United States Patent Application Publication	20250265925
Kind Code	A1
Publication Date	August 21, 2025
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ROADSIDE DEVICE

Abstract

A roadside device provided at a position where a pedestrian crosses a road, wherein the control unit acquires information including a plurality of items related to approach of an automated driving vehicle approaching the position and information indicating whether a preceding vehicle of the automated driving vehicle has stopped in front of the position, notifies the pedestrian of the entirety of the plurality of items when the preceding vehicle is not stopped in front of the position, and notifies the pedestrian of a part of the plurality of items when the preceding vehicle is stopped in front of the position.

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Appl. No.: **18/950174**

Filed: **November 18, 2024**

Foreign Application Priority Data

JP	2024-023070	Feb. 19, 2024

Publication Classification

Int. Cl.: **G08G1/005** (20060101); **G08G1/01** (20060101)

U.S. Cl.:

CPC **G08G1/005** (20130101); **G08G1/0116** (20130101);

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Japanese Patent Application No. 2024-023070 filed on Feb. 19, 2024, incorporated herein by reference in its entirety.

BACKGROUND

1. Technical Field

[0002] The present disclosure relates to a roadside device.

2. Description of Related Art

[0003] Conventionally, there is technology for performing notification regarding behavior of an automated driving vehicle. For example, Japanese Unexamined Patent Application Publication No. 2023-050629 (JP 2023-050629 A) discloses performing notification, in accordance with behavior of an automated driving vehicle that is scheduled to pass through a predetermined traffic region, to a vehicle, a pedestrian, or the like, other than the automated driving vehicle, such as whether passage is permissible, an alert, or the like.

SUMMARY

[0004] There is room for improvement in technology for notifying pedestrians of information regarding approach of an automated driving vehicle.

[0005] A roadside device according to the present disclosure is a roadside device provided at a position where a pedestrian crosses a road, and includes a control unit, in which the control unit

[0006] acquires approaching information including a plurality of items relating to approach of an automated driving vehicle approaching the position, and stopping information indicating whether a vehicle traveling ahead of the automated driving vehicle has stopped short of the position, and

[0007] when the vehicle traveling ahead is not stopped short of the position, an entirety of the items is notified to the pedestrian, and when the vehicle traveling ahead is stopped short of the position, a part of the items is notified to the pedestrian.

[0008] According to the present disclosure, technology for notifying pedestrians of information related to approach of automated driving vehicles can be improved.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Features, advantages, and technical and industrial significance of exemplary embodiments of the disclosure will be described below with reference to the accompanying drawings, in which like signs denote like elements, and wherein:

[0010] FIG. **1** is a diagram illustrating a schematic configuration of a system according to the present embodiment;

[0011] FIG. **2** is a flowchart showing an operation of the system according to the present embodiment;

[0012] FIG. **3** is a diagram for explaining a positional relationship between an automated driving vehicle and a preceding vehicle;

[0013] FIG. **4** is an illustration of images displayed on a display of a roadside device; and

[0014] FIG. **5** is an example of an image displayed on a display of a roadside device.

DETAILED DESCRIPTION OF EMBODIMENTS

[0015] Hereinafter, an embodiment of the present disclosure will be described below with reference

to the drawings. In the drawings, the same or corresponding parts are denoted by the same reference numerals. In the description of the present embodiment, description of the same or corresponding components will be appropriately omitted or simplified.

[0016] A configuration of the system **1** according to the present embodiment will be described with reference to FIG. **1**. The system **1** includes an information processing device **10**, a roadside device **20**, an automated driving vehicle **30**, and a preceding vehicle V of the automated driving vehicle **30**. The information processing device **10** can communicate with the roadside device **20**, the automated driving vehicle **30**, and the preceding vehicle V via the network **40**. In FIG. **1**, one preceding vehicle V is shown, but the number of preceding vehicles V is not limited to this.

[0017] The information processing device **10** is a computer installed in a facility such as a data center. The information processing device **10** is, for example, a server belonging to a cloud computing system or another computing system.

[0018] The roadside device **20** notifies the pedestrian who intends to cross the road of the presence of the automated driving vehicle **30** approaching the roadside device **20** through the road. The roadside device **20** may also notify the automated driving vehicle **30** of the presence of a pedestrian. The roadside device **20** is provided at a position where the pedestrian crosses the road. The position specifically includes a position within a predetermined range from the start position of the crosswalk. The roadside device **20** may be installed near the boundary between the road and the sidewalk. In the present embodiment, the road is a road in which the passage of the vehicle is prioritized rather than the pedestrian.

