphs 0012 - 0035, Fig. 1)

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0006]

However, a wireless system using radio wave has difficulty in communication between vehicles, and thus wiring work is still required at key portions of a LAN that connect vehicles with each other. In addition, work is required for installing network control equipment such as a wireless LAN access point or a DHCP server. Further, it is necessary to install RFID tags for identifying installation positions in vehicles, and this requires time and effort for installation work of RFID tags and for issuing and managing RFI tags, for example. Accordingly, a system using a wireless LAN can have only a partial effect in simplification from a viewpoint of the whole installation work.

[0007]

Further, a currently-prevailing wireless LAN system uses

a radio wave of the ISM band. The ISM band is originally a band for a radio source of non-communication use. Accordingly, it should be taken as the premise that stable communication is not possible due to interference of another radio source when a wireless LAN system is used for a communication purpose.

[0008]

Further, since a radio wave can be used without a license when some requirements are satisfied, the ISM band is also used for various communication purposes. In particular, owing to the widespread use of smartphones and tablet terminals having a plurality of wireless communication functions in addition to a wireless function for original telephone communication, there are a lot of radio waves of a wireless LAN, Bluetooth, and the like within a train. Thus it is possible that these interfere with the wireless LAN, to make communication unstable.

[0009]

In addition, considering along a railroad, vehicles themselves that a train or a passing train has become sources of radio disturbance; and facilities such as overhead wires or power lines, and the like become sources of radio disturbance. Accordingly, it is difficult to use stably a wireless LAN that uses a radio wave.

[0010]

Thus, an object of the present invention is to provide an information display device that is easy in installation work and hardly affected by radio wave interference.

MEANS OF SOLVING THE PROBLEM

[0011]

One mode of the present invention provides an information display device for transmitting and receiving data to and from one another, comprising: a display panel that displays information; and a plurality of optical communication modules that perform transmission and reception of the data including the information to be displayed on the display panel by wireless using light; wherein, the plurality of optical communication modules include a first optical communication module directed in a first direction and a second optical communication module directed in a different direction from the first direction; and the data received by the first optical communication module is transmitted from the second optical communication module.

EFFECTS OF THE INVENTION

[0012]

According to the present invention, by using optical communication, it is possible to provide an information display device that is easy in installation work and hardly affected by radio wave interference.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a block diagram showing schematically a configuration of an information display device according to a first and a second embodiments;

Fig. 2 is a schematic diagram showing an example of a hardware configuration of the information display device according to the first and the second embodiments;

Fig. 3 is a schematic view showing an example of an outer configuration of the information display device of the first embodiment when the information display device is made to be a so-called hanging type device that is placed in space above a passage;

Fig. 4 is a schematic diagram showing an example in which the information display devices of the first embodiment are placed in vehicles;

Fig. 5 is a schematic diagram for explaining a communicable angle of an optical communication part in the information display device of the first embodiment;

Fig. 6 is a schematic diagram for explaining a communicable angle of an optical communication part in the information display device of the first embodiment;

Fig. 7 is a flowchart showing data transmission and reception control of the information display device of the first embodiment;

Fig. 8 is a flowchart showing data transmission and reception control of the information display device of the second embodiment;

Fig. 9 is a block diagram showing schematically a configuration of an information display device according to a third – a fifth embodiments;

Fig. 10 is a schematic diagram showing an example of a hardware configuration of the information display device of the first – the third embodiments;

Fig. 11 is a schematic view showing an example of an outer configuration of the information display device of the third embodiment when the information display device is made to be a so-called above-entrance-door installation type device that is placed above an entrance door;

Fig. 12 is a schematic diagram showing an example in which the information display devices of the third embodiment are placed in vehicles;

Fig. 13 is a flowchart showing data transmission and reception control of the information display device of the third embodiment;

Fig. 14 is a diagram showing an example of connection information in the third embodiment;

Fig. 15 is a diagram showing an example of update of the connection information in the third embodiment;

Fig. 16 is a flowchart showing connection information transmission and reception control for detecting an installation position in the third embodiment;

Fig. 17 is a schematic view showing an example of an outer configuration of the information display devices of the fourth embodiment when the information display devices are made to be so-called above-gangway installation type devices that are placed above a gangway between vehicles; and

Fig. 18 is a schematic diagram showing arrangement of the information display devices of the fourth embodiment in a train.

MODE FOR CARRYING OUT THE INVENTION

[0014]

FIRST EMBODIMENT

Fig. 1 is a block diagram showing schematically a configuration of an information display device 100 as an information display device according to a first embodiment. Reference characters shown in parentheses indicate components in a second embodiment.

[0015]

The information display device 100 has one or more display parts 101; a display data switching part 104; a control part 105; one or more optical communication parts 106; and a storage part 107.

The storage part 107 has a data accumulation part 102; and a data storage part 103.

A plurality of information display devices 100 are installed in a vehicle.

The display data switching part 104 is an example of a display control part.

[0016]

The display part 101 displays various categories of information. The information includes character information, image information, or the like.

[0017]

The data accumulation part 102 stores data for displaying information on the display part 101, data for identifying position and the like of the information display device 100, and the like.

[0018]

The data storage part 103 stores data for processing in the information display device 100. For example, the data stored in the data storage part 103 are information such as temporary data used by the control part 105, data transmitted and received by the information display device 100, or intermediate values of arithmetic operation.

[0019]

The display data switching part 104 causes the display part

101 to display information, based on the data stored in the data accumulation part 102. Further, the display data switching part 104 switches information displayed on the display part 101.

[0020]

The control part 105 controls processing in the information display device 100. For example, the control part 105 controls communication performed by the optical communication part 106 with another information display device 100, data accumulation performed by the storage part 107, and the like. Further, displaying of information on the display part 101, switching of display depending on the location and conditions of the train, and the like, which are performed by the display data switching part 104, are controlled by the control part 105.

[0021]

The optical communication part 106 performs wireless communication using light. For example, the optical communication part 106 is installed to face another information display device 100. The optical communication part 106 performs optical space communication or optical wireless communication. The “optical space communication” is optical communication utilizing space propagation. The “optical wireless communication” is communication using a light ray, which is one type of wireless communication. In other words, the optical communication part 106 performs communication without using a communication path such as optical fiber. Here, the “communication path” means a medium for transferring information from a transmitter of the information to a recipient.

[0022]

Typically, the optical communication part 106 has a light emitting element and a light receiving element. A pair of optical communication parts 106 positioned to face each other perform one-to-one communication. However, many other variations can be considered.

[0023]

The storage part 107 has the data accumulation part 102 and the data storage part 103 as components.

[0024]

Fig. 2 is a schematic diagram showing an example of a hardware configuration of each information display device 100.

[0025]

Each information display device 100 has one or more display panels 11; a CPU 15; one or more optical communication modules 16; and a memory 17.

The memory 17 includes a nonvolatile memory 12 and a volatile memory 13.

In Fig. 2, reference characters shown in parentheses indicate components in the second embodiment.

[0026]

The CPU 15 functions as a processor. The processor is hardware for executing instruction sets described in software programs. Although one CPU is used in Fig. 2, a plurality of CPUs 15 may be employed to perform processing.

[0027]

For example, the display part 101 can be substantiated when the CPU 15 uses the display panel 11. For example, the display part 101 is substantiated when the CPU 15 takes out image data

from the nonvolatile memory 12 and renders the image data on the display panel 11.

[0028]

The data accumulation part 102 of Fig. 1 can be substantialized when the CPU 15 uses the nonvolatile memory 12. That is to say, by storing and reading data to and from the nonvolatile memory 12 by the CPU 15, the data accumulation part 102 can store and read display data, installation information, or information such as order of data transfer.

[0029]

The data storage part 103 of Fig. 1 can be substantialized when the CPU 15 uses the volatile memory 13. That is to say, by storing and reading data to and from the volatile memory 13 by the CPU 15, the data storage part 13 can store communication data or information such as intermediate values of arithmetic operation.

[0030]

The display data switching part 104 and the control part 105 of Fig. 1 can be substantialized when the CPU 15 reads programs stored in the nonvolatile memory 12 into the volatile memory 13 and executes those programs. That is to say, the CPU 15 selects image data to be displayed on the display panel 11 depending on a lapse of time, a traveling location of the vehicle, conditions of the vehicle, and renders the selected image data on the display panel 11. In other words, the CPU 15 of Fig. 2 has the functions of the display data switching part 104 and the control part 105 of Fig. 1.

[0031]

The optical communication part 106 of Fig. 1 can be

substantialized when the CPU 15 uses the optical communication module 16. That is to say, the CPU 15 sends data, which the CPU 15 desires to transmit, to the optical communication module 16. Further, the CPU 15 receives data received by the optical communication module 16. By these operations, the optical communication part 106 can perform wireless communication using light. At that time, depending on the type of the optical communication module 16, there is either a case where the CPU 15 sends and receives information as data to and from the optical communication module 16, or a case where the CPU 15 performs conversion into the level of a blinking signal so as to control the optical communication module 16 directly.

[0032]

In the case where the CPU 15 sends and receives information as data to and from the optical module 16, the CPU 15 delivers data to be transmitted in the form of character data or numerical data to the optical communication module 16. Then, the optical communication module 16 converts the data into a blinking light of a prescribed format to transmit the converted data. At the time of receiving data, the optical communication module 16 receives blinking of light, and measures the blinking pattern. When the received blinking signal coincides with a blinking signal of a prescribed format, the received data is interpreted as character data or numerical data. Then, the data whose interpretation has been finished by the optical communication module 16 is received by the CPU 15.

[0033]

In the case where the optical communication module 16 is directly controlled by converting the data into the level of a blinking

signal, usually the optical module 16 has simply a light emitting element and a light receiving element. The CPU 15 converts the data to be transmitted into an ON signal or an OFF signal of a prescribed format. Further, the CPU 15 adds a control signal for the optical communication module 16, and outputs the signal to a control terminal of the light emitting element to cause the light emitting element to blink directly.

[0034]

At the time of receiving data, for example, an electric signal outputted by the light receiving element is measured and the times of turning-on and turning-off of the received light are recorded. The CPU 15 finds out a pattern of the ON signal or OFF signal of the prescribed format from the record of the times of turning-on and turning-off, to interpret the pattern as data. Such a method is usually used in the case where a relatively simple optical signal format such as a format in an infrared remote controller of a home electric appliance is used.

[0035]

Although an example of a blinking light signal has been described, it can be considered to use another method utilizing change of color, change of the number of light emitting points, or a configuration of light emitting points, for example.

[0036]

Referring to Fig. 2, the description has been given taking an example where the display data switching part 104 and the control part 105 are substantialized when the CPU 15 executes the programs. However, the embodiment is not limited to this example.

[0037]

For example, all or a part of the functions of the display data switching part 104 and the control part 105 may be substantialized by hardware using an integrated logic IC such as Application Specific Integrated Circuits (ASIC) or a Field Programmable Gate Array (FPGA), based on instructions of the CPU 15. Alternatively, all or a part of the functions of the display data switching part 104 and the control part 105 may be substantialized by software used by a Digital Signal Processor (DSP), based on instructions of the CPU 15.

[0038]

Fig. 3 is a schematic view showing an example of an outer configuration of the information display device 100.

Fig. 3 shows a hanging type information display device 100. Here, the "hanging type" means hanging of a poster or the like in space above a passage of a train or a bus, for example.

In Fig. 3, the direction Df indicates the front side of a vehicle, and the direction Db the rear side of the vehicle.

[0039]

In this example, the information display device 100 is installed in space above a passage of a vehicle. Further, the information display device 100 has a display part 101a in the front surface of the information display and a display part 101b in the rear surface of the information display device 100, so that it is easy to see the display parts from both of the front side and the rear side.

[0040]

Further, other information display devices 100 are placed on the front and rear sides of this information display device 100. Accordingly, optical communication parts 106a and 106b are

positioned to face forward and backward, respectively. In other words, the optical communication parts 106a and 106b are positioned to face in the different directions from each other. Here, the optical communication parts 106a and 106b are positioned to face opposite directions from each other. That is to say, the optical communication part 106 faces in the direction Df, and the optical communication part 106b in the direction Db.

[0041]

In Fig. 3, the optical communication parts 106a and 106b are positioned in the upper parts of the information display device 100. This is for the purpose of positioning an optical communication path near the ceiling, so that communication is not prevented by passengers or their luggage. Here, the "optical communication path" means space through which light used for optical communication passes.

[0042]

In the case where a structural object or the like exists on the ceiling and becomes a blockage or where optical communication is performed through a gangway that connects vehicles with each other, the optical communication parts 106 can be positioned in the lower parts of the information display device 100. Alternatively, the optical communication parts 106 may be positioned to project from the information display device 100. The "gangway" means a passage provided in a connection part of a train, through which passengers can move between vehicles.

[0043]

Fig. 4 is a schematic diagram showing an example of arrangement of the information display devices 100 shown in Fig. 3, which are

installed in vehicles 901a and 901b. Fig. 4 is a schematic view of a train 900 seen in the lateral direction.

[0044]

The train 900 is usually operated with a plurality of vehicles connected. For example, in Fig. 4, the train 900 has the vehicle 901a and the vehicle 901b that are connected with each other by a coupler (not shown). When it is not necessary to differentiate the vehicle 901a and the vehicle 901b, they are referred to as vehicle(s) 901. Some trains 900 are of a small scale having only one vehicle 901, while other trains 900 are of a large scale having dozens of vehicles 901.

[0045]

For the sake of explanation, Fig. 4 shows an example where the train 900 has two vehicles 901. In Fig. 4, reference characters in parentheses indicate examples in the second embodiment.

[0046]

The information display devices 100 are arranged along the passages of the vehicles 901. Further, the information display devices 100 are arranged dispersedly in the longitudinal direction of the vehicles 901. In other words, the information display devices 100 are arranged at intervals in the longitudinal direction of the vehicles 901.

[0047]

Further, the information display devices 100 are installed so that display surfaces of the display parts 101 face each other, for example. Here, three information display devices 100 are installed for each vehicle 901. In the train 900 as a whole, six information display devices 100a, 100b, 100c, 100d, 100e, and 100f

are installed.

[0048]

Further, in the head or the tail of the train 900, a train operation system 910 is placed. The train operation system 910 functions as an information processing device.

[0049]

The train operation system 910 transmits data to the information display device 100a placed in the neighborhood by using optical communication or another interface (not shown). Alternatively, it is also possible that an operator 930 has a terminal device 920 as an information processing device, and transmits data from the terminal device 920 to the information display device 100a by using optical communication or another interface (not shown).

[0050]

The "interface" is what determines a connection form for connecting a plurality of devices to perform communication. Here, the interface is a form of communication between the information display device 100a and the train operation system 910 or the terminal device 920. The above-mentioned "another interface" means wired or wireless communication, for example.

[0051]

In the example shown in Fig. 4, the information display device 100c and the information display device 100d communicate with each other through the connection part between the vehicles. In this case, an optical communication part 106 of the information display device 100c and an optical communication part 106 of the information display device 100d are positioned so that each optical communication part can see the other optical communication part. In other words,

nothing interrupts light used for communication between the optical communication part 106 of the information display device 100c and the optical communication part 106 of the information display device 100d. Accordingly, light emitted from the optical communication part 106 of the information display device 100c can reach the optical communication part 106 of the information display device 100d. Which allows optical communication.

[0052]

Optical communication through a connection part of vehicles is also affected by conditions of the train 900. Fig. 5 and Fig. 6 are schematic diagrams for explaining a communicable angle of an optical communication part 106 of the information display device 100. Both Fig. 5 and Fig. 6 are schematic diagrams of vehicle(s) seen from above. Description will be given referring to Fig. 5 and Fig. 6.

[0053]

The information display device 100c is mounted in the end area in the longitudinal direction of the vehicle 901a. The information display device 100c has the optical communication part 106b. The optical communication part 106b is directed toward the adjacent vehicle 901b.

[0054]

Further, the information display device 100d is mounted in the end area in the longitudinal direction of the vehicle 901b. The information display device 100d has the optical communication part 106a. The optical communication part 106a is directed toward the adjacent vehicle 901a.

[0055]

The optical communication part 106b can emit light used for communication in the range of an effective angle ANG. In other words, the effective angle ANG is an angle that allows the optical communication part 106 to perform communication.

[0056]

As shown in Fig. 6, the optical communication part 106b of the information display device 100c emits light toward the optical communication part 106a of the information display device 100d. Further, the optical communication part 106a of the information display device 100d emits light toward the optical communication part 106b of the information display device 100c.

[0057]

When the optical communication part 106a of the information display device 100d goes out of this range (effective angle ANG) from the position where the optical communication part 106a faces the optical communication part 106b of the information display device 100c, communication between them stops. Accordingly, for example, to perform communication during operation of the train 900, it is necessary to set the effective angle ANG so that the optical communication part 106a remains in the range allowing communication even if the angle of the vehicle 901b to the vehicle 901a becomes the assumed maximum value while the train 900 is moving.

[0058]

When the train 900 is in a curved section of a railroad, vehicles 901 adjacent to each other in the longitudinal direction of the train 900 are not aligned in a line, but have a positional relationship of forming an angle with each other.

[0059]

The angle between the vehicles 901 when the train 900 is in a curved section of a railroad is determined by the vehicle length, the curvature radius of the railroad, and the inclination amounts of cant and the vehicles 901 themselves.

The vehicle length is the length of a vehicle and represents a distance between the coupling surfaces of one vehicle 901. The curvature radius represents a degree of curving of the railroad. The cant represents inward inclination of the railroad surface.
[0060]

In fact, in the operating section, the angle becomes maximum in a low-speed section having a small curvature radius. In that section, the inclination amounts of cant and the vehicles themselves are small. Accordingly, it is possible to calculate the angle between vehicles 901 approximately from the vehicle length and the curvature radius.

[0061]

A vehicle length and a minimum curvature radius that are standard are determined by each railroad company for each line. Thus, the maximum value of the angle between vehicles 901 (maximum angle between vehicles) in a train 900 traveling a specific line is expressed approximately by the equation (1).

[Equation 1]

$$\text{Maximum angle between vehicles} \approx 2 \times \tan^{-1} \frac{\text{Vehicle length} \div 2}{\text{Minimum curvature radius}} \quad (1)$$

[0062]

It is possible that the angle between vehicles 901 swings in a horizontal direction. In other words, the train 900 may turn to the right or to the left. Accordingly, the optical communication

part 106b requires that the effective angle ANG of optical communication is more than or equal to twice the maximum value of the angle between vehicles.

[0063]

That is to say, when the effective angle ANG of optical communication for the optical communication part 106b satisfies the equation (2), the optical communication part 106 can perform communication even if the train 900 is passing through a curved railroad section. In the equation (2), "Optical communication effective angle" represents the effective angle ANG of optical communication.

[Equation 2]

$$\text{Optical communication effective angle} > 4 \times \tan^{-1} \frac{\text{Vehicle length} \div 2}{\text{Minimum curvature radius}} \quad (2)$$

[0064]

For example, in the case where the standards for the target line are the vehicle length of 20 m, the minimum curvature radius of 400 m in a high-speed traveling section, and the minimum curvature radius of 100 m in a low-speed traveling section, the effective angle ANG of optical communication can be calculated by using the minimum curvature radius of 100 m in a low-speed traveling section of a large curvature. By applying the equation (2), it is found that the effective angle ANG of optical communication requires 28 degrees or more. Depending on conditions, for example, it is possible to use, in part, wired communication or wireless system for connecting the information display devices 100 with each other. Wired communication uses optical fiber, or electric wire, for example. Wireless system uses radio wave, for example.

[0065]

Fig. 7 is a flowchart showing data transmission and reception control of the information display device 100 in the first embodiment.

[0066]

First, in the step S10, the information display device 100 is in a reception standby state. When one of the optical communication parts 106 receives data, the processing proceeds to the step S11. For example, the information display device 100 shown in Fig. 3 has two optical communication parts 106a and 106b.

[0067]

In the step S11, the control part 105 causes the data storage part 103 to store optical communication part identification information D_1 for identifying the optical communication part 106 that has received data D_0 . Here, as the optical communication part identification information D_1 , information on the position of the optical communication part 106 arranged in the information display device 100 can be used.

[0068]

Next, in the step S12, the control part 105 causes the data accumulation part 102 to accumulate the received data D_0 .

[0069]

Next, in the step S13, the control part 105 selects an optical communication part 106 (transmission destination) to which the received data D_0 is to be transmitted. Here, for example, the control part 105 performs transmission from all the optical communication parts 106 that have not been used for receiving the data D_0 . Taking the information display device 100 shown in Fig. 3 as an example, in the case where the information display device 100 has received

the data by the optical communication part 106a, transmission is performed from the optical communication part 106b.

[0070]

In the step S14, the control part 105 sends the received data D_0 to the selected optical communication part 106, and causes the selected optical communication part 106 to transmit the data D_0 .

[0071]

Then, after completion of the transmission of the data D_0 , the control part 105 returns to the reception standby state (S10) again.

[0072]

Application of the control shown in Fig. 7 to the information display device 100 shown in Figs. 1 and 3 will be described.

[0073]

The information display device 100 in the reception standby state (S10) receives data D_0 by the optical communication part 106a.

[0074]

On receiving the data D_0 , the control part 105 causes the data storage part 103 to store optical communication part identification information D_1 of the optical communication part 106a that has received the data D_0 (S11).

[0075]

Then, the control part 105 causes the data accumulation part 102 to accumulate the received data D_0 (S12).

[0076]

Further, referring to the optical communication part identification information D_1 stored in the data storage part 103,

the control part 105 selects the optical communication part 106b that has not received the data D_0 (S13).

[0077]

Then, the control part 105 causes the optical communication part 106b, which is mounted on the back side, to transmit the received data D_0 (S14).

[0078]

That is to say, the information display device 100 of the first embodiment accumulates the received data D_0 . Then, the information display device 100 transfers the received data D_0 . The word "transfer" means that something that has been transmitted from one is further transmitted to another. Here, the data D_0 received by the optical communication part 106a is further transmitted from the optical communication part 106b to another information display device 100.

[0079]

For example, the information display device 100 transmits the received data D_0 in a direction different from the direction of the reception. In Fig. 4, the received data D_0 is transmitted in the opposite direction (direction Db) from the direction of the reception (direction Df).

[0080]

Hereinabove, the control within the information display device 100 has been described.

Next, control performed in the case where a plurality of information display devices 100 are installed in a train 900 will be described.

[0081]

For example, the information display devices 100 are placed as shown in Fig. 4. First transmission of data D_0 is started from the terminal device 920 of an operator or from the train operation system 910.

[0082]

In the case of data D_{01} that is accumulated in each information display device 100 before train operation, the operator 930 operates the terminal device 920 to transmit the data D_{01} first to the information display device 100a positioned at the end of the train 900 through optical communication or a dedicated interface. The data D_{01} in this case is initially-set data such as station names to display, door opening and closing guidance messages, or advertisements.

[0083]

Further, in the case of data D_{02} that depends on traveling locations of the train 900, the data D_{02} is transmitted from the train operation system 910 to the information display device 100a positioned at the end of the train 900 through optical communication or the dedicated interface. The data D_{02} in this case is data such as an instruction to switch display contents or an instruction to switch display depending on opening or closing guidance.

[0084]

The data D_{01} or the data D_{02} is an example of the data D_0 .

[0085]

The information display device 100a accumulates the received data D_0 in the data accumulation part 102. Further, the information display device 100a transfers the received data D_0 , for example, from the optical communication part 106 to the adjacent information

display device 100b.

[0086]

The information display device 100b, which has received the transferred data, accumulates the received data D_0 . Then, the information display device 100b transfers the data D_0 further to the adjacent information display device 100c.

[0087]

As described above, each of the information display devices 100 repeat transfer and accumulation in turn. Finally, the data D_0 is accumulated in all the six information display devices 100a - 100f installed within the train 900. Thus, only by transmitting the data D_0 to one information display device 100, it is possible to transmit the data D_0 to all the information display devices 100.

[0088]

SECOND EMBODIMENT

The first embodiment has been described as a case in which all the information display devices 100 accumulate the same data. However, sometimes it is convenient that the information display devices 100 have different data from one another. For example, it is the case where display contents are changed depending on vehicle numbers, door positions, or the like.

[0089]

As a case where display contents are changed depending on vehicle numbers, a case can be mentioned where display contents are changed depending on whether the vehicle in question is a non-reserved-seat vehicle or a reserved-seat vehicle, for example. Further, as a case where display contents are changed depending on door positions or the like, a case can be mentioned where such

a message as "Doors on this side will open at the next station" is displayed above the doors on the exit side for the next station, for example.

[0090]

As shown in Fig. 1, each information display device 200 in the second embodiment has one or more display parts 101; a display data switching part 204; a control part 205; one or more optical communication parts 106; and a storage part 107. The storage part 107 has a data accumulation part 102; and a data storage part 103.

[0091]

In each information display device 200 of the second embodiment, the display parts 101, the data accumulation part 102, the data storage part 103, and the optical communication parts 106 are similar to those in the information display device 100 of the first embodiment. Description of these components is replaced by the description in the first embodiment. In the following, the display data switching part 204 and the control part 205, which are different from those of the information display device 100 of the first embodiment, will be mainly described.

[0092]

The control part 205 performs processing similar to the processing performed by the control part 105 of the first embodiment. In addition, the control part 205 performs processing for identifying the position of its own device in a train 900.

[0093]

For example, the control part 205 identifies the position of its own device by a value of a position counter (count value) included in data D_0 received by the optical communication part 106.

In other words, the value of the position counter functions as position identification information D_2 that can identify the position of the information display device 100.

[0094]

The display data switching part 204 switches information displayed on the display part 101, based on the position identified by the control part 205.

[0095]

Fig. 8 is a flowchart showing data transmission and reception control of the information display device 200.

In the flowchart shown in Fig. 8, the same processes as those in the flowchart of the first embodiment shown in Fig. 7 are indicated by the same reference characters.

The processes of the step S10 to the step S13 in Fig. 8 are similar to those of the step S10 to the step S13 in Fig. 7. However, after the step S13, the processing proceeds to the process of the step S20. Description of the steps S10 - S13 is replaced by the description in the first embodiment.

[0096]

In the step S20, the control part 205 checks whether the received data D_0 includes the position counter D_2 .

[0097]

In the case where the position counter D_2 is included, the processing proceeds to the step S21. In Fig. 8, "YES" is selected in the step S20. In the case where the position counter D_2 is not included, the processing proceeds to the step S22. In Fig. 8, "NO" is selected in the step S20.

[0098]

In the step S21, the control part 205 causes the data storage accumulation part 102 to store the value of the position counter D_2 included in the received data D_0 . Further, the control part 205 increments the value of the position counter D_2 . For example, the control part 205 adds "1" to the value of the position counter D_2 . The value "1" added to the value of the position counter D_2 is, for example, a predetermined value.

[0099]

In the step S22, the control part 205 causes the optical communication part 106 that is selected in the step S13 to transmit the received data D_0 . At that time, in the case where the received data D_0 included the position counter D_2 , the value of the position counter D_2 , which is incremented in the step S21, is included in the data to be transmitted.

[0100]

Then, the control part 205 returns to the reception standby state (S10) again after completion of the transmission of the data D_0 .

[0101]

Here, the optical communication part 106 that is used for reception is not used for transmission so as to prevent endless transfer of the same data D_0 .

[0102]

Now, the position counter D_2 will be described.

[0103]

In the description given here, the data D_0 transmitted to the information display device 200a is represented by D_{0a} . Further, the data D_0 transmitted to the information display device 200b is

represented by D_{0b} . Further, the position counter D_2 transmitted to the information display device 200a is represented by D_{2a} . And, the position counter D_2 transmitted to the information display device 200b is represented by D_{2b} . Similar expressions will be used with respect to the other information display devices 200c - 200f.

[0104]

As an example, a case is taken where data D_{0a} in which "1" is set as the value of the position counter D_{2a} at the time of the initial setting before the start of operation is transmitted to the information display device 200a (See Fig. 4). The data D_{0a} is transmitted to the information display device 200a from the terminal device 920 of the operator 930 or the train operation system 910 through optical communication or a dedicated interface. The information display device 200a is an information display device 200 positioned at the end of the train 900.

[0105]

According to the flowchart shown in Fig. 8, the information display device 200a records, for example, the value "1" at the time of the initial setting of the position counter D_{2a} in the data accumulation part 102. Then, the information display device 200a adds "1" to the value of the position counter D_{2a} so that the value (of the position counter D_{2a}) becomes "2". Then, the information display device 200a transfers data D_{0b} including the position counter D_{2b} that has been changed to "2" to the adjacent information display device 200b.

[0106]

By repeating such processing sequentially, finally the value "1" of the position counter D_{21} through the value "6" of the position

counter D_{2f} are set to the information display device 200a through the information display device 200f respectively.

[0107]

The transferred data D_{0a} , D_{0b} , D_{0c} , D_{0d} , D_{0e} , and D_{0f} each include the position identification information (position counters D_{2a} , D_{2b} , D_{2c} , D_{2d} , D_{2e} , and D_{2f}) and starting point information. The position identification information (position counters D_{2a} , D_{2b} , D_{2c} , D_{2d} , D_{2e} , and D_{2f}) indicates positions of the information display devices 100 in the train 900. The starting point information is the value of the position counter D_{21} of the starting point. Here, the starting point is the position of the information display device 200a.

[0108]

Based on the position counter D_2 , each information display device 200 can know the position at which the information display device 200 itself is placed.

[0109]

For example, as shown in Fig. 4, three information display devices 200 are arranged for each vehicle. The information display devices 200 are arranged dispersedly in the longitudinal direction of the train 900. In other words, the information display devices 200 are arranged at intervals in the longitudinal direction of the train 900.

[0110]

The position identification information of these information display devices 200 is the position counters D_{2a} , D_{2b} , D_{2c} , D_{2d} , D_{2e} , and D_{2f} .

[0111]

Further, the value "1" of the position counter D_{2a} is assigned

to the first information display devices 200a in the foremost position in the vehicle No. 1 (vehicle 901a). The value of the position counter D_{2a} indicates the starting point information.

[0112]

Data including the position identification information D_{2a} , D_{2b} , D_{2c} , D_{2d} , D_{2e} , and D_{2f} and the starting point information (the position counter D_{2a}) is previously transmitted, for example, before operation of the train 900.

[0113]

Based on the above-mentioned information, the information display device 200e can recognize that its own position is second from the front in the direction D_f of the vehicle 901b i.e. the vehicle No. 2, since the information display device 200e holds the value "5" of the position counter D_{2e} . That is to say, the information display device 200e can recognize its own installation position in the train 900.

[0114]

The data D_0 includes the data for displaying information on the display part 101. The data D_0 is stored in the data accumulation part 102. And, the data D_0 is associated with the installation position in the train 900.

[0115]

Based on the thus-identified installation position of the information display device 200, the display data switching part 204 selects data to be displayed from the data D_0 accumulated in the data accumulation part 102. Based on the selected data, the display data switching part 204 causes the display part 101 to display information.

[0116]

In this way, the information display device 200 can add display of the vehicle number of the vehicle 901 or display dependent on the door position or the like to the guidance (information) to be displayed.

[0117]

For example, a wireless LAN performs communication equally with all the terminals within the effective range in which communication is possible. On the other hand, the information display device 200 can obtain its own installation position by using the function of transmitting and receiving the data D_0 . It is difficult for a wireless LAN to implement such a function.

[0118]

In the above-described second embodiment, the position counter D_2 is included in the transmission data D_0 . The second embodiment is not limited to this example. For example, the information display device 200 can make the transmission data D_0 which include a vehicle number counter D_3 (vehicle number identification information) in addition to the position counter D_2 .

[0119]

In that case, the information display device 200 can identify an optical communication part 106 that performs communication between vehicles. In Fig. 4, optical communication parts 106 that perform communication between vehicles are the optical communication part 106b of the information display device 200c and the optical communication part 106a of the information display device 200d.

[0120]

When the information display device 200c shown in Fig. 4 transmits information to the information display device 200d, the information display device 200c increments the value of the vehicle number counter D_3 . The information display device 200d sets the same value "1" as that of the position counter D_{2a} to the value of the position counter D_{2d} and transmits that position counter D_{2d} . That is to say, the position counter D_2 is counted up in one vehicle 901. When a vehicle 901 is changed, the value of the position counter D_2 is returned to "1". Here, the information display device 200c is installed in the vehicle 901a, while the information display device 200d is installed in the vehicle 901b next to the vehicle 901a.

[0121]

For example, by setting the maximum value of the position counter D_2 beforehand, the control part 205 can perform the above-described processing. For example, in the case shown in Fig. 4, the maximum value of the position counter is "3".

[0122]

Because of this, the information display device 200 can directly identify the vehicle number and the position in the vehicle 901. As a result, the information display device 200 can flexibly cope with a change of the train formation, for example.

[0123]

In the first and the second embodiments described above, the optical communication part 106 has been described as one that is substantialized by the optical communication module (optical transmitter and receiver) 16 that has a light emitting part and a light receiving part. However, the first and the second embodiments

is not limited to this example. Examples described in the following can be applied to the information display device 100 of the first embodiment.

[0124]

For example, in the case where the direction of display by the display part 101 coincides with the direction of transmission and reception of the data D_0 as in the example shown in Figs. 3 and 4, it is also possible to perform data transfer using the display part 101 and an imaging part 206 such as a camera.

[0125]

An information display device 100, 200 on the side of transmitting the data D_0 displays a light-emitting pattern, a bar code, a two-dimensional code, characters, or the like on the display surface of the display part 101. An information display device 100, 200 on the side of receiving the data D_0 takes an image of the display surface of the adjacent information display device 100, 200 by the imaging part 206. The information display device 100, 200 on the receiving side obtains the data D_0 by decoding the taken image. The imaging part 206 is provided at the position of the optical communication part 106 of Fig. 3, for example.

[0126]

In the case where a camera is installed in the train 900 for security reasons, it is possible to use the camera as the optical communication part 106, to simplify the structure of the information display device 100, 200 and to reduce costs.

[0127]

In the example shown in Figs. 3 and 4, there is only one path for performing communication. Accordingly, when the optical

communication path is interrupted by passenger's luggage or like, the data D_0 is not transferred to the subsequent information display devices 100, 200. Thus, it is favorable to implement redundancy by providing a plurality of optical communication paths.

[0128]

The "redundancy" means arrangement of a preparatory device even in time of usual conditions as a backup in anticipation of occurrence of some obstacle in a part of a system, so that the functions of the system as a whole can be maintained after occurrence of obstacle. For example, in the below-described example shown in Fig. 12, a plurality of communication paths exist between information display devices 300, so that information can be transferred through an alternative route even if interruption occurs in one place of the communication paths.

[0129]

Thus, by transferring data sequentially between the information display devices 100, 200 by using optical communication, it is unnecessary to install cables such as network cables or video cables. Therefore, it is possible to provide an information display device 100, 200 that is suitable for retrofitting to existing vehicles 901.

[0130]

Further, since a cause of communication failure can be visually confirmed, it is easy to confirm communication paths at the time of installation and to take countermeasures against a failure at the time of operation. Further, it is possible to simplify maintenance.

[0131]

Further, since a radio wave is not used, the information display device 100, 200 is not affected by radio wave conditions within and outside the vehicles 901. Further, the information display device 100, 200 does not affect radio waves used within the vehicles 901.

[0132]

THIRD EMBODIMENT

Fig. 9 is a block diagram showing schematically a configuration of an information display device 300 according to a third embodiment.

[0133]

The information display device 300 has one or more display parts 101; a display data switching part 304; a control part 305; one or more optical communication parts 106; an installation position presumption part 308; and a storage part 317. The storage part 317 has a data accumulation part 102; a data storage part 103; and an identifier storage part 307. The installation position presumption part 308 functions as a communication control part. A plurality of information display devices 300 are installed within a vehicle.

[0134]

In each information display device 300 of the third embodiment, the display parts 101, the data accumulation part 102, the data storage part 103, and the optical communication parts 106 are similar to those in the information display device 100 of the first embodiment. Description of these components is replaced by the description of those in the first embodiment. In the following, the display data switching part 304, the control part 305, the identifier storage part 307, and the installation position presumption part 308, which

are different from those of the information display device 100 of the first embodiment, will be mainly described.

In Fig. 9, the reference characters shown in parentheses indicate components in a fourth or a fifth embodiment.

[0135]

The display data switching part 304 causes the display part 101 to display information based on an installation position presumed by the installation position presumption part 308. Further, the display data switching part 304 switches information displayed on the display part 101 based on the installation position presumed by the installation position presumption part 308.

[0136]

The control part 305 controls processing in the information display device 300. For example, the control part 305 performs control similar to the processing control described with respect to the control part 105 of the first embodiment. Further, the control part 305 gives an instruction to the display data switching part 304 to cause the display part 101 to display a suitable guidance screen based on a combination of the installation position of the information display device 300 and the operating conditions of the train 900.

[0137]

For example, the control part 305 can select a different guidance display, which depends on the position of the vehicle 901 in the train 900 or the position of the door, based on the presumption result of the installation position of the information display device 300 and the operating conditions of the train 900. That is to say, the control part 305 can switch the guidance display by

differentiating a door to open from a door on the other side.

[0138]

Further, in the case where the train 900 is traveling, the control part 305 can display guidance of the next station, while in the case where the train 900 is stopping at a station, the control part 305 can display guidance of that station.

[0139]

In the third embodiment, in the case where data D_0 received by the optical communication part 106 has been already accumulated in the data accumulation part 102, the control part 305 does not perform accumulation and transfer of such data D_0 .

[0140]

The control part 305 acquires arrangement information through the optical communication part 106 before the installation position presumption part 308 presumes the installation position of its own device. Then, the control part 305 causes the data accumulation part 102 to store the acquired arrangement information. The arrangement information is map information that indicates arrangement positions of the plurality of information display devices 300 in the train 900. The arrangement information may be simple information such as "three devices of the installation-above-entrance-door type on one side, and thus six devices on both sides", for example.

[0141]

The identifier storage part 307 stores individual identifiers D_4 and type identifiers D_5 .

[0142]

Each individual identifier D_4 is identification information

for identifying an information display device 300. For example, an individual identifier D_4 is a serial number, a Universally Unique Identifier (UUID), or the like. Each individual identifier D_4 is determined not to be shared by the plurality of information display devices 300. Further, the individual identifiers D_4 are not changed at least in a train-travel period.

[0143]

Each type identifier D_5 is identification information for identifying a type (model number) of the information display devices 300. For example, a type identifier D_5 indicates a mounting position of an information display device 300. In addition, a type identifier D_5 indicates a model code of the device.

[0144]

In a vehicle 901, there are a plural kinds of information display devices 300 depending on mounting positions. For example, an information display device 300 installed above a passage is different in kind (type) from an information display device 300 installed above a door. Information display devices 300 of different types are different in the number or mounting direction of the optical communication parts 106, for example.

[0145]

In the third embodiment, as type identifiers D_5 , the hanging type as shown in Fig. 3, the door installation type as shown in Fig. 11, and the gangway installation type can be mentioned, for example.

An information display device 300 of the hanging type is installed above a passage of a vehicle 901. An information display device 300 of the door installation type is installed in space above

an entrance door. And, an information display device 300 of the gangway installation type is installed in space above an entrance of a gangway.

[0146]

The installation position presumption part 308 presumes the installation position of an information display device 300 based on a state of connection with other information display devices 300. The state of connection with other information display devices 300 is confirmed by optical communication using the optical communication parts 106.

[0147]

Fig. 10 is a schematic diagram showing an example of a hardware configuration of each information display device 300.

[0148]

Each information display device 300 has one or more display panels 11; a first nonvolatile memory 12A; a second nonvolatile memory 12B; a volatile memory 13; a CPU 15 as a processor; and one or more optical communication modules 16. Further, a memory 17 includes the first nonvolatile memory 12A, the second nonvolatile memory 12B, and the volatile memory 13. Although Fig. 10 shows one CPU 15, a plurality of CPUs 15 may be employed to perform processing.

[0149]

In the information display device 300 of the third embodiment, the display panels 11, the volatile memory 13, the CPU 15, and one or more optical communication modules 16 are similar to those in the information display device 100 of the first embodiment. Description of these components is replaced by the description of those in the first embodiment.

[0150]

In the following, the display data switching part 304, the control part 305, the identifier storage part 307, and the installation position presumption part 308, which are different components from those of the information display device 100, will be described.

The reference characters shown in parentheses in Fig. 9 indicate components in the fourth or the fifth embodiment.

[0151]

Similarly to the first embodiment, for example, the display part 101 of Fig. 9 can be substantialized when the CPU 15 uses the display panel 11. The data accumulation part 102 of Fig. 9 can be substantialized when the CPU 15 uses the first nonvolatile memory 12A. The data storage part 103 of Fig. 9 can be substantialized when the CPU 15 uses the volatile memory 13. The optical communication part 106 of Fig. 9 can be substantialized when the CPU 15 uses the optical communication module 16.

[0152]

The display data switching part 304, the control part 305, and the installation position presumption part 308 of Fig. 9 can be substantialized when the CPU 15 reads programs stored in the first nonvolatile memory 12A or the second nonvolatile memory 12B into the volatile memory 13 and executes those programs.

[0153]

That is to say, the first nonvolatile memory 12A or the second nonvolatile memory 12B stores, for example, a program for switching display data. This program is stored as executable data or compressed executable data.

[0154]

The CPU 15 reads these data and locates the data in an executable area of the volatile memory 13. Then, the CPU 15 allocates a working memory area, permits execution of the program, and sets, to the memory area, whether read and write is enable or disable.

[0155]

Thereafter, the CPU 15 gives the control right to the program for switching display data located in the volatile memory 13. Then, the CPU 15 executes the program for switching display data, to start operating as the display data switching part 304.

[0156]

The control part 305 or the installation position presumption part 308 can be substantialized similarly. In the case where an executable area can be set in the first nonvolatile memory 12A or the second nonvolatile memory 12B, reading and locating of programs by the CPU 15 can be omitted. In that case, after the allocation of the working area in the volatile memory 13, the execution right is given to the executable data in the first nonvolatile memory 12A or the second nonvolatile memory 12B, and the programs are executed, to implement each function.

[0157]

The identifier storage part 307 of Fig. 9 can be substantialized when the CPU 15 uses the second nonvolatile memory 12B.

[0158]

That is to say, the individual identifiers D_4 and the type identifiers D_5 are previously stored in the second nonvolatile memory 12B. Then, the CPU 15 reads these data. For that purpose, an EPROM,

a mask ROM, or the like is often used. These are memory elements that cannot be rewritten by a CPU. In this case, previously, for example, at the time of producing of the information display device 300, the individual identifiers D_4 and the type identifiers D_5 are written into the second nonvolatile memory 12B.

[0159]

Recently, with progress in large capacity of a memory element, sometimes information that is conventionally stored in a non-rewritable memory element such as an EPROM is stored in a rewritable memory such as a flash memory. The CPU rewrites information in a rewritable memory element. In that case, the second nonvolatile memory 12B becomes one section of the same memory element as the first nonvolatile memory 12A. The CPU 15 writes the individual identifiers D_4 and the type identifiers D_5 in the second nonvolatile memory 12B. Here, the second nonvolatile memory 12B is a rewritable memory element such as a flash memory.

[0160]

It has been described referring to Fig. 10 that the display data switching part 304, the control part 305, and the installation position presumption part 308 are substantialized when the CPU 15 executes the programs. The third embodiment, however, is not limited to this example.

[0161]

For example, all or a part of the functions of the display data switching part 304, the control part 305, and the installation position presumption part 308 may be substantialized by hardware using an integrated logic IC such as an ASIC or an FPGA. Or, all or a part of the functions of the display data switching part 304,

the control part 305, and the installation position presumption part 308 may be substantialized by software used by a DSP.

In Fig. 10, reference characters in parentheses indicate components in the fourth or the fifth embodiment.

[0162]

Fig. 11 is a schematic view showing an example of an outer configuration of the information display device 300 of the door installation type in the third embodiment.

The door installation type information display device 300 is installed in space above an entrance door. In Fig. 11, the information display device 300 is mounted above a right side door seen in the traveling direction (direction Df) of a vehicle 901.

In Fig. 11, the direction Df is the forward direction of the vehicle 901, and the direction Db the backward direction of the vehicle 901.

[0163]

It is assumed that the information display device 300 shown in Fig. 11 is mounted in space above an entrance door.

[0164]

The information display device 300 has one display part 101 and three optical communication parts 106a, 106b, and 106c.

[0165]

The optical communication part 106a and the optical communication part 106b are mounted so as to face in the longitudinal directions of the vehicle 901. In Fig. 11, the optical communication part 106a is mounted on the right side (the side in the direction Db) seen from a viewpoint facing the display part 101. Further, the optical communication part 106b is mounted on the left side

(the side in the direction Df) seen from a viewpoint facing the display part 101.

[0166]

The optical communication part 106c is mounted so as to face in the transverse direction of the vehicle 901. In other words, the optical communication part 106c is mounted to face in the same direction as the direction of display by the display part 101. In Fig. 11, the optical communication part 106c is mounted in the same surface in which the display part 101 is mounted.

[0167]

Fig. 12 is a schematic diagram showing an example in which the information display devices 300 shown in Fig. 11 are installed in vehicles 901. Fig. 12 is a schematic diagram in which the train 900 is seen from above.

In Fig. 12, the left side in the figure is the direction Df, and the right side in the figure the direction Db.

[0168]

In the example shown in Fig. 12, the information display devices 300 are mounted above the doors on the right and left sides seen in the traveling direction of the vehicles 901a and 901b. In each of the vehicles 901a and 901b, the information display devices 300 are mounted at three positions on each of the right and left sides. That is to say, in each of the vehicles 901a and 901b, the information display devices 300 are mounted at total six positions of both sides.

[0169]

Further, the information display devices 300 mounted on both sides of the vehicles 901a and 901b are arranged to face each other.

[0170]

The information display devices 300a, 300b, and 300c are mounted on the right side seen in the traveling direction of the vehicle 901a. The information display devices 300g, 300h, and 300i are mounted on the left side seen in the traveling direction of the vehicle 901a. The information display devices 300d, 300e, and 300f are mounted on the right side seen in the traveling direction of the vehicle 901b. The information display devices 300j, 300k, and 300l are mounted on the left side seen in the traveling direction of the vehicle 901b. The traveling direction of the vehicles 901a and 901b is the direction Df.

[0171]

On the right side of the vehicle 901a, the information display devices 300a, 300b, and 300c are arranged in that order in the traveling direction. Further, on the left side of the vehicle 901b, the information display devices 300g, 300h, and 300i are arranged in that order in the traveling direction.

[0172]

On the right side of the vehicle 901b, the information display devices 300d, 300e, and 300f are arranged in that order in the traveling direction. Further, on the left side of the vehicle 901b, the information display devices 300j, 300k, and 300l are arranged in that order in the traveling direction.

[0173]

Optical communication paths through which each information display device 300 performs communication are formed in the longitudinal direction and in the transverse direction (facing direction) of the vehicles 901a and 901b. The information display

devices 300 are installed so that an obstacle does not interrupt the optical communication paths.

[0174]

The information display device 300a receives data D_0 from the train operation system 910 or the terminal device 920 of the operator 930. The information display device 300a transmits the received data D_0 to the information display devices 300g and 300b. The information display device 300g transmits the received data D_0 to the information display device 300h. The information display device 300b transmits the received data D_0 to the information display devices 300c and 300h. The information display device 300h transmits the received data D_0 to the information display devices 300i and 300b. The information display device 300c transmits the received data D_0 to the information display devices 300i and 300j. The information display device 300i transmits the received data D_0 to the information display devices 300c and 300d.

[0175]

The information display device 300d transmits the received data D_0 to the information display devices 300e and 300j. The information display device 300j transmits the received data D_0 to the information display devices 300k and 300d. The information display device 300e transmits the received data D_0 to the information display devices 300f and 300k. The information display device 300k transmits the received data D_0 to the information display devices 300l and 300e. The information display device 300f transmits the received data D_0 to the information display device 300l. The information display device 300l transmits the received data D_0 to the information display device 300f.

[0176]

In the example shown in Fig. 12, between the vehicles 901a and 901b, the information display devices 300 communicate with each other through the gangway 902. Each of the information display devices 300c, 300d, 300i, and 300j, which are located at the end in the longitudinal direction of the vehicle 901a or the vehicle 901b, has an optical communication part 106 whose direction is adjusted so that the communication direction becomes an oblique direction. And, each of the information display devices 300c, 300d, 300i, and 300j communicates with an information display device 300 located on the opposite side in the oblique direction through the gangway 902.

[0177]

In the example shown in Fig. 12, the information display device 300c communicates with the information display device 300j. Further, the information display device 300i communicates with the information display device 300d.

[0178]

Here, instead of adjusting the communication direction of an optical communication part 106, it is possible to employ an optical communication part 106 that has a sufficiently wide effective angle ANG for optical communication.

[0179]

Fig. 13 is a flowchart showing data transmission and reception control of the information display device 300 in the third embodiment.

[0180]

First, in the step S30, the information display device 300 is in a reception standby state. When one of the optical

communication parts 106 receives data, the processing proceeds to the step S31.

[0181]

In the step S31, the control part 305 causes the data storage part 103 to store optical communication part identification information D_1 . The optical communication part identification information D_1 is information for identifying the optical communication part 106 that has received the data D_0 . Here, as the optical communication part identification information D_1 , information on the position of the optical communication part 106 arranged in the information display device 300 can be used.

[0182]

The information communication part identification information D_1 can be indicated by a character corresponding to the position at which the optical communication part 106 is mounted. Taking the example of Fig. 11, the position information of the optical communication part 106a can be made "L", the position information of the optical communication part 106b "R", and the optical communication part 106c "F".

[0183]

Further, also information indicating the angle of the communication direction of the optical communication part 106 can be added to the optical communication part identification information D_1 . For example, by defining the direction of display by the display part 101 as the angle of 0 degrees, it is possible to express the direction of communication of the optical communication part 106 by an angle in the range from 0 to 360 degrees.

[0184]

Taking the information display device 300 shown in Fig. 11 as an example, the optical communication part identification information D_1 can indicate F00 for the optical communication part 106c, L090 for the optical communication part 106a, and R270 for the optical communication part 106b. Further, in the case where communication is performed in an oblique direction, taking Fig. 12 as an example, the optical communication part identification information D_1 can indicate L045 for the optical communication parts 106a of the information display devices 300c and 300j, and R270 for optical communication parts 106b of the information display devices 300d and 300i. Taking an information display device 400 shown in Fig. 17 as an example, also optical communication parts 106d and 106e projecting outside can be indicated similarly. For example, the optical communication part 106d can be indicated by UR000, and the optical communication part 106e by UL000. Further, it is possible to represent an optical communication part 106 by replacing it with a numerical value instead of characters.

[0185]

Next, in the step S32, the control part 305 checks whether the received data D_0 has been already accumulated in the data accumulation part 102.

[0186]

For example, data identification information that can identify different data D_0 is added to the received data D_0 . The data identification information is, for example, a sequence number. A "sequence number" is a serial number given to a packet to be transmitted. The receiving side can refer to sequence numbers to know the correct order of packets, a packet loss in a communication

path, and the like.

Based on such data identification information, the control part 305 can judge whether the received data D_0 has been already accumulated.

[0187]

Further, in the case where data identification information is not added to the data D_0 , all the data D_0 may be compared. Alternatively, a hash value of the data D_0 may be calculated for comparison. A "hash value" is a fixed-length value that has no regularity and the fixed-length value is obtained from original data by a certain calculation procedure. Use of hash value can shorten a data search time.

[0188]

For example, in Fig. 12, the information display device 300b receives the data D_0 from the information display device 300a and the information display device 300h. In the case where the data D_0 is received first from the information display device 300a, the data D_0 received from the information display device 300h is judged to be the already accumulated data D_0 .

[0189]

In the case where the received data D_0 has not been accumulated yet, the processing proceeds to the step S33. In Fig. 13, this is the case where "NO" is selected in the step S32.

In the case where the received data D_0 has been already accumulated (Yes in the step S32), the processing returns to the step S30. In Fig. 13, this is the case where "YES" is selected in the step S32.

[0190]

In the step S33, the control part 305 causes the data accumulation part 102 to accumulate the received data D_0 .

[0191]

Next, in the step S34, the control part 305 selects a transmission destination. Here, the control part 305 transmits from all the optical communication parts 106 that have not been used for the reception of the data D_0 .

[0192]

For example, in Fig. 12, the information display device 300b transmits the data D_0 to the information display device 300c and the information display device 300h. In the case where the data D_0 is received only from the information display device 300a, the information display device 300b transmits the data D_0 to the information display device 300c and the information display device 300h. In the case where the data D_0 is received from the information display devices 300a and 300h, the information display device 300b transmits the data D_0 only to the information display device 300c.

[0193]

Although, in Fig. 12, arrows pointing in opposite directions are depicted between the information display device 300b and the information display device 300h, the data D_0 is transmitted depending on the reception state as described above.

[0194]

In the step S35, the control part 305 causes the selected optical communication part(s) 106 to transmit the received data D_0 .

[0195]

After completion of the transmission of the data D_0 , the

control part 305 returns to the reception standby state again.
[0196]

As described above, in the third embodiment, a plurality of optical communication paths are formed. Accordingly, it is possible to enhance the resistance of communication to the case where part of optical communication paths becomes unavailable, such as the case, for example, where an obstacle interrupts an optical communication path. Here, "resistance" means ability to adapt to changes in environment. In other words, the optical communication shown in the third embodiment is made to have redundancy.

[0197]

On the other hand, in the case where the data D_0 has been already accumulated, such data D_0 is not accumulated and transferred, and thus it is possible to avoid duplication of transfer of the data D_0 .

[0198]

In the third embodiment, for the sake of simplicity, description has been given by focusing attention to the case where the data D_0 is received from one optical communication part 106. However, in practice, there is a case where a plurality of optical communication parts 106 transmit and receive the data D_0 . Accordingly, judgment on whether the data D_0 has been already accumulated, or on selection of transmission destination, or the like should be performed with a plurality of operations considered. For example, processing is required for preventing new data D_0 received from another information display device 300 from overwriting the data D_0 that is under transfer.

[0199]

Next, processing in the installation position presumption part 308 will be described.

[0200]

Hereinabove, description has been given assuming that communication in the longitudinal direction of a vehicle 901 is performed only in one direction. That is to say, the data D_0 is transmitted in the direction D_b .

[0201]

However, in the case where enhancing of redundancy is desired, or the case of presuming installation positions of the information display devices 300 arranged in a complex configuration, it is often better to perform also communication in the reverse direction (direction D_f). Although, in Fig. 12, the arrows indicating communication in the longitudinal direction of the vehicles 901 are depicted in only one direction (direction D_b), the following description of install position presumption will be given assuming that communication is performed in both directions.

[0202]

The install position presumption part 308 generates connection information 120 that associates its own information display device 300 and other information display devices 300 with which communication has been performed. Then, the information display device 300 gives the generated connection information 120 to the other information display devices 300. At the same time, the information display device 300 acquires connection information 120 generated by the other information display devices 300.

[0203]

Based on the connection information 120, the information

display device 300 generates a graph that indicates the connection state of a plurality of information display devices 300.

[0204]

Here graph is information expressed by, for example, nodes (intersection points) and links (branches). It is possible to express relationship between the information display devices 300 by putting individual information display device 300 as a node and an optical communication path between information display devices 300 as a link.

[0205]

Here, this information that expresses relationship between the information display devices 300 is referred to as connection information.

[0206]

The installation position presumption part 308 executes examination, comparing the generated graph indicating the connection state with the arrangement information stored in the data accumulation part 102. Then, the installation position presumption part 308 specifies the installation position of individual information display device 300 in the train 900.

[0207]

The arrangement information indicates arranged positions of a plurality of information display devices 300 in the train 900. The arrangement information functions as an arrangement map in the actual train 900.

[0208]

Fig. 14 is a schematic diagram showing an example of the connection information 120.

[0209]

The connection information 120 has an individual identifier field 121, a type identifier field 122, and a communication part field 123.

[0210]

The individual identifier field 121 stores the individual identifier D_4 of an information display device 300.

The type identifier field 122 stores the type identifier D_5 of the information display device 300.

The communication part field 123 stores, for each optical communication part 106 provided in the information display device 300, the connection destination of the optical communication part 106 and the direction of communication performed by the optical communication part 106.

[0211]

The communication part field 123 shown in Fig. 14 has fields of a communication part a, a communication part b, and a communication part c. In the field of the communication part a, the information of the optical communication part 106a shown in Fig. 11 is described. In the field of the communication part b, the information of the optical communication part 106b shown in Fig. 11 is described. In the field of the communication part c, the information of the optical communication part 106c shown in Fig. 11 is described.

[0212]

Each field has a field for describing a connection destination and a field for describing the position of the optical communication part 106. For example, "Connection destination of Communication part a" is a field for describing the connection destination of

the optical communication part 106a. "Communication part a - Right" indicates that the optical communication part 106a is mounted on the right side (the side in the direction Db). Here, "right" means the right side seen from a viewpoint facing the information display device 300, as shown in Fig. 11.

[0213]

Fig. 14 shows an example for a door installation type information display device 300 shown in Fig. 11. For each of the three optical communication parts 106a, 106b, and 106c, its direction and connection destination are stored in the communication part field 123.

[0214]

Here, an initial state of the connection information 120 will be described.

[0215]

The installation position presumption part 308 of an information display device 300 generates the connection information 120 that indicates the connection state of its own information display device 300. Then, the information display device 300 causes the data accumulation part 102 to store the connection information 120.

[0216]

The installation position presumption part 308 stores the individual identifier D_4 and the type identifier D_5 of its own information display device 300, which are stored in the identifier storage part 307, into the connection information 120 of its own information display device 300. Further, the installation position presumption part 308 stores the communication direction and the connection destination of each optical communication part 106

mounted on its own information display device 300 into the connection information 120 of its own information display device 300.

[0217]

The information of the communication direction of an optical communication part 106 is previously stored in the identifier storage part 307 or the data accumulation part 102 for each information display device 300. In the case where the communication direction can be specified from the type identifier D_5 , the installation position presumption part 308 can specify the communication direction from the type identifier D_5 . As an initial value of the connection destination of an optical communication part 106, a value meaning empty or no connection is set. Here, "empty" means that there is no value that can be taken as an initial value. As a value meaning no connection, "0" may be considered, for example.

[0218]

Next, update of the connection information 120 and communication of the connection information 120 will be described.

[0219]

For example, as shown in Fig. 12, the information display device 300a as the starting point of transfer of the data D_0 performs transmitting of the connection information 120 through the optical communication part 106 of its own information display device 300a. At that time, the connection information 120 to be transmitted contains a value (source identification information) indicating source in the field of the connection destination of the optical communication part 106 that is used for the transmitting. This source identification information is also referred to as a transmitting mark.

[0220]

The word "transmitting" means sending of data or the like as an electric signal with a circuit. Here, data is sent as an optical signal through an optical communication path.

[0221]

Here, the case will be described where the optical communication part 106 on the right side (the side in the direction Db) of the information display device 300a of Fig. 12 performs communication with the optical communication part 106 on the left side (the side in the direction Df) of the information display device 300b. The optical communication part 106 on the right side (the side in the direction Db) shown in Fig. 11 is the optical communication part 106a. The optical communication part 106 on the left side (the side in the direction Df) shown in Fig. 11 is the optical communication part 106b.

[0222]

In the connection information 120 transmitted from the information display device 300a, the individual identifier D₄ indicating the information display device 300a, its type identifier D₅, and the optical communication part 106a that is used for the transmission are described.

[0223]

For example, "Communication part a" of the connection information 120 shown in Fig. 14 indicates the optical communication part 106a. The field of "Connection destination of Communication part a" of the communication part field 123 stores the value indicating a source. This value indicating the source functions as the source identification information (the transmitting mark) that can identify

the optical communication part 106a as the source.

[0224]

When the information display device 300b receives the connection information 120 transmitted from the information display device 300a, the installation position presumption part 308 compares the connection information 120 of its own information display device 300b, which is stored in the data accumulation part 102, with received connection information 120. Then, the installation position presumption part 308 judges whether the connection information 120 transmitted from the information display device 300a has been already recorded in the connection information 120 of its own information display device 300b.

[0225]

In the case where the connection information 120 transmitted from the information display device 300a is not recorded yet, the installation position presumption part 308 causes the data accumulation part 102 to record the received connection information 120.

[0226]

For example, Fig. 15 is a schematic diagram showing an example of connection information 120a and connection information 120b stored in the data accumulation part 102 of the information display device 300b.

[0227]

The connection information 120a indicates connection information transmitted from the information display device 300a. The connection information 120b is connection information of its own information display device 300b, which has been generated by

the information display device 300b.

[0228]

The information display device 300b has received the connection information 120a transmitted from the information display device 300a with the optical communication part 106b. Accordingly, the installation position presumption part 308 of the information display device 300b stores connection destination identification information D_6 in the field of "Connection destination of Communication part b_2 " of the connection information 120b of its own information display device 300b.

[0229]

The field of "Connection destination of Communication part b_2 " is a field for writing the information of the connection destination (connection destination identification information D_6) of the optical communication part 106b. This connection destination identification information D_6 is information (connection destination identification D_{62}) that can identify the source of the connection information 120a received with the optical communication part 106b. Here, the connection destination identification information D_{62} may be, for example, "the individual identifier D_{41} " and "the communication part a_1 " of the information display device 300a.

[0230]

Further, the installation position presumption part 308 of the information display device 300a stores the connection destination identification information D_6 in the field of "Connection destination of Communication part a_1 " of the connection information 120a of its own information display device 300a. This connection

destination identification information D_6 is information (connection destination identification information D_{61}) identifying the optical communication part 106b that has received the connection information 120a transmitted from the information display device 300a. This connection destination identification information D_{61} is information (connection destination identification information D_{61}) that can identify the recipient destination of the connection information 120a transmitted by the optical communication part 106a. Here, the connection destination identification information D_{61} may be, for example, "the individual identifier D_{42} " and "the communication part b_2 " of the information display device 300b.

[0231]

In this way, the communication part a_1 of the connection information 120a is associated with the connection part b_2 of the connection information 120b. As a result, the installation position presumption part 308 can link the optical communication part 106a of the information display device 300a with the optical communication part 106b of the information display device 300b.

[0232]

Here, to "link" means to store, in each connection information 120, the information (connection destination identification information D_6) indicating that "the optical communication part 106a of the information display device 300a" and "the optical communication part 106b of the information display device 300b" have a positional relationship allowing direct communication with each other.

[0233]

For example, in Fig. 15, this link is expressed on the right

side of the connection information 120a and the connection information 120b as a line 124 that connects the connection information 120a and the connection information 120b. In detail, "the communication part b_2 of the connection information 120b" is recorded in the Connection destination of the Communication part a_1 in the connection information 120a, and "the communication part a_1 of the connection information 120a" is recorded in the Connection destination of the Communication part b_2 in the connection information 120b. This expresses that the information display device 300a and the information display device 300b can directly communicate with each other.

[0234]

Then, the installation position presumption part 308 of the information display device 300b updates the received connection information 120a and the connection information 120b accumulated in the inside. After the update of the connection information 120b, the installation position presumption part 308 transmits all the connection information 120 to all the optical communication parts 106a, 106b, and 106c. The connection information 120 is stored in the data accumulation part 102. The connection information 120 contains the updated connection information 120a and 120b.

[0235]

Thus, by transmission and reception in both directions, each information display device 300 can acquire the connection information 120 of all the information display devices 300 installed in the train 900. Therefore, each information display device 300 holds the connection information 120 of all the information display devices 300 installed in the train 900.

[0236]

By repeating the above-described processing, all the information display devices 300 mounted in the train 900 can share the connection information 120 of all the information display devices 300. As a result, all the information display devices 300 can generate a graph that indicates the connection state of all the information display devices 300 mounted in the train 900.

[0237]

The installation position presumption part 308 refers to the thus-generated graph indicating the connection state and the arrangement information stored in the data accumulation part 102. This enables the installation position presumption part 308 to presume the installation position of its own information display device 300 in the train 900.

[0238]

Based on the connection state, the order and the direction in which the information display device 300 is connected can be specified, for example.

[0239]

In other words, the installation position presumption part 308 can acquire graph information and arrangement information. The graph information indicates the relation of connection between the information display devices 300. The arrangement information is a map indicating the installation positions of the information display devices 300.

[0240]

By using the graph information, the connection relationship among the specific information display devices 300 can be specified.

However, by using the graph information, it is impossible to know the actual installation positions of the information display devices 300.

[0241]

By using the arrangement information, the positions at which the information display devices 300 are mounted in the train 900 can be specified. However, by using the arrangement information, it is impossible to know the position of installation of each individual.

[0242]

Accordingly, the installation position presumption part 308 determines, as a starting point, an information display device 300 whose position can be specified; and, based on the graph information and the arrangement information, tries to find out a consistent combination of the information display devices 300 and the installation positions by applying the connection information in turn to the information of the installation positions. The information display device 300 whose position can be specified is, for example in Fig. 12, the information display device 300a that receives the data D_0 at the beginning. When one consistent combination remains, the installation positions of the information display devices 300 are specified.

[0243]

Further, in the case where the arrangement information stored in the data accumulation 102 includes the information (type identifiers D_5) on the types of the information display devices 300, it is possible to specify more certainly the installation positions of the information display devices 300 by inserting the type

identifiers D_5 previously in the connection state.

[0244]

According to the above-described processing, transfers of the data D_0 are performed endlessly. Thus, in practice, a termination condition for transfers of the data D_0 is required. As the termination condition, for example, time, the number of transfers of the data D_0 , or the like may be mentioned. For example, it is possible to employ a method in which when, after turning on power, 10 minutes or more elapses from the first reception of information specifying position, information specifying position received thereafter is not transferred any more. Alternatively, it is possible to prevent transfer of the overlapped information by not transferring the same information as already-received information (data D_0) to the source.

[0245]

Fig. 16 is a flowchart showing control of transmission and reception of the connection information 120 in the third embodiment. The connection information 120 is information for detecting the installation positions of the information display devices 300.

[0246]

First, in the step S40, the information display device 300 is in a reception standby state. When one of the optical communication parts 106 receives the connection information 120, the control part 305 puts the processing to the step S41.

[0247]

In the step S41, the installation position presumption part 308 stores the optical communication part identification information D_1 temporarily in the data storage part 103. This is for addition to the already-accumulated connection information at the same time

when the connection information is updated in the step S43. The optical communication part identification information D_1 is information identifying the optical communication part 106 that has received the connection information 120.

[0248]

Here, as the optical communication part identification information D_1 , information of the position of the optical communication part 106 arranged in the information display devices 300 can be used. The information of the position of the optical communication part 106 can be specified, for example, by using the type identifier D_5 .

[0249]

Next, in the step S42, the installation position presumption part 308 compares the received connection information 120 with the connection information 120 stored in the data accumulation part 102, to judge whether new information exists.

[0250]

Referring to Fig. 15, the received connection information 120a is compared with the connection information 120a stored in the data accumulation part 102, to judge whether new information exists. Further, the received connection information 120a is compared with the information relating to the connection information 120a in the connection information 120b stored in the data accumulation part 102, to judge whether new information exists.

[0251]

For example, in the case where information stored in the individual identifier field 121a or the communication part field 123a of the received connection information 120a is different from

the information corresponding to the connection information 120a, which is already stored in the data accumulation part 102, the installation position presumption part 308 judges that new information exists.

[0252]

In the case where new information exists, the processing proceeds to the step S43. In Fig. 16, this is the case where "YES" is selected in the step S42. In the case where new information does not exist, the processing returns to the step S40. In Fig. 16, this is the case where "NO" is selected in the step S42.

[0253]

In the step S43, based on the received connection information 120, the installation position presumption part 308 updates the communication part field 123 of the connection information 120 stored in the data accumulation part 102. In the case where the individual identifier D_4 of the received connection information 120 is different from the individual identifier D_4 of the connection information 120 stored in the data accumulation part 102, the installation position presumption part 308 causes the data accumulation part 102 to store the received connection information 120.

[0254]

For example, in the case where the received connection information 120a is different from the already-stored connection information 120a, the stored connection information 120a is rewritten based on the new connection information 120a. Further, in the case where the received connection information 120a is different from the corresponding information in the connection information 120b, the connection information 120b is rewritten.

[0255]

Then, in the step S44, the installation position presumption part 308 performs selection of destinations. Here, the destinations may be all the optical communication parts 106. Further, in the case where the connection information 120 to be transmitted is same as the received connection information 120, the installation position presumption part 308 can omit transmission to the source of the received connection information 120.

[0256]

In the step S45, the installation position presumption part 308 causes the selected optical communication part(s) 106 to transmit all the connection information 120 stored in the data accumulation part 102.

[0257]

Referring to Fig. 12, for example, in the case where the connection information 120a is received from the information display device 300a, the updated connection information 120a and the connection information 120b are transmitted to the information display devices 300a, 300c, and 300h.

[0258]

The connection information 120 to be transmitted contains the value indicating the source in the field corresponding to the optical communication part 106 that becomes the source.

[0259]

For example, a case will be described where, in Fig. 12, the connection information 120 from the information display device 300a is transmitted to the information display device 300b, to the information display device 300c, and to the information display

device 300j in this order.

[0260]

The information display device 300a generates its own connection information 120a, and transmits the generated connection information 120a to the information display device 300b. The information display device 300b adds information of its own connection information 120b to the received connection information 120a to store it, and transmits both the connection information 120a and the connection information 120b to the information display device 300c. The information display device 300c adds information of its own connection information 120c to the received connection information 120a and 120b to store it, and transmits the connection information 120a, the connection information 120b, and the connection information 120c, three items of information in all, to the information display device 300j.

[0261]

As a result, the information display device 300j has four items of connection information 120a, 120b, 120c, and 120j. These items of information are the connection information 120 that the information display device 300j stores at this point.

[0262]

In this state, a case will be considered where the information display device 300j receives five items of connection information 120a, 120b, 120c#, 120i, and 120d. The connection information 120c# includes information added to the connection information 120c. For example, in the case where information is transmitted from the information display device 300c to the information display device 300j through the information display device 300i and the information

display device 300d, the connection information 120c# includes additional information of the information display devices 300i and 300d.

[0263]

The connection information 120i and 120d, which is not included in the connection information 120 received from the information display device 300c, is newly stored. Further, since the connection information 120c is updated to the connection information 120c#, the difference of information is newly stored. In other words, the information added to the connection information 120c# is newly stored.

[0264]

Further, information of the information display device 300d as a new connection destination is added to its own connection information 120j, to update the connection information 120j#. Then, information of itself (i.e. the information display device 300j) as a new connection destination is added to the connection information 120d, to update the connection information 120d#.

[0265]

At this point, the information display device 300j has six items of connection information 120a, 120b, 120c#, 120d#, 120i, and 120j#.

[0266]

The information display device 300j transmits all these items of connection information 120a, 120b, 120c#, 120d#, 120i, and 120j# to the information display devices 300c, 300d, and 300k with which the information display device 300j communicates. The information display device 300d, which is the source of the last-received

information, is also included in the destinations of the connection information 120.

[0267]

Then, after completion of transmission of the data D_0 , the installation position presumption part 308 returns to the reception standby state (S30).

[0268]

In this way, the information display devices 300 can acquire a graph from the connection information 120 of the connection in the train 900. By this graph, the information display devices 300 can specify the connection state of the information display devices 300 in the train 900.

[0269]

Based on the specified connection state, it is possible to specify the installation position of each information display device 300 by applying in turn each device to a place in the arrangement of the information display devices 300. Here, the arrangement is specified by the arrangement information stored in the data accumulation part 102. In other words, by applying the graph acquired from the connection information 120 to the arrangement information of the information display devices 300, the installation positions of the information display devices 300 can be specified. The same arrangement information is accumulated in the data accumulation part 102a through the data accumulation part 102l.

[0270]

However, depending on the pattern of the arrangement or the like of the information display devices 300, sometimes it is possible to consider a plurality of combinations of the arranged devices.

[0271]

For example, it is possible to consider a case where in Fig. 12 each information display device 300 is constructed not to differentiate right and left directions in communication and the train operating system 910 or the terminal device 920 transmits information to both the information display device 300a and the information display device 300g. The train operating system 910 or the terminal device 920 is the starting point of communication.

[0272]

In this case, a combination of the graph and the arrangement information cannot specify the right and left directions of the vehicles 901; therefore, even in the case where all the information display devices 300 are interchanged with respective information display devices 300 installed in opposite positions on the right and left sides of the vehicles 901, a combination of the graph information and the arrangement information does not become inconsistent. For example, it is possible to consider a case where the information display device 300a is interchanged with the information display device 300g, or a case where the information display device 300b with the information display device 300h.

[0273]

Considering such cases, the installation position presumption part 308 may use a sensor to acquire information on installation positions on the right and left sides of the vehicles 901 or information on a positional relationship with devices in another vehicle, to use the acquired information to specify the installation positions of the information display devices 300. As a sensor to be used, an acceleration sensor, a location sensor such

as a Global Positioning System (GPS), a door opening/closing detection sensor, or a camera can be considered, for example.

[0274]

For example, when acceleration in the left direction seen from a viewpoint facing the display part 101 is detected by using an acceleration sensor at the time of departure of the train 900, it is possible to determine that the information display device 300 is installed on the right side of the vehicle 901. Further, when acceleration in the right direction seen from a viewpoint facing the display part 101 is detected, it is found that the information display device 300 is installed on the left side of the vehicle 901.

[0275]

Except at the time of coupling or decoupling, at least during operation of the train 900, the installation positions of the information display devices 300 do not change. Accordingly, it is sufficient that communication for detecting the positions of the information display devices 300 is performed once before the start of the operation of the train 900. Thus, the information display devices 300 can perform communication for detecting the positions in a state that an obstacle such as a passenger or luggage does not exist.

[0276]

Here, "coupling" means increasing of connected vehicles of a train. Thus, more vehicles are connected in a train on the way or incidentally. On the other hand, "decoupling" means decreasing of the number of vehicles in a time zone of a few passengers such as the daytime on weekdays, to decrease transportation capacity

per train.

[0277]

Further, the first – the third embodiments described above have been described, assuming that the train operation system 910 transmits timing information for switching display of information, for example.

[0278]

However, data transmission using optical communication in a passenger car can be interrupted by a passenger or passenger's luggage during operation.

[0279]

Accordingly, display contents and their display timing together with geographical information of the railroad line are previously transmitted to all the information display devices 100, 200, 300 before the start of operation of the train 900. The display data switching part 104, 204, 304 presumes the traveling location by using a sensor such as GPS, a speed sensor, an acceleration sensor, or a door sensor and the geographical information of the railroad line. As a result, also the information display devices 100, 200, 300 can switch display autonomously. In that case, it is not necessary to perform communication during operation of the train 900, and interruption of communication does not cause any problem.

[0280]

In the above-described third embodiment, the connection information includes the type identifier D_5 . However, in the case, for example, where all the information display devices 300 placed in a train 900 are of the same type, it is not necessary to include such information (type identifier D_5).

[0281]

FOURTH EMBODIMENT

A configuration of an information display device 400 according to a fourth embodiment is similar to that of the information display device 300 of the third embodiment as shown in Fig. 9 and Fig 10.

[0282]

Description of the third embodiment replaces description of components having reference characters similar to those in the third embodiment, namely, a display part 101, a data accumulation part 102, a data storage part 103, optical communication parts 106, a display data switching part 304, a control part 305, an identifier storage part 307, an installation position presumption part 308, a storage part 317, display panels 11, nonvolatile memories 12A, 12B, a volatile memory 13, a CPU 15, optical communication modules 16, and a memory 17.

[0283]

Fig. 17 is a schematic view showing an example of an outer configuration of the information display device 400 in the fourth embodiment.

[0284]

The information display device 400 is a gangway installation type device. The information display device 400 is used for communication through the gangway 902 that connecting the vehicle 901a and the vehicle 901b.

[0285]

Here, it is assumed that the openings (entrances) of the gangway 902 are not sufficiently wide. In other words, it is assumed that the entrances to the gangway 902 are narrow for performing

optical communication between the vehicles 901a and 901b. The gangway 902 connects between the vehicles 901a and 901b.

[0286]

The information display devices 400 are installed in space above the respective entrances to the gangway 902 between the vehicles 901a and 901b.

[0287]

Optical communication parts 106d and 106e of an information display device 400 project downward from the body of the information display device 400. That is to say, the optical communication parts 106d and 106e jut out downward from the body of the information display device 400. Further, for example, the optical communication parts 106d and 106e can be installed separately from the body of the information display device 400.

[0288]

In this way, due to projection of the optical communication parts 106d and 106e into an entrance of the gangway 902, it is possible to secure light paths (optical communication paths) for optical communication even if the gangway 902 is not wide. Here, "projection" means jutting.

[0289]

Here, the optical communication parts 106d and 106e are installed to project into the entrance of the gangway 902. However, the fourth embodiment is not limited to this example.

[0290]

For example, communication can be performed between vehicles through end windows (not shown) at the ends of the vehicles 901a and 901b. Here, "end window" is a window provided in an end face

in the longitudinal direction of a vehicle. Usually, an end window is provided beside an entrance of a gangway 902.

[0291]

Further, the optical communication parts 106d and 106e may be installed outside the vehicles 901a and 901b, so that optical communication is performed outside the vehicles 901a and 901b. This can adapt also to a train 900 having no gangway 902.

[0292]

Fig. 18 is a schematic diagram showing arrangement of information display devices 300, 400 in a train 900.

[0293]

The information display device 300a is installed at the end in the direction Df of the vehicle 901a. The information display device 300f is installed at the end in the direction Db of the vehicle 901b. Differently from Fig. 12, the information display devices 300a and 300f are positioned to face the gangway 902. That is to say, the information display devices 300a and 300f are installed at the ends of the passages of the vehicles 901a and 901b.

[0294]

Assuming that the direction Df is the traveling direction of the vehicle 901a, the information display devices 300b and 300c are installed in space above the entrance doors on the right side seen in the traveling direction of the vehicle 901a. And, the information display devices 300g and 300h are installed in space above the entrance doors on the left side seen in the traveling direction of the vehicle 901a.

[0295]

The information display devices 300d and 300e are installed

in space above the entrance doors on the right side seen in the traveling direction of the vehicle 901b. The information display devices 300i and 300j are installed in space above the entrance doors on the left side seen in the traveling direction.

[0296]

The information display device 400 shown in Fig. 17 can be used in combination with, for example, the information display device 300 shown in Fig. 11. The information display devices 300, 400 can be arranged as shown in Fig. 18.

[0297]

In Fig. 18, each of the information display devices 300a - 300j is the information display device 300 shown in Fig. 11. Each of the information display devices 400a and 400b is the information display device 400 shown in Fig. 17.

[0298]

However, as for each of the information display devices 300a and 300f, it is necessary to change the positions of the optical communication parts 106a and 106b arranged on the right and left sides to the positions of the optical communication parts 106a and 106b shown in Fig. 17. The information display devices 300a and 300f are installed at the ends of the vehicles 901a and 901b, respectively.

[0299]

The optical communication parts 106a and 106b shown in Fig. 17 are mounted in the same surface in which the display part 101 is mounted. The optical communication part 106a is positioned on the right side seen from a viewpoint facing the display part 101. The optical communication part 106b is positioned on the left side

seen from a viewpoint facing the display part 101. The optical communication parts 106a and 106b are positioned above the display part 101.

[0300]

The optical communication part 106c is mounted in the same surface in which the display part 101 is mounted. The optical communication part 106c is arranged at the horizontal middle of the display part 101. The optical communication part 106c is positioned above the display part 101.

[0301]

First data D_0 is transmitted from the terminal device 920 held by an operator 930 or from a train operation system 910 to the information display device 300a. The information display device 300a transmits the data D_0 to the information display devices 300b and 300g.

[0302]

The information display device 300b transmits the data D_0 to the information display devices 300c and 300g. The information display device 300g transmits the data D_0 to the information display devices 300b and 300h. The information display device 300c transmits the data D_0 to the information display devices 300h and 400a. The information display device 300h transmits the data D_0 to the information display devices 300c and 400a.

[0303]

The information display device 400a transmits the data D_0 to the information display device 400b. The optical communication part 106d of the information display device 400a transmits the data D_0 to the optical communication part 106e of the information display

device 400b. The optical communication part 106e of the information display device 400a transmits the data D_0 to the optical communication part 106d of the information display part 400b. The information display device 400b transmits the data D_0 to the information display devices 300d and 300i.

[0304]

The information display device 300d transmits the data D_0 to the information display devices 300e and 300i. The information display device 300i transmits the data D_0 to the information display devices 300d and 300j. The information display device 300e transmits the data D_0 to the information display devices 300j and 300f. And, the information display device 300j transmits the data D_0 to the information display devices 300e and 300f.

[0305]

Further, communication in the longitudinal direction in the vehicle 901 can be communication in both directions as described above.

[0306]

In this way, it is also possible to secure optical communication between different vehicles 901a and 901b.

[0307]

FIFTH EMBODIMENT

Fig. 9 is a block diagram showing schematically a configuration of an information display device 500 according to a fifth embodiment.

[0308]

As shown in Fig. 9, the information display device 500 of the fifth embodiment has one or more display parts 101; a display

switching part 304; a control part 505; a plurality of optical communication parts 106; an installation position presumption part 508; and a storage part 317. The storage part 317 has a data accumulation part 102; a data storage part 103; and an identifier storage part 307. The installation position presumption part 508 functions as a communication control part. A plurality of information display devices 500 are installed in a vehicle.

[0309]

In the information display device 500 of the fifth embodiment, the display parts 101, the data accumulation part 102, the data storage part 103, the display data switching part 304, the control part 305, the optical communication parts 106, and the identifier storage part 307 are similar to those in the information display device 300 of the third embodiment. Description of the components similar to those in the third embodiment is replaced by the description in the third embodiment. In the following, the installation position presumption part 508, which is different from that in the information display device 300 of the third embodiment, will be described.

[0310]

In the third and the fourth embodiments described above, examples have been shown in which communication between the different vehicles 901a and 901b is not particularly differentiated from communication within the same vehicle 901. Alternatively, description has been given assuming that the information display devices 300, 400 can recognize the optical communication parts 106 used for communication between the different vehicles 901a and 901b.

[0311]

However, it is convenient if the information display device

500 can automatically differentiate communication within the same vehicle 901a, 901b from communication between the different vehicles 901a and 901b.

[0312]

Thus, the installation position presumption part 508 in the fifth embodiment performs processing for differentiating communication within the same vehicle 901a, 901b from communication between the different vehicles 901a and 901b, in addition to the processing performed by the installation position presumption part 308 in the third embodiment.

[0313]

For example, a camera or a sensor that can discriminate incidence angles is used in a light receiving section of each optical communication part 106. As a result, the installation position presumption part 508 can automatically discriminate communication within the same vehicle 901a, 901b from communication between the different vehicles 901a and 901b.

[0314]

The optical communication part 106b of the information display device 300d shown in Fig. 12 receives from an oblique direction the data D_0 transmitted by the optical communication part 106a of the information display device 300i. Similarly, the optical communication part 106b of the information display device 300j receives from an oblique direction the data D_0 transmitted by the optical communication part 106a of the information display device 300c. On the other hand, for example, the optical communication part 106b of the information display device 300b receives from a lateral direction the data D_0 transmitted by the optical communication

part 106a of the information display device 300a.

[0315]

If the information display device 300 has a sensor that can discriminate incidence angles at the light receiving section of each optical communication part 106, communication between the different vehicles 901a and 901b can be automatically discriminated.

[0316]

Further, if the light receiving section of each optical communication part 106 has a camera, the information display device 300 can recognize the gangway 902 as an image. Accordingly, the information display device 300 can automatically discriminate communication between the different vehicles 901a and 901b.

[0317]

As described referring to Fig. 6, as for communication between the different vehicles 901a and 901b, the angle between the optical communication parts 106 changes when the vehicles 901a and 901 are moving in a curved section of a railroad. Generally, this change occurs by a relatively large angle over a period of several seconds to several tens of seconds mainly in the lateral direction of the vehicle 901.

[0318]

On the other hand, even as for communication between the information display devices 300 mounted adjacently in the same vehicle 901a, 901b, the angle between the optical communication parts 106 changes as well. This is caused by vibration or distortion of the body during operation, and the change occurs mainly by a small angle of one second or less.

[0319]

Accordingly, the installation position presumption part 508 judges whether the communication party is one installed in the same vehicle 901a, 901b or one installed in a different vehicle 901a, 901b, based on the change in the communication angle.

[0320]

Then, by adding this judgment result to the connection information 120, it becomes possible to identify the information display devices 500 installed in the same vehicle 901a, 901b. This also makes it easy to presume the installation positions of the information display devices 500.

DESCRIPTION OF REFERENCE CHARACTERS

[0321]

100, 200, 300, 400, 500: information display device; 11: display panel; 12: nonvolatile memory; 13: volatile memory; 15: CPU; 16: optical communication module; 17: memory; 101: display part; 102: data accumulation part; 103: data storage part; 104, 204, 304: display data switching part; 105, 205, 305: control part; 106: optical communication part; 107, 317: storage part; 206: image taking part; 120: connection information; 121: individual identifier field; 122: type identifier field; 123: communication part field; 307: identifier storage part; 308, 508: installation position presumption part; 900, 901a, 901b: train; 901: vehicle; 902: gangway; 910: train operating system; 920: terminal device; 930: operator; D_f, D_b: direction; ANG: effective angle; D₀, D₀₁, D₀₂, D_{0a}, D_{0b}, D_{0c}, D_{0d}, D_{0e}, D_{0f}, D_{2a}, D_{2b}, D_{2c}, D_{2d}, D_{2e}, D_{2f}: data; D₁: optical communication part identification information; D₂: position identification information; D₃: vehicle number identification information; D₄,

D_{41} , D_{42} : individual identifier; D_5 : type identifier; and D_6 , D_{61} , D_{62} : connection destination identification information.

WHAT IS CLAIMED IS:

1. An information display device for transmitting and receiving data to and from one another, comprising:

a display panel that displays information; and

a plurality of optical communication modules that perform transmission and reception of the data including the information to be displayed on the display panel by wireless using light; wherein,

the plurality of optical communication modules include a first optical communication module directed in a first direction and a second optical communication module directed in a different direction from the first direction; and

the data received by the first optical communication module is transmitted from the second optical communication module.

2. The information display device according to claim 1, wherein:

the optical communication modules have an effective angle satisfying a following equation (1):

[Equation 1]

$$Optical\ communication\ effective\ angle > 4 \times \tan^{-1} \frac{Vehicle\ length \div 2}{Minimum\ curvature\ radius} \quad (1)$$

3. The information display device according to claim 1 or 2, wherein:

when the received data includes first position identification information that can identify a position of its own information display device, a second position identification

information that can identify a position of another information display device is added to the received data before transmission of the received data.

4. The information display device according to claim 3, wherein:

the first position identification information indicates a first count value, and the second position identification information indicates a second count value that is the first count value changed by a predetermined value.

5. The information display device according to claim 3 or 4, wherein:

information corresponding to the first position identification information included in the received data is displayed on the display panel.

6. The information display device according to claim 1 or 2, wherein:

connection information includes an individual identifier for identifying its own information display device, a direction of an optical communication module that has been used for transmission of the data, a connection destination of the optical communication module that has been used for transmission of the data, or a type identifier for identifying a type of its own information display device; and

when the optical communication module receives the connection information of other information display devices, its

own connection information and the connection information of the other information display devices are transmitted from the optical communication module.

7. The information display device according to claim 6, wherein:

the information display device specifies its own installation position based on its own connection information and the connection information of the other information display devices.

8. The information display device according to claim 6 or 7, wherein:

the optical communication module identifies a source of light that includes the data; and

based on an incident direction of the light, whether the source is in the vehicle or in a different vehicle is determined.