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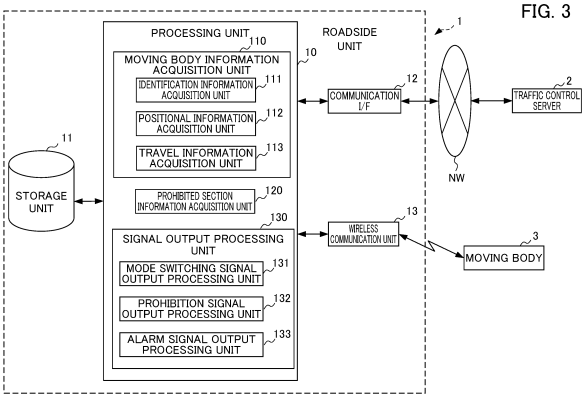
(54) **COORDINATION DEVICE, ROADSIDE UNIT, MOVEMENT CONTROL SYSTEM, PROGRAM, MOVEMENT CONTROL METHOD, AND MOVING BODY**

(57) The purpose of the present invention is to provide a coordination device, a roadside unit, a movement control system, a program, and a movement control method with which it is possible to safely support a moving body using a simple configuration and process. The roadside unit 1 comprises: a positional information-acquiring unit 112 that acquires positional information that indicates a position of a moving body 3; and a signal output processing unit 130 that compares the positional information and prohibited sector information that indicates a prohibited sector A in which movement of the moving body 3 is prohibited, and, on the basis of the compared result, outputs a prohibition signal P that prohibits movement of the moving body 3 in the prohibited sector A. The signal output processing unit 130 determines, on the basis of the compared result, whether or not the moving body 3 is present in the prohibited sector A, and outputs the prohibition signal when it has been determined that the moving body 3 is present in the prohibited sector A.

FIG. 3



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Description

TECHNICAL FIELD

[0001] The present invention relates to a traffic control device, a roadside unit, a movement control system, a program, a movement control method, and a moving body.

BACKGROUND ART

[0002] Conventionally, a device for controlling the movement of a moving body has been known. Patent document 1 is an example of this type of technology. Patent document 1 describes a device including: an acquisition means for acquiring automatic travel information which is information relating to a host vehicle and a state around the host vehicle; an automatic travel means for performing automatic travel by controlling a traveling direction and a speed of the host vehicle based on the automatic travel information; a determination means for determining whether or not a problem related to the automatic travel information has occurred; and a change means for changing, in the case of a problem occurring, a traveling state of the host vehicle or a traveling state of another vehicle in accordance with the content of the problem.

Citation List

Patent Document

[0003] Patent Document 1: Japanese Unexamined Patent Application, Publication No. 2016-181031

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

[0004] However, the device described in Patent document 1 requires a high-performance and expensive device capable of appropriately determining an abnormal state of a moving body. Therefore, in a case where a high-performance control device cannot be installed on a moving body due to cost constraints, the abnormal state of the moving body cannot be appropriately determined due to insufficient redundancy or insufficient calculation capability of the control device, and there is a possibility that the moving body cannot be safely moved.

[0005] In view of these circumstances, an object of the present invention is to provide a traffic control device, a roadside unit, a movement control system, a program, and a movement control method that can support safe movement of a moving body with a simpler configuration and processing. Further, it is another object of the present invention to provide a moving body that is managed and controlled by the traffic control device.

Means for Solving the Problems

[0006]

(1) A traffic control device includes: a positional information acquisition unit that acquires positional information indicating a position of a moving body; and a signal output processing unit that compares the positional information with prohibited section information indicating a prohibited section in which a movement of the moving body is prohibited, and outputs, based on a result of the comparison, a prohibition signal that prohibits the movement of the moving body in the prohibited section, in which the signal output processing unit determines whether the moving body exists in the prohibited section based on the result of the comparison, and when it is determined that the moving body exists in the prohibited section, outputs the prohibition signal.

(2) In the traffic control device as described in (1), the prohibited section information includes information indicating an alarm area set around the prohibited section, and the signal output processing unit determines whether the moving body exists in the alarm area based on a result of the comparison, and when it is determined that the moving body exists in the alarm area, outputs an alarm signal that causes the moving body to execute processing of generating an alarm.

(3) In the traffic control device as described in (1), the moving body is a moving body that is configured to move autonomously.

(4) A roadside unit includes each component of the traffic control device as described in any one of (1) to (3) above, and the roadside unit is installed on a road on which the moving body moves or on a roadside of the road.

(5) A movement control system is configured to wirelessly communicate with a moving body, and the movement control system includes: a plurality of first traffic control devices each installed in a different area; and a second traffic control device that is communicably connected to the plurality of first traffic control devices, in which the second traffic control device includes a prohibited section information management unit that generates prohibited section information indicating a prohibited section in which a movement of the moving body is prohibited, and transmits the prohibited section information to each of the plurality of first traffic control devices, the first traffic control device includes a positional information acquisition unit that acquires positional information indicating a position of the moving body, and a signal output processing unit that compares the positional information with the prohibited section information received from the second traffic control device, and outputs, based on a result of the comparison, a prohibition signal that prohibits the move-

ment of the moving body in the prohibited section, and the signal output processing unit determines whether the moving body exists in the prohibited section based on the result of the comparison, and when it is determined that the moving body exists in the prohibited section, outputs the prohibition signal.

(6) In the movement control system as described in (5), the prohibited section information includes information indicating an alarm area set around the prohibited section, and the signal output processing unit of the first traffic control device determines whether the moving body exists in the alarm area based on the result of the comparison, and when it is determined that the moving body exists in the alarm area, outputs an alarm signal that causes the moving body to execute processing of generating an alarm.

(7) In the movement control system as described in (6), the prohibited section information management unit of the second traffic control device generates the prohibited section information which varies depending on a time period.

(8) In the movement control system as described in any one of (5) to (7), the moving body is a moving body that is configured to move autonomously.

(9) In the movement control system as described in (8), the moving body has driving modes including an autonomous driving mode for traveling autonomously along a set traveling route, and a remote driving mode for traveling based on a remote operation signal for remotely operating the moving body, and the second traffic control device further includes a mode switching signal output processing unit that, when the signal output processing unit outputs the prohibition signal, outputs a driving mode switching signal that switches the driving mode of the moving body to the remote driving mode.

(10) A program causes a computer included in a traffic control device to execute: a positional information acquisition function that acquires positional information indicating a position of a moving body; and a signal output processing function that compares the positional information with prohibited section information indicating a prohibited section in which a movement of the moving body is prohibited, and outputs, based on a result of the comparison, a prohibition signal that prohibits the movement of the moving body in the prohibited section, in which the signal output processing function determines whether the moving body exists in the prohibited section based on the result of the comparison, and when it is determined that the moving body exists in the prohibited section, outputs the prohibition signal.

(11) A movement control method executed by a traffic control device includes: a positional information acquisition step of acquiring positional information indicating a position of a moving body; and a signal output processing step of comparing the positional information with prohibited section information indicating a prohibited section in which a movement of the moving body is prohibited, and outputs, based on a result of the comparison, a prohibition signal that prohibits the movement of the moving body in the prohibited section, in which the signal output processing step further includes determining whether the moving body exists in the prohibited section based on the result of the comparison, and when it is determined that the moving body exists in the prohibited section, outputting the prohibition signal.

(12) A moving body includes: a wireless communication unit that performs communication with the traffic control device as described in any one of (1) to (4) above; a self-position estimation unit that estimate a self-position; a driving unit; and a movement control unit that performs control of driving of the driving unit, in which the self-position estimation unit transmits estimated self-position information to the traffic control device using the wireless communication unit, and when the wireless communication unit receives a prohibition signal transmitted from the traffic control device, the movement control unit controls the driving unit to perform operation corresponding to the prohibition signal.

(13) In the moving body as described in (12) above, the wireless communication unit receives a plurality of prohibition signals relating to restriction of movement into a same prohibited section from different traffic control devices.

(14) In the moving body as described in (13), when the wireless communication unit receives a predetermined number of prohibition signals, the movement control unit controls the driving unit to perform operation corresponding to the prohibition signals.

Effects of the Invention

[0007] According to the present invention, it is possible to support safe movement of a moving body with a simpler configuration and processing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

FIG. 1 is a schematic diagram showing a movement control system according to an embodiment of the present invention and an example of a road to which the movement control system is applied, and is a diagram showing a state in which a moving body moves outside a prohibited section;

FIG. 2 is a schematic diagram showing a movement control system according to an embodiment of the present invention and an example of a road to which the movement control system is applied, and is a diagram showing a state in which a moving body is located in a prohibited section;

FIG. 3 is a block diagram showing a configuration of

hardware and functional blocks of a roadside unit according to an embodiment of the present invention;

FIG. 4A is a schematic diagram showing a positional relationship between a prohibited section and a control target area in the movement control system according to an embodiment of the present invention;

FIG. 4B is a schematic diagram showing a positional relationship between a prohibited section and a control target area in the movement control system according to an embodiment of the present invention;

FIG. 5 is a block diagram showing a configuration of hardware and functional blocks of a traffic control server according to an embodiment of the present invention;

FIG. 6 is a block diagram showing a configuration of hardware and functional blocks of a moving body in the movement control system according to an embodiment of the present invention; FIG. 7 is a flowchart showing an example of movement control executed by a roadside unit 1 according to one embodiment of the present invention;

FIG. 8 is a flowchart showing an example of movement control executed by the roadside unit 1 according to one embodiment of the present invention;

FIG. 9 is a flowchart showing an example of movement control executed by a traffic control server 2 according to one embodiment of the present invention;

FIG. 10 is a flowchart showing an example of movement control executed by a moving body 3;

FIG. 11 is a flowchart showing an example of movement control executed by the moving body 3;

FIG. 12 is a schematic diagram showing a movement control system according to a modification of the present invention and an example of a flight path of an unmanned flying object to which this movement control system is applied; and

FIG. 13 is a schematic diagram illustrating a movement control system according to a modification of the present invention and an example of a road to which this movement control system is applied.

PREFERRED MODE FOR CARRYING OUT THE INVENTION

[0009] Hereinafter, a movement control system S according to an embodiment of the present invention will be described. The present invention is not limited to the following embodiments. In addition, the drawings referred to in the following description merely schematically show shapes, sizes, and positional relationships so that the contents of the present disclosure can be understood. That is, the present invention is not limited to the shapes, sizes, and positional relationships illustrated in the drawings.

<Configuration and Operation of Movement Control System S>

[0010] An overall configuration of a movement control system S according to one embodiment of the present invention will be described with reference to FIG. 1. FIG. 1 is a schematic diagram illustrating an example of a road 4 to which the movement control system S according to the present embodiment is applied.

[0011] The movement control system S is a system that controls a moving body 3 so that the moving body 3 does not move within a defined section on the road 4. The movement control system S is capable of performing wireless communication with the moving body 3, which is a vehicle traveling on the road 4, and includes a plurality of roadside units 1 installed on the road 4 or on the roadside of the road 4, and a traffic control server 2 communicably connected to each of the plurality of roadside units 1 via a communication network NW. Each of the plurality of roadside units 1 includes a processing unit 10 (traffic control device, first traffic control device) described later, and the traffic control server 2 includes a processing unit 20 (traffic control device, second traffic control device) described later. That is, the movement control system S includes a plurality of processing units 10 capable of performing wireless communication with the plurality of moving bodies 3, and a processing unit 20 communicably connected to the plurality of processing units 10. As shown in FIG. 1, in the present embodiment, a system for controlling autonomous driving of a vehicle will be described as an example.

[0012] The moving body 3 is, for example, a self-driving vehicle that can move autonomously. The moving body 3 has a driving mode including an autonomous driving mode in which the vehicle autonomously travels along a travel route set based on positional information of a destination or the like, and a remote driving mode in which the vehicle travels based on a remote operation signal for remotely operating the moving body 3. In the autonomous driving mode, the moving body 3 performs autonomous driving to a predetermined place based on estimated positional information of itself and map information of surroundings of where the moving body 3 exists, which change from moment to moment. The predetermined place refers to a destination set in advance or a place on a route to the destination set in advance. The moving body 3 is configured to be wirelessly communicable with the roadside unit 1.

[0013] The communication network NW may be a wide area network (WAN) including a private network and the Internet. In the former private network, for example, a PON access system formed by an OLT (optical line terminal), a plurality of ONUs (optical network units) connected to the OLT via an optical line, or the like, a layer 2 switch, a layer 3 switch, or the like can be used. On the other hand, in the example of the WAN, an MPLS (Multiprotocol Label Switching) network or the like is used.

[0014] The roadside unit 1 is also called a road side unit (RSU) or the like. The plurality of roadside units 1 are installed in different areas around the road 4 (roadside) or the like. The area indicates a range in which each roadside unit 1 is in charge of communication with each moving body 3, and indicates, for example, a geographical range set along the road 4. In the example illustrated in FIG. 1, the plurality of roadside units 1 are installed along the road 4 at predetermined intervals.

[0015] The roadside unit 1 provides a V2X (Vehicle-to-everything) communication service by performing wireless communication with the moving body 3 traveling on the road 4 or various devices present around the road 4. Further, the roadside unit 1 transmits, to the traffic control server 2 via the communication network NW, data acquired by wireless communication with the moving body 3 traveling in an area where wireless communication is possible (hereinafter, referred to as a communicable area) and various devices in the area. The processing unit 10 included in the roadside unit 1 executes movement control of the moving body 3 by outputting various control signals to the moving body 3. The various control signals are outputted based on the prohibited section information stored in each roadside unit 1. The prohibited section information refers to information related to a prohibited section A indicating a predetermined section on the road 4 as shown in FIG. 1. Details of the prohibited section information will be described later.

[0016] The traffic control server 2 is communicably connected to the plurality of roadside units 1 via the communication network NW. The traffic control server 2 according to the present embodiment generates prohibited section information stored in each of the plurality of roadside units 1, and manages the timing of transmitting the generated prohibited section information to the roadside units 1. The configuration of the traffic control server 2 and the prohibited section information will be described in detail later.

<Configuration and Operation of Roadside Unit 1>

[0017] Next, a functional configuration of the roadside unit 1 in the movement control will be described. FIG. 2 is a schematic diagram illustrating the movement control system S and an example of the road 4 to which the movement control system S is applied, and is a diagram illustrating a situation in which the moving body 3 is located outside the prohibited section A. FIG. 3 is a block diagram illustrating a configuration of hardware and functional blocks of the roadside unit 1.

[0018] As illustrated in FIG. 3, the roadside unit 1 includes a processing unit 10, a storage unit 11, a communication I/F 12, and a wireless communication unit 13.

[0019] The processing unit 10 is an arithmetic device configured by a processor such as a CPU, reads and executes various programs and data from the storage unit 11 described later to realize a movement control function. In the present embodiment, the processing unit 10 executes data processing of each functional unit of a moving body information acquisition unit 110, a prohibited section information acquisition unit 120, and a signal output processing unit 130. The operation of each functional unit will be described later. The operation of each functional unit will be described later. The function of the movement control of the processing unit 10 may be realized by hardware or may be realized by software.

[0020] The storage unit 11 is a storage area for various programs and various data for causing the hardware group to function as the roadside unit 1, and can be configured by ROM, RAM, flash memory, a semiconductor drive (SSD), hard disk drive (HDD), or the like. Specifically, the storage unit 11 stores a program for causing the processing unit 10 to execute each function of the present embodiment, a control program of the roadside unit 1, various parameters, data used for movement control of the moving body 3, identification information such as an IP address and a MAC address of the roadside unit 1, information related to geographical map information including a communicable area, prohibited section information in the communicable area to be described later, and information indicating a position of an area to be the target of a controlled mode to be described later.

[0021] The communication I/F 12 is an interface for the roadside unit 1 to communicate via the communication network NW. The roadside unit 1 is communicably connected to the traffic control server 2 via the communication I/F 12.

[0022] The wireless communication unit 13 executes processing for the roadside unit 1 to perform V2X communication with surrounding devices wirelessly. The wireless communication unit 13 performs wireless communication with moving body 3 traveling in the communicable area of the roadside unit 1. The wireless communication unit 13 receives, for example, identification information for identifying the moving body 3, positional information indicating the position of the moving body 3, travel information of the moving body 3, and the like.

[0023] Next, a functional configuration for the processing unit 10 to execute the movement control of the moving body 3 will be described.

[0024] The moving body information acquisition unit 110 executes processing of acquiring information relating to the moving body 3 traveling in the communicable area of the roadside unit 1. The moving body information acquisition unit 110 includes the identification information acquisition unit 111, the positional information acquisition unit 112, and the travel information acquisition unit 113.

[0025] The identification information acquisition unit 111 executes processing of acquiring the identification information of the moving body 3 received via the wireless communication unit 13. The identification information acquired by the identification information acquisition unit 111 may include, for example, a size of the moving body 3, an identification ID of an on-board device mounted on the moving body 3, a MAC address, and an IPv6 address of an on-board terminal device or the like

connected to the on-board device, and number plate information.

[0026] The positional information acquisition unit 112 executes processing of acquiring the positional information of the moving body 3 received via the wireless communication unit 13. Examples of the positional information include latitude, longitude, and altitude of a position where the moving body 3 exists. In the present embodiment, the positional information acquisition unit 112 acquires at least latitude and longitude information as the positional information.

[0027] The travel information acquisition unit 113 executes processing of acquiring the travel information of the moving body 3 received via the wireless communication unit 13. The travel information includes, for example, information relating to a travel speed, a travel direction, and the like of the moving body 3. The moving body information acquisition unit 110 associates the acquired identification information, the positional information, and the travel information of the moving body 3 with one another, and stores them as the moving body information.

[0028] The prohibited section information acquisition unit 120 executes processing of acquiring the prohibited section information. The prohibited section information is information indicating the position of the prohibited section A provided in the communicable area of the roadside unit 1 as shown in FIGS. 1 and 2. The prohibited section A refers to a geographical range on the road 4 in which the movement of the moving body 3 in the controlled mode described later in detail is prohibited. The prohibited section information is indicated by, for example, latitude, longitude, altitude, and the like. In FIGS. 1 and 2, the prohibited section A indicated by the prohibited section information of the roadside unit 1A is indicated by a broken line. In the example of FIGS. 1 and 2, the prohibited section A of the roadside unit 1 is formed in regions on both sides of the road 4 (regions on the road side and the periphery thereof). In FIGS. 1 and 2, the prohibited section A on the lower side of the drawing shows the positional relationship of the prohibited section A on the road 4, and the prohibited section A and the moving body 3 on the upper side of the drawing virtually show the contents of the comparison processing of the positional information of the moving body 3 and the prohibited section A by the processing unit 10 described later.

[0029] Further, the prohibited section information includes information indicating an alarm area B set around the prohibited section A. That is, the alarm area B is an area in which there is a high possibility that the moving body 3 will move out of the prohibited section A when the moving body 3 continues to move. In the present embodiment, the alarm area B is provided so as to surround the prohibited section A in a plan view.

[0030] The prohibited section information acquisition unit 120 executes processing of acquiring prohibited section information from the traffic control server 2 or the storage unit 11. In the present embodiment, when the prohibited section information is received from the traffic control server 2, the prohibited section information acquisition unit 120 updates the prohibited section information stored in the storage unit 11 to the received prohibited section information.

[0031] The signal output processing unit 130 executes processing of outputting various signals for controlling the moving body 3 based on the positional information of the moving body 3 and the like. The signal output processing unit 130 includes a mode switching signal output processing unit 131, a prohibition signal output processing unit 132, and an alarm signal output processing unit 133.

[0032] The mode switching signal output processing unit 131 executes processing of outputting the first mode switching signal based on the positional information of the moving body 3 and the prohibited section information. The first mode switching signal is a control signal including an instruction to perform mode switching for switching the mode in which the moving body 3 moves to the controlled mode or the non-controlled mode. The controlled mode refers to a mode in which the operation of the moving body 3 is controlled in accordance with a control signal such as a prohibition signal P or an alarm signal transmitted from the roadside unit 1. The non-controlled mode is a mode in which the operation of the moving body 3 is not controlled by a control signal such as the prohibition signal P or the alarm signal transmitted from the roadside unit 1.

[0033] Here, a relationship between an area subject to the controlled mode (hereinafter, referred to as a control target area C) and the prohibited section A will be described. FIGS. 4A and 4B are diagrams for explaining the relationship between the control target area C and the prohibited section A. In FIGS. 4A and 4B, the prohibited section A is indicated by a one-dot chain line, and the control target area C is indicated by a broken line. As shown in FIG. 4A, the control target area C is set to be outside the entrance and the exit of the prohibited section A in the traveling direction of the moving body 3 on the road 4 and to be wider than the widths of the two prohibited sections A. Further, as shown in FIG. 3B, the control target area C may be set to be at the same place as the entrance and the exit of the alarm area B existing around the prohibited section A and to be wider than the widths of the two prohibited sections A.

[0034] For example, when it is determined that the moving body 3 has entered the control target area C based on the positional information of the moving body 3, the mode switching signal output processing unit 131 outputs a first mode switching signal for performing mode switching from the non-controlled mode to the controlled mode. In addition, when it is determined that the moving body 3 has exited the control target area C based on the positional information of the moving body 3, the mode switching signal output processing unit 131 outputs the first mode switching signal for executing mode switching

from the controlled mode to the non-controlled mode.

[0035] The prohibition signal output processing unit 132 executes processing of outputting the prohibition signal P for prohibiting the movement of the moving body 3 in the controlled mode. The prohibition signal output processing unit 132 compares the positional information of the moving body 3 with the prohibited section information, and outputs the prohibition signal P based on the comparison result. Specifically, the prohibition signal output processing unit 132 determines whether or not the moving body 3 exists in the prohibited section A based on the comparison result between the positional information of the moving body 3 and the prohibited section information, and outputs the prohibition signal P when it is determined that the moving body 3 exists in the prohibited section A. For example, the prohibition signal output processing unit 132 may determine that the moving body 3 exists in the prohibited section A only when the entire moving body 3 is located in the prohibited section A by using the information relating to the size of the moving body 3, which is the identification information. For example, the prohibition signal output processing unit 132 may determine that the moving body exists in the prohibited section A when at least a part of the moving body 3 is located in the prohibited section A. Further, when the center of the vehicle body of the moving body 3 is located in the prohibited section A, it may be determined that the moving body 3 exists in the prohibited section A. For example, the moving body 3 receives control for restricting the continuous travel when the prohibition signal P is received in the controlled mode, and is allowed to perform the continuous travel when the prohibition signal P is not received.

[0036] The alarm signal output processing unit 133 executes processing of outputting an alarm signal based on the positional information of the moving body 3 and the prohibited section information. The alarm signal refers to a control signal including an instruction to cause the moving body 3 to perform processing of generating an alarm that alerts the operator of the moving body 3. The alarm signal output processing unit 133 compares the positional information with the information indicating the alarm area B included in the prohibited section information, and determines whether or not the moving body 3 exists in the alarm area B based on the comparison result. When it is determined that the moving body 3 exists in the alarm area B, the alarm signal output processing unit 133 outputs an alarm signal indicating that the moving body 3 exists in the alarm area B to the moving body 3.

<Configuration and Operation of Traffic control server 2>

[0037] Next, a functional configuration of the traffic control server 2 in the movement control will be described. FIG. 5 is a block diagram illustrating a configuration of hardware and functional blocks of the traffic control server 2.

[0038] As illustrated in FIG. 5, the traffic control server 2 includes a processing unit 20, a storage unit 21, and a communication I/F 22.

[0039] The processing unit 20 is an arithmetic device configured by a processor such as a CPU, and reads and executes various programs and data from the storage unit 21 described later to realize a function of movement control. In the present embodiment, the processing unit 20 executes data processing of each functional unit of a roadside unit information acquisition unit 210, a map information management unit 220, a prohibited section information management unit 230, and a mode switching signal output processing unit 240. The operation of each functional unit will be described later. The function of the movement control of the processing unit 20 may be realized by hardware or software.

[0040] The storage unit 21 is a storage area for various programs for causing a hardware group to function as the traffic control server 2, various data, and the like, and can be configured by ROM, RAM, flash memory, a semiconductor drive (SSD), hardware (HDD), or the like. Specifically, the storage unit 21 stores a program for causing the processing unit 20 to execute each function of the present embodiment, a control program of the traffic control server 2, various parameters, data used for movement control of the moving body 3, identification information such as IP addresses and MAC addresses of a plurality of roadside units 1 communicably connected to the traffic control server 2, geographical map information including communicable areas of the plurality of roadside units 1, and prohibited section information in each communicable area of the plurality of roadside units 1.

[0041] The communication I/F 22 is an interface for the traffic control server 2 to communicate via the communication network NW. The traffic control server 2 is communicably connected to the plurality of roadside units 1 and other communication devices via the communication I/F 22.

[0042] Next, a functional configuration for the processing unit 20 to execute the movement control of the moving body 3 will be described.

[0043] The roadside unit information acquisition unit 210 (positional information acquisition unit) executes processing of acquiring roadside unit information transmitted from each of the plurality of roadside units 1. Examples of the roadside unit information include moving body information acquired by each of the plurality of roadside units 1, information relating to an event occurring on the road 4, and information relating to an output state of various control signals by the roadside unit 1. Examples of the information relating to the event include a traffic accident, traffic congestion, a breakdown of a vehicle, traveling of an emergency vehicle, a road surface abnormality, a fire, traveling of a maintenance vehicle on the road 4, and the like. That is, the roadside unit information acquisition unit 210 acquires information

such as identification information, positional information, and travel information of the moving body 3 traveling in the communicable area of each roadside unit 1, information relating to the occurrence situation of a traffic accident on the road 4, and the like. Examples of the information relating to the output status of the various control signals include the presence or absence of the output of the first mode switching signal, the alarm signal, the prohibition signal P, and the like.

[0044] The map information management unit 220 generates map information based on information acquired from the outside and updates the map information as needed. The map information may be, for example, a dynamic map. The dynamic map is a combination of static information such as road surface information, lane information, and structures, and dynamic information such as traffic regulations, construction, congestion, vehicles, pedestrians, and signals, and is a three-dimensional digital map having latitude, longitude, and altitude information. The map information management unit 220 updates the dynamic map as needed based on information acquired from the outside, and transmits the dynamic map to each of the plurality of roadside units 1. The map information transmitted to each roadside unit 1 is transmitted from the roadside unit 1 to the moving body 3 while traveling.

[0045] The prohibited section information management unit 230 executes processing of generating and managing prohibited section information for each of the plurality of roadside units 1. Specifically, the prohibited section information management unit 230 generates prohibited section information for each of the plurality of roadside units 1 based on information acquired via the communication network NW or a predetermined program stored in the storage unit 21. Then, the prohibited section information management unit 230 transmits the generated prohibited section information to the corresponding roadside unit 1. The prohibited section information management unit 230 may generate different prohibited section information depending on, for example, a time period. For example, the prohibited section information management unit 230 may provide the prohibited section A on the road side of the road 4, and may set the size of the prohibited section A in a time period such as the morning or evening when children go (back) to school (hereinafter, referred to as a school time period) to be larger than other time periods. Further, for example, the prohibited section information management unit 230 may provide the prohibited section A only in the school time period. The prohibited section information management unit 230 may generate different prohibited section information based on information acquired from the outside. For example, the prohibited section information management unit 230 may change the prohibited section information based on the information relating to the event acquired from the roadside unit 1. More specifically, when acquiring the information relating to the occurrence of the traffic accident on the road 4, the prohibited section information management unit 230 may generate the prohibited section information indicating the prohibited section A provided at and around the accident occurrence location. Further, for example, when acquiring information indicating that a maintenance vehicle is traveling on an expressway, the prohibited section information management unit 230 may generate the prohibited section information for the maintenance vehicle to move.

[0046] The mode switching signal output processing unit 240 executes processing of outputting a second mode switching signal (operation mode switching signal). The second mode switching signal refers to a control signal including a command to execute driving mode switching for switching the driving mode of the moving body 3 to the autonomous driving mode or the remote driving mode. The mode switching signal output processing unit 240 may output the second mode switching signal based on the output state of the prohibition signal P by the signal output processing unit 130 of the roadside unit 1, for example. Specifically, in a case where it is determined that the prohibition signal P is outputted from the roadside unit 1, the mode switching signal output processing unit 240 may output the second mode switching signal to execute driving mode switching for switching the driving mode of the moving body 3 from the autonomous driving mode to the remote driving mode. In addition, when it is determined that the positional information of the moving body 3 is outside the prohibited section A after a predetermined time elapses from the output of the prohibition signal P, the mode switching signal output processing unit 240 may output the second mode switching signal to execute driving mode switching for switching the driving mode of the moving body 3 from the remote driving mode to the autonomous driving mode, for example.

<Configuration and Operation of Moving Body 3>

[0047] Next, a functional configuration of the moving body 3 will be described. FIG. 6 is a block diagram illustrating the configuration of hardware and functional blocks of the moving body 3.

[0048] As illustrated in FIG. 6, the moving body 3 includes the processing unit 30, the storage unit 31, the wireless communication unit 32, the sensor unit 33, the GNSS unit 34, and the driving unit 35.

[0049] The processing unit 30 is an arithmetic device configured by a processor such as a CPU, and reads and executes various programs and data from the storage unit 31 described later to realize a function of movement control. In the present embodiment, the processing unit 30 executes data processing of each functional unit of a self-position estimation unit 310, a signal acquisition unit 320, a mode switching unit 330, a movement control unit 340, and an alarm control unit 350. The operation of each functional unit will be described later.

[0050] The storage unit 31 is a storage area for various programs and various data for causing a hardware group

to function as the moving body 3, and can be configured by ROM, RAM, flash memory, a semiconductor drive (SSD), hardware (HDD), or the like. Specifically, the storage unit 31 stores a program (a control program of the moving body 3) for causing the processing unit 30 to execute each function of the present embodiment, various parameters, data used for movement control of the moving body 3, identification information such as an identification ID and an IP address of the moving body 3, map information, and the like. Examples of the map information include a dynamic map.

[0051] The wireless communication unit 32 executes processing for the moving body 3 to wirelessly communicate with the roadside unit 1. The wireless communication unit 32 transmits, for example, identification information for identifying the moving body 3, positional information indicating the position of the moving body 3, travel information of the moving body 3, and the like to the roadside unit 1, and receives various control signals such as the first mode switching signal, the prohibition signal P, and the alarm signal, the map information generated by the traffic control server 2, and the like from the roadside unit 1. The wireless communication unit 32 communicates with the processing unit 10 via the wireless communication unit 13 of the roadside unit 1.

[0052] The sensor unit 33 is a device for detecting information relating to the surroundings of the moving body 3 itself. The sensor unit 33 may be, for example, radar or LIDAR (light detection and ranging) that detects a distance, a direction, a relative speed, or the like relative to an object present around the moving body 3 based on a transmission wave transmitted to the periphery of the moving body 3 and a reflected received wave, or may be a camera or the like. In the present embodiment, as the sensor unit 33, LIDAR is used which irradiates laser light around the moving body 3 and detects a surrounding object as point cloud data. According to LIDAR, it is possible to detect the position, the shape, and the like of the surrounding object with high accuracy. The sensor unit 33 transmits the detected point cloud data to the processing unit 30.

[0053] The GNSS (Global Navigation Satellite System) unit 34 includes an antenna and receives a GNSS signal and the like. The GNSS signal is transmitted from a navigation satellite or the like that make up a GNSS such as GPS (Global Positioning System) or a quasi-zenith satellite system. The GNSS unit 34 transmits the received GNSS signal to the processing unit 30.

[0054] The driving unit 35 is a part related to driving of the moving body 3, such as an engine, a motor, or a brake.

[0055] Next, a functional configuration for the processing unit 30 to execute movement control of the moving body 3 will be described.

[0056] The self-position estimation unit 310 executes processing of estimating positional information indicating the position of the moving body 3 itself. For example, the self-position estimation unit 310 may estimate the positional information of the moving body 3 based on the map information received from the traffic control server 2, the point cloud data around the moving body 3 received from the sensor unit 33, the GNSS signal received from the GNSS unit 34, and the like. More specifically, the self-position estimation unit 310 may estimate the positional information of the moving body 3 by collating the map information with the point cloud data around the moving body 3. The positional information estimated by the self-position estimation unit 310 is transmitted to the roadside unit 1 via the wireless communication unit 32.

[0057] The signal acquisition unit 320 executes processing of acquiring various control signals such as the first mode switching signal, the second mode switching signal, the prohibition signal P, and the alarm signal from the roadside unit 1 via the wireless communication unit 32.

[0058] When the first mode switching signal is acquired by the signal acquisition unit 320, the mode switching unit 330 switches the movement mode of the moving body 3. Specifically, when the first mode switching signal for executing mode switching from the non-controlled mode to the controlled mode is acquired in a state where the movement mode of the moving body 3 is the non-controlled mode, the mode switching unit 330 switches the movement mode to the controlled mode. On the other hand, when the first mode switching signal for performing mode switching from the controlled mode to the non-controlled mode is acquired in a state where the movement mode of the moving body 3 is the controlled mode, the mode switching unit 330 switches the movement mode from the controlled mode to the non-controlled mode.

[0059] When the second mode switching signal is acquired by the signal acquisition unit 320, the mode switching unit 330 switches the operation mode of the moving body 3. Specifically, when the second mode switching signal is acquired in a state where the driving mode of the moving body 3 is the autonomous driving mode, the mode switching unit 330 switches the driving mode to the remote driving mode. Conversely, when the second mode switching signal is acquired in a state where the driving mode of the moving body 3 is the remote driving mode, the mode switching unit 330 switches the driving mode from the remote driving mode to the autonomous driving mode.

[0060] When the driving mode of the moving body 3 is the autonomous driving mode, the movement control unit 340 executes processing of controlling the movement of the moving body 3 based on the positional information, etc. estimated by the self-position estimation unit 310. Specifically, the movement control unit 340 controls the movement to the set destination by controlling the driving of the driving unit 35 based on the positional information and the travel information of the moving body 3, the map information stored in the storage unit 31, and the like.

[0061] When the driving mode of the moving body 3 is the remote driving mode, the movement control unit 340

stops the autonomous driving and executes processing of controlling the movement of the moving body 3 based on the remote operation signal. For example, the remote control signal may be transmitted to the moving body 3 via the communication network NW from a facility such as a traffic control center having, for example, the traffic control server 2. The remote control signal may be generated as a signal such that the moving body 3 moves to the outside of the prohibited section A based on, for example, the positional information of the moving body 3 or the map information acquired via the traffic control server 2, the prohibited section information, the image captured by the moving body 3 or the roadside unit 1, or the like.

[0062] When the movement mode of the moving body 3 is the controlled mode, the movement control unit 340 executes processing of controlling the driving of the moving body 3 based on the acquisition status of the prohibition signal P by the signal acquisition unit 320. When the prohibition signal P transmitted from the processing unit 10 of the roadside unit 1 is received by the wireless communication unit 32, the movement control unit 340 controls the driving unit 35 to perform an operation corresponding to the prohibition signal P. The operation corresponding to the prohibition signal P refers to, for example, an operation of stopping the driving of the moving body 3 or an operation for the moving body 3 to leave from the prohibited section A. When the prohibition signal P is acquired by the signal acquisition unit 320, the movement control unit 340 may execute control for stopping the moving body 3, and may control the moving body 3 so that the moving body 3 in the prohibited section A leaves the prohibited section A. The control for stopping the moving body 3 may be, for example, control for stopping the moving body 3 after decelerating to a predetermined speed. In addition, for example, when the prohibition signal P is acquired a predetermined number of times or more within the determination period, the movement control unit 340 may execute control for stopping the moving body 3 or control for leaving the prohibited section A.

[0063] When the movement mode of the moving body 3 is the controlled mode and the alarm signal is acquired by the signal acquisition unit 320, the alarm control unit 350 executes processing for generating an alarm. The alarm may be audio information, textual information, or the like to inform the operator of the moving body 3 of the possibility of entering the prohibited section A. For example, the alarm control unit 350 may display an alarm on a liquid crystal display or a mirror disposed in the moving body 3 or may generate audio information from a speaker disposed in the moving body 3.

[0064] Next, an example of movement control on the road 4 by the movement control system S will be described with reference to FIGS. 1 and 2.

[0065] In the situation shown in FIG. 1, the moving body 3 is traveling between two prohibited sections A on the road 4. As shown in FIG. 1, in the comparison result by the prohibition signal output processing unit 132 of the roadside unit 1, the moving body 3 is located outside the prohibited section A, and thus the prohibition signal P is not outputted. Therefore, the moving body 3 is continuously running.

[0066] On the other hand, in a case of the situation shown in FIG. 2, in the comparison result by the prohibition signal output processing unit 132 of the roadside unit 1, the moving body 3 is located in the prohibited section A, and thus the prohibition signal P is transmitted to the moving body 3. As a result, the moving body 3 decelerates and stops as shown in FIG. 2, for example.

[0067] Next, a flow of the movement control of the moving body 3 by the movement control system S according to the present embodiment will be described. It is to be noted that the contents of the processing in the following operation description are merely examples, and various types of processing capable of obtaining similar results can be adopted as appropriate.

[0068] First, the flow of processing of the movement control executed by the roadside