[0019] The automated driving vehicle **30** and the preceding vehicle V are any type of motor vehicle, such as a gasoline-powered vehicle, a diesel-powered vehicle, a BEV (Battery Electric Vehicle), an HEV (Hybrid Electric Vehicle), a PHEV (Plug-in Hybrid Electric Vehicle), or an FCEV (Fuel Cell Electric Vehicle). In addition to the automated driving vehicle **30**, the preceding vehicle V may also be movable by autonomous driving. Automated driving includes, for example, Levels 1 to 5 defined by the Society of Automotive Engineers (SAE). However, automated driving is not limited to the above, and may be arbitrarily defined.

[0020] The network **40** includes the Internet, at least one WAN, at least one MAN, or any combination thereof. WAN is an abbreviation for wide area network. MAN is an abbreviation for metropolitan area network. The network **40** may include at least one wireless network, at least one optical network, or any combination thereof. The wireless network is, for example, an ad hoc network, a cellular network, a wireless LAN, a satellite communication network, or a terrestrial microwave network. The term “LAN” is an abbreviation for “local area network”.

[0021] First, the outline of the present embodiment will be described, and the details will be described later. The roadside device **20** is provided at a position where the pedestrian crosses the road. The roadside device **20** acquires approach information including a plurality of items related to the approach of the automated driving vehicle **30** approaching the position, and stop information indicating whether or not the preceding vehicle V of the automated driving vehicle **30** has stopped before the position. The roadside device **20** notifies the pedestrian of the entirety of the plurality of items when the preceding vehicle V is not stopped in front of the position, and notifies the pedestrian of a part of the plurality of items when the preceding vehicle V is stopped in front of the position.

[0022] In general, when the preceding vehicle V of the automated driving vehicle **30** stops in front of the position where the pedestrian crosses the road, it is considered that the preceding vehicle V is stopped for the purpose of traversing the pedestrian first. In this case, since the automated driving vehicle **30** traveling behind the preceding vehicle V also stops, the pedestrian can safely cross the road without being particularly conscious of the automated driving vehicle **30**. At this time, if the entire item included in the approach information of the automated driving vehicle **30** is notified to the pedestrian, the pedestrian may feel troublesome. On the other hand, according to the present embodiment, when the preceding vehicle V of the automated driving vehicle **30** is stopped in front

of the position where the pedestrian crosses the road, only some items included in the approach information of the automated driving vehicle **30** are notified to the pedestrian. As described above, since it is possible to notify the approach of the automated driving vehicle **30** while omitting information that is rather troublesome for the pedestrian, it is possible to improve a technique of notifying the pedestrian of information related to the approach of the automated driving vehicle.

[0023] A configuration of the information processing device **10** according to the present embodiment will be described with reference to FIG. **1**. The information processing device **10** includes a control unit **11**, a storage unit **12**, and a communication unit **13**.

[0024] The control unit **11** includes at least one processor, at least one programmable circuit, at least one dedicated circuit, or any combination thereof. The processor is a general-purpose processor such as a CPU or a GPU, or a dedicated processor specialized for a specific process. The term "CPU" is an abbreviation for "central processing unit". The term "GPU" is an abbreviation for "graphics processing unit". The programmable circuit is, for example, an FPGA. The term "FPGA" is an abbreviation for "field-programmable gate array". The dedicated circuit is, for example, an ASIC. The term "ASIC" is an abbreviation for "application specific integrated circuit". The control unit **11** executes processing related to the operation of the information processing device **10** while controlling each unit of the information processing device **10**.

[0025] The storage unit **12** includes at least one semiconductor memory, at least one magnetic memory, at least one optical memory, or any combination thereof. The semiconductor memory is, for example, a RAM, a ROM, or a flash memory. The term "RAM" is an abbreviation for "random access memory". The term "ROM" is an abbreviation for "read-only memory". The RAM is, for example, an SRAM or a DRAM. The term "SRAM" is an abbreviation for "static random access memory". The term "DRAM" is an abbreviation for "dynamic random access memory". The ROM is, for example, an EEPROM.

[0026] The term "EEPROM" is an abbreviation for "electrically erasable programmable read-only memory". The flash memory is, for example, an SSD. "SSD" is an abbreviation for solid-state drive. The magnetic memory is, for example, an HDD. "HDD" is an abbreviation for hard disk drive. The storage unit **12** may function as, for example, a main storage device, an auxiliary storage device, or a cache memory. The storage unit **12** stores information used for the operation of the information processing device **10** and information obtained by the operation of the information processing device **10**.

[0027] The communication unit **13** includes at least one communication module. The communication module is, for example, a module compatible with a wired LAN communication standard such as Ethernet (registered trademark) or a wireless LAN communication standard such as IEEE 802.11. "IEEE" is an abbreviation for Institute of Electrical and Electronics Engineers. The communication unit **13** communicates with devices other than the information processing device **10**. The communication unit **13** receives information used for the operation of the information processing device **10** and transmits information obtained by the operation of the information processing device **10**.

[0028] A configuration of the roadside device **20** according to the present embodiment will be described with reference to FIG. **1**. The roadside device **20** includes a control unit **21**, a storage unit **22**, a communication unit **23**, an input unit **24**, an output unit **25**, and a photographing unit **26**. The hardware configurations of the control unit **21** and the storage unit **22** of the roadside device **20** may be the same as the hardware configurations of the control unit **11** and the storage unit **12** of the information processing device **10**, respectively. The description here is omitted.

[0029] The communication unit **23** includes at least one communication interface. The communication interface is, for example, an interface compatible with mobile communication standards such as LTE, the 4G standard, or the 5G standard, an interface compatible with short-range wireless communication standard such as Bluetooth (registered trademark), or a LAN interface. The term "LTE" is an abbreviation for "long term evolution". The term "4G" is an

abbreviation for “fourth generation”. The term “5G” is an abbreviation for “fifth generation”. The communication unit **23** receives information used for the operation of the roadside device **20** and transmits information obtained by the operation of the roadside device **20**.

[0030] The input unit **24** includes at least one input interface. The input interface is, for example, a physical key, a capacitive key, a pointing device, a touch screen integrated with a display, or a microphone. The input unit **24** receives an operation of inputting data used for the operation of the roadside device **20**. Instead of being provided in the roadside device **20**, the input unit **24** may be connected to the roadside device **20** as an external input device. As a connection method, for example, any method such as a universal serial bus (USB), a high-definition multimedia interface (HDMI) (registered trademark), or Bluetooth (registered trademark) can be used. The term “USB” is an abbreviation for “universal serial bus”. The term “HDMI (registered trademark)” is an abbreviation for “high-definition multimedia interface”.

[0031] The output unit **25** includes at least one output interface. The output interface is, for example, a display or a speaker. The display is, for example, an LCD or an organic EL display. The term “LCD” is an abbreviation for “liquid crystal display”. EL is an abbreviation for electro luminescence. The display may be a LED display. The term “LED” is an abbreviation for “light emitting diode”. The output unit **25** outputs data obtained by the operation of the roadside device **20**. Instead of being provided in the roadside device **20**, the output unit **25** may be connected to the roadside device **20** as an external output device. As a connection method, for example, any method such as a universal serial bus (USB), a high-definition multimedia interface (HDMI) (registered trademark), or Bluetooth (registered trademark) can be used. The output unit **25** may include a light-emitting device such as a LED light.

[0032] The photographing unit **26** is a camera that photographs the periphery of the roadside device **20**. The camera may include a lens capable of capturing **360** degrees. The photographing unit **26** can output the captured image to the control unit **21**.

[0033] A configuration of the automated driving vehicle **30** according to the present embodiment will be described with reference to FIG. **1**. The automated driving vehicle **30** includes a control unit **31**, a storage unit **32**, a communication unit **33**, a positioning unit **34**, and a photographing unit **35**. The hardware configuration of the storage unit **32** of the automated driving vehicle **30** may be the same as the hardware configuration of the storage unit **12** of the information processing device **10**. The description here is omitted. The hardware configuration of the communication unit **33** of the automated driving vehicle **30** may be the same as the hardware configuration of the communication unit **23** of the roadside device **20**. The description here is omitted.

[0034] The control unit **31** includes at least one processor, at least one programmable circuit, at least one dedicated circuit, at least one ECU, or any combination thereof. ECU is an abbreviation for electronic control unit. The processor is a general-purpose processor such as a CPU or a GPU, or a dedicated processor specialized for a specific process. The programmable circuit is, for example, an FPGA. The dedicated circuit is, for example, an ASIC. The control unit **31** executes processing related to the operation of the automated driving vehicle **30** while controlling each unit of the automated driving vehicle **30**.

[0035] The positioning unit **34** includes at least one GNSS receiver. GNSS is an abbreviation for global navigation satellite system. GNSS is, for example, GPS, QZSS, BeiDou, GLONASS, or Galileo. GPS is an abbreviation for Global Positioning System. The “QZSS” is an abbreviation for quasi-zenith satellite system. A satellite for the QZSS is referred to as a quasi-zenith satellite. GLONASS is an abbreviation for Global Navigation Satellite System. The positioning unit **34** measures the position of the automated driving vehicle **30**.

[0036] The photographing unit **35** is a camera that photographs the surroundings of the automated driving vehicle **30**. The photographing unit **35** can output the acquired image to the control unit **31**. The photographing unit **35** includes a drive recorder.

[0037] A control unit having a hardware configuration similar to that of the automated driving

vehicle **30**, a storage unit, a communication unit, and a positioning unit may be provided with a preceding vehicle V. The automated driving vehicle **30** and the preceding vehicle V may be capable of transmitting position information indicating the position of the host vehicle to the information processing device **10**.

[0038] The functions of the information processing device **10**, the roadside device **20**, or the automated driving vehicle **30** are realized by executing the program according to the present embodiment by a processor serving as the control unit **11**, the control unit **21**, or the control unit **31**. That is, the functions of the information processing device **10**, the roadside device **20**, or the automated driving vehicle **30** are realized by software. The program causes the computer to execute the operations of the information processing device **10**, the roadside device **20**, or the automated driving vehicle **30**, thereby causing the computer to function as the information processing device **10**, the roadside device **20**, or the automated driving vehicle **30**. That is, the computer functions as the information processing device **10**, the roadside device **20**, or the automated driving vehicle **30** by executing the operations of the information processing device **10**, the roadside device **20**, or the automated driving vehicle **30** in accordance with the program.

[0039] The program can be stored in a non-transitory computer-readable medium. The non-transitory computer-readable medium is, for example, a flash memory, a magnetic recording device, an optical disc, a magneto-optical recording medium, or a ROM. The program is distributed, for example, by selling, transferring, or lending a portable medium such as a SD card, DVD, or CD-ROM storing the program. The term “SD” is an abbreviation for “secure digital”. The term “DVD” is an abbreviation for “digital versatile disc”. The term “CD-ROM” is an abbreviation for “compact disc read-only memory”. The program may be stored in the storage of the server and transferred from the server to other computers to distribute the program. The program may be provided as a program product.

[0040] The computer temporarily stores the program stored in the portable medium or the program transferred from the server in the main storage device, for example. The computer then causes the processor to read the program stored in the main storage device, and causes the processor to execute processes in accordance with the read program. The computer may read the program directly from the portable medium and execute processes in accordance with the program. The computer may execute the processes in accordance with the received program each time the program is transferred from the server to the computer. The processes may be executed by a so-called ASP service that realizes the function only by execution instruction and result acquisition without transferring the program from the server to the computer. The term “ASP” is an abbreviation for “application service provider”. The program includes information that is used for processing by electronic computers and equivalent to a program. For example, data that is not a direct command to a computer but has the property of defining the processing of the computer corresponds to the “data equivalent to a program”.

[0041] Part or all of the functions of the information processing device **10**, the roadside device **20**, or the automated driving vehicle **30** may be realized by a programmable circuit or a dedicated circuit as the control unit **11**, the control unit **21**, or the control unit **31**. That is, some or all of the functions of the information processing device **10**, the roadside device **20**, or the automated driving vehicle **30** may be realized by hardware.

[0042] The operation of the system **1** according to the present embodiment will be described with reference to FIGS. **2** and **3**. Among the operations illustrated in FIG. **2**, the operation of the roadside device **20** corresponds to the method according to the present embodiment. In the following description, communication between the information processing device **10** and the external device is performed via the communication unit **13** and the network **40**. In the following description, communication between the roadside device **20** and the external device is performed via the communication unit **23** and the network **40**. In the following description, communication between the automated driving vehicle **30** and the external device is performed via the

communication unit **33** and the network **40**.
[0043] In S**1** of FIG. **2**, the control unit **11** of the information processing device **10** determines whether or not there is a pedestrian who intends to cross the street. When there is no pedestrian who intends to cross the street (S**1**: NO), the operation of the control unit **11** returns to the start. When there is a pedestrian who intends to cross the street (S**1**: YES), the operation of the control unit **11** proceeds to S**2**.
[0044] Any method may be employed to determine whether there is a pedestrian attempting to cross a road. For example, the control unit **11** may receive and acquire an image captured by the photographing unit **26** of the roadside device **20** from the roadside device **20**, analyze the image using an arbitrary image analysis technique, and determine whether or not a pedestrian who intends to cross a road is reflected in the image. The control unit **11** may acquire the image by receiving the image from an outdoor camera that captures an image of a certain position of the roadside device **20**. The control unit **11** may communicate with the terminal device used by the pedestrian, acquire terminal position information indicating the position of the terminal device, and determine whether there is a pedestrian who is going to cross the road based on the terminal position information.
[0045] In S**2**, the control unit **11** determines whether there is an automated driving vehicle **30** that is coming to a position where the pedestrian crosses the road. When the automated driving vehicles **30** do not exist (S**2**: NO), the operation of the control unit **11** returns to the start. When the automated driving vehicles **30** exist (S**2**: YES), the operation of the control unit **11** proceeds to S**3**.
[0046] Any method may be employed to determine whether there is an incoming automated driving vehicle **30**. For example, the control unit **11** first acquires an image captured by the photographing unit **26** of the roadside device **20** or an image captured by an outdoor camera from the roadside device **20** or the outdoor camera. The control unit **11** analyzes the image using an arbitrary image analysis technique. The control unit **11** determines that the automated driving vehicle **30** is present when the automated driving vehicle **30** that the pedestrian is moving toward the position crossing the road is reflected. The control unit **11** may determine that the automated driving vehicle **30** does not exist when the automated driving vehicle **30** is not reflected. The control unit **11** may acquire position information indicating the position of the automated driving vehicle **30** from the automated driving vehicle **30**, and determine whether or not there is an automated driving vehicle **30** that is heading on the basis of the position information.
[0047] In S**3**, the control unit **11** determines whether or not the preceding vehicle V of the automated driving vehicle **30** exists. When the preceding vehicles V do not exist (S**3**: NO), the operation of the control unit **11** proceeds to S**4**. When the preceding vehicles V are present (S**3**: YES), the operation of the control unit **11** proceeds to S**5**.
[0048] Any method may be employed for determining whether or not the preceding vehicle V is present. For example, the control unit **11** analyzes an image captured by the roadside device **20** or an outdoor camera using an arbitrary image analysis technique. The control unit **11** may determine that the preceding vehicle V is present when the preceding vehicle V of the automated driving vehicle **30** is reflected in the image, and may determine that the preceding vehicle V is not present when the preceding vehicle V is not reflected. The control unit **11** acquires positional information indicating respective positions of a plurality of vehicles including the automated driving vehicle **30**. The control unit **11** may identify, based on the position information, a vehicle traveling in front of the automated driving vehicle **30** within a predetermined distance as the preceding vehicle V, and determine that the preceding vehicle V is present. The information indicating the predetermined distance may be set in advance and stored in the storage unit **12**.
[0049] First, in S**3**, the control unit **11** determines that the preceding vehicle V of the automated driving vehicle **30** does not exist. In S**4**, the control unit **11** generates information indicating that the preceding vehicle V does not exist. Thereafter, the process of the control unit **11** proceeds to S**8**.
[0050] Next, a description will be given of cases where the control unit **11** determines that the preceding vehicles V are present in S**3**. In S**5**, the control unit **11** determines whether or not the

preceding vehicle V is stopped in front of the position where the pedestrian is going to cross. If it is not stopped (S**5**: NO), the operation of the control unit **11** proceeds to S**6**. If it is stopped (S**5**: YES), the operation of the control unit **11** proceeds to S**7**.

[0051] Any method may be adopted for determining whether or not the preceding vehicle V has stopped. For example, the control unit **11** acquires an image in which the preceding vehicle V is captured from the photographing unit **26** of the roadside device, the outdoor camera, or the photographing unit **35** of the automated driving vehicle **30**. The control unit **11** may analyze whether or not the preceding vehicle V of the automated driving vehicle **30** has stopped using an arbitrary image analysis technique based on the image. Based on the image, the control unit **11** may determine that the preceding vehicle V of the automated driving vehicle **30** has stopped when analyzing that the driver of the preceding vehicle V has recognized the pedestrian using an arbitrary image analysis technique. In this case, the control unit **11** may acquire an image obtained by capturing the facial expression of the driver from the preceding vehicle V by the in-vehicle camera as the photographing unit included in the preceding vehicle V. Further, the control unit **11** may analyze the line of sight of the driver reflected in the image and analyze that the driver recognizes the pedestrian.

[0052] The control unit **11** may acquire position information indicating the position of the preceding vehicle V, and analyze whether or not the preceding vehicle V has stopped based on the position information. The control unit **11** may acquire information indicating the speed of the preceding vehicle V from the preceding vehicle V, and may determine that the preceding vehicle V has stopped when the speed becomes less than a predetermined value.

[0053] First, in S**5**, the control unit **11** determines that the preceding-vehicle V is not stopped. In S**6**, the control unit **11** generates stop data indicating that the preceding vehicle V is not stopped in front of the position where the pedestrian is going to cross. Thereafter, the process of the control unit **11** proceeds to S**8**.

[0054] Next, in S**5**, the control unit **11** determines that the preceding-vehicle V has stopped. In S**7**, the control unit **11** generates stop data indicating that the preceding vehicle V has stopped in front of the position where the pedestrian is going to cross. The stop information may include information about the preceding vehicle V. The stop information may include information indicating the speed of the preceding vehicle V.

[0055] FIG. **3** is a diagram illustrating an example of a positional relationship between the automated driving vehicle **30** and the preceding vehicle V according to the present embodiment. In the present example, as shown in FIG. **3**, there is an automated driving vehicle **30** traveling on the road R at a position between the pedestrian P and the roadside device **20**, and the preceding vehicle V is stopped in front of the automated driving vehicle **30** in front of the position where the pedestrian P crosses the road R. The control unit **11** determines that the preceding vehicle V has stopped, and generates stop information indicating that the preceding vehicle V has stopped before the position where the pedestrian is going to cross.

[0056] In S**8** of FIG. **2**, the control unit **11** generates approach data including a plurality of items related to the approach of the automated driving vehicles **30**. Any method may be employed for generating the approach information. The control unit **11** may generate approach information based on the position information of the automated driving vehicle **30**. In the present embodiment, the approach information includes, as items, the arrival of the automated driving vehicle **30**, the remaining amount from the automated driving vehicle **30** to the position where the pedestrian crosses the road, and the direction in which the automated driving vehicle **30** comes. The remaining amount specifically includes the “remaining distance” until the automated driving vehicle **30** arrives at the position or the remaining time until the automated driving vehicle **30** arrives at the position. The direction specifically includes a “right direction” or a “left direction” or the like as a front face in a direction in which the pedestrian crosses the road. The direction is not limited to this, and may include “diagonal right front direction”, “diagonal right rear direction”, “diagonal left

front direction", "diagonal left rear direction", and the like. The direction may include an cast-west-north direction, a road name, a road number, or the like. The approach information is not limited to this, and may include any item. For example, the approach information may include, as items, elements for the pedestrian to identify the automated driving vehicle **30**, such as the color of the vehicle body of the automated driving vehicle **30**.

[0057] In the example of FIG. **3**, there is an automated driving vehicle **30** that comes from the right direction with the pedestrian's crossing direction as the front. It is assumed that the remaining distance from the automated driving vehicle **30** to the position where the pedestrian traverses the road is 20 m. The control unit **11** generates approach data including "the automated driving vehicle **30** is coming", "20 m" as the remaining distance, and "the right direction" as the direction toward the automated driving vehicle **30** as items.

[0058] In S**9** of FIG. **2**, the control unit **11** transmits the generated approach information and the stopping information or the information indicating that the preceding vehicles V generated by S**4** do not exist to the roadside device **20**.

[0059] In S**10**, the control unit **21** of the roadside device **20** acquires the approach information and the stop information or the information indicating that the preceding vehicle V generated by S**4** does not exist from the information processing device **10**.

[0060] In S**11**, the control unit **21** determines an item to be notified to the pedestrian from among the items included in the approach information. In the present embodiment, when the stop information indicates that the preceding vehicle V has stopped before the position where the pedestrian crosses, the control unit **21** determines a part of a plurality of items included in the approach information as an item to be notified. When the stop information indicates that the preceding vehicle V is not stopped in front of the position, the control unit **21** determines the whole of the plurality of items included in the approach information as an item to be notified. That is, the control unit **21** determines to notify a part of a plurality of items included in the approach information when the preceding vehicle Vis stopped before the position. When the preceding vehicle V is not stopped before the position, the control unit **21** decides to notify all of a plurality of items included in the approach information. The control unit **21** also determines the whole of the plurality of items included in the approach information as an item to be notified when the information indicating that the preceding vehicles V generated by S**4** do not exist is received.

[0061] The control unit **21** may determine an item to be notified to the pedestrian by referring to information specifying an item to be omitted without notification among a plurality of items included in the approach information. The information may be set in advance and stored in the storage unit **22**. For example, the control unit **21** refers to the information. Among the three items of "arrival of the automated driving vehicle **30**", "remaining distance", and "direction" included in the approach information, the two items of "arrival of the automated driving vehicle **30**" and "direction", in which the item of "remaining distance" is omitted, are determined by the control unit **21** as a part of items to be notified. As a result, when the preceding vehicle V is stopped in order to cross the pedestrian and the subsequent automated driving vehicle **30** is also stopped, the pedestrian is notified of an item excluding an item that may become inaccurate information of "remaining distance" among the approach information. Therefore, the possibility that the pedestrian feels troublesome can be reduced.

[0062] For example, when the preceding vehicle V is stopped, the control unit **21** may further acquire information indicating the shape of the road, and determine, according to the shape of the road, an item in which the item of "direction" is further omitted in addition to the item of "remaining distance" described above as a part of the item to be notified. The information may be set in advance and stored in the storage unit **22**. In this case, when the road has a shape in which there are a plurality of directions in which the automated driving vehicle **30** comes, the control unit **21** may determine two items of "the automated driving vehicle **30** comes" and "the direction" as some items to be notified. In a case where the road has a shape in which the direction in which the

automated driving vehicle **30** comes is only one direction, the control unit **21** may determine only "the automated driving vehicle **30** comes" as a part of the items to be notified. Thus, when the direction in which the automated driving vehicle **30** comes is clear, the item in which the "direction" is further omitted is notified. Therefore, it is possible to further reduce the possibility of the pedestrian feeling troublesomeness.

[0063] The control unit **21** may further acquire recognition information indicating whether or not the automated driving vehicle **30** recognizes the presence of a pedestrian, and when the automated driving vehicle is recognized, determine a part of the plurality of items included in the approach information as an item to be notified. When the automated driving vehicle **30** does not recognize the presence of a pedestrian, the control unit **21** may determine the entire plurality of items included in the approach information as an item to be notified. Any method may be adopted for the acquisition of the recognition information. For example, the control unit **21** may directly communicate with the automated driving vehicle **30**, analyze an image or the like captured by the photographing unit **35** from the automated driving vehicle **30**, and acquire information indicating whether the automated driving vehicle **30** recognizes the presence of a pedestrian as recognition information.

[0064] The determination of the item may be performed by the control unit **11** of the information processing device **10**. In this case, the control unit **11** transmits information indicating the determined item to the roadside device **20**.

[0065] In S**12**, the control unit **21** notifies the pedestrian of the items determined by S**11** by outputting them via the output unit **25**. Any method may be adopted for the notification to the pedestrian. For example, the control unit **21** communicates with a terminal device used by a pedestrian, and transmits information indicating the determined item to the terminal device. When the terminal device displays the information on a display or the like as an output unit, the determined item is notified to the pedestrian. Thereafter, the operation of the system **1** ends.

[0066] For example, when the control unit **21** determines the items of "the automated driving vehicle **30** is coming" and "the right direction" in S**11** as the items to be notified as a part, the automated driving vehicle comes from the right direction. A message such as a message is generated and output by voice via a speaker as the output unit **25** to notify the pedestrian. The control unit **21** may notify the pedestrian by displaying the information on a display as the output unit **25**. FIG. **4** is an example of an image displayed on the display by the control unit **21**. The image shows the automated driving vehicle **30**, the preceding vehicle V, the pedestrian, and the roadside device **20** on a schematic map. In the image, the preceding vehicle V is stopped, the automated driving vehicle **30** is located behind the preceding vehicle V, and information indicating the automated driving vehicle **30** is displayed in text. The automated driving vehicle **30** may be highlighted by color coding, arrows, blinking, etc. The image displayed on the display is not limited to the example of FIG. **4**, and a text message such as "automated driving vehicle is coming from the right direction" may be displayed.

[0067] For example, when the control unit **21** determines that all items included in the approach information are to be notified of the "arrival of the automated driving vehicle **30**", "rightward direction", and "remaining distance" in S**11**, a message such as a message "The automated driving vehicle comes from the rightward direction. The remaining length is 20 m later." is generated and output by voice via a speaker as the output unit **25** to notify the pedestrian. The control unit **21** may notify the pedestrian by displaying the information on a display as the output unit **25**. FIG. **5** is an example of an image displayed on the display by the control unit **21**. The image shows the automated driving vehicle **30**, the preceding vehicle V, the pedestrian, and the roadside device **20** on a schematic map. In the images, the preceding vehicle V and the automated driving vehicle **30** travel on the roadside and approach the roadside device **20** and the pedestrian, and "20 m" as the remaining distance of the automated driving vehicle **30** to the roadside device **20** is displayed in texts. If "remaining time" is also determined as a notification item in S**11**, for example, "20

seconds" as the remaining time may be displayed in the text instead of or in addition to displaying the "20 m" in the text. The automated driving vehicle **30** may be highlighted by color coding, arrows, blinking, etc. The image displayed on the display is not limited to the example shown in FIG. **5**, but text messages such as "Automated driving vehicles come from the right. The remaining length is 20 m later." may be displayed.

[0068] The present disclosure is not limited to the embodiment described above. For example, two or more blocks shown in the block diagram may be integrated, or a single block may be divided. Instead of executing two or more steps shown in the flowchart in chronological order according to the description, the steps may be executed in parallel or in a different order, depending on the processing capacities of the devices that execute the steps, or as necessary. Other changes may be made without departing from the scope of the present disclosure.

[0069] For example, the control unit **21** may acquire the width information indicating the width of the road that the pedestrian is going to cross and the above-described recognition information, and determine an item to be notified to the pedestrian. Specifically, when the width of the road indicated by the width information is less than the predetermined value and the automated driving vehicle **30** recognizes the presence of the pedestrian, the control unit **21** determines a part of the plurality of items included in the approach information as an item to be notified. The predetermined value is a value of a width such that two vehicles can run side by side. The width information and the information indicating the predetermined value may be set in advance and stored in the storage unit **22**.

[0070] In the present modification, when the width of the road is equal to or greater than the predetermined value, or when the automated driving vehicle **30** does not recognize the presence of the pedestrian, the control unit **21** determines the whole of the plurality of items included in the approach information as an item to be notified. Accordingly, only when the width of the road is narrow and the automated driving vehicle **30** does not overtake the preceding vehicle V and the automated driving vehicle **30** recognizes the pedestrian, a part of the approach information is determined as an item to be notified. Therefore, it is possible to flexibly notify necessary information regarding the approach of the automated driving vehicle **30** while reducing the troublesomeness felt by the pedestrian.

Claims

1. A roadside device provided at a position where a pedestrian crosses a road, the roadside device comprising a control unit, wherein: the control unit acquires information including a plurality of items relating to approach of an automated driving vehicle approaching the position, and information indicating whether a vehicle traveling ahead of the automated driving vehicle has stopped short of the position; and when the vehicle traveling ahead is not stopped short of the position, an entirety of the items is notified to the pedestrian, and when the vehicle traveling ahead is stopped short of the position, a part of the items is notified to the pedestrian.

2. The roadside device according to claim 1, wherein: the items relating to the approach of the automated driving vehicle include a remaining distance until the automated driving vehicle arrives at the position, as the items; and when the vehicle traveling ahead is stopped short of the position, the control unit notifies the pedestrian of items from which the remaining distance is omitted.

3. The roadside device according to claim 1, wherein: the items related to the approach of the automated driving vehicle include a remaining time until the automated driving vehicle arrives at the position, as the items; and when the vehicle traveling ahead is stopped short of the position, the control unit notifies the pedestrian of items from which the remaining time is omitted.

4. The roadside device according to claim 1, wherein: the items relating to the approach of the automated driving vehicle include a direction from which the automated driving vehicle is approaching the position, as the items; and when the vehicle traveling ahead is stopped short of the

position, the control unit notifies the pedestrian of items from which the direction is omitted.

5. The roadside device according to claim 1, wherein: the control unit further acquires recognition information indicating whether the automated driving vehicle recognizes the pedestrian; and when the vehicle traveling ahead is stopped short of the position, and also the automated driving vehicle recognizes the pedestrian, a part of the items is notified to the pedestrian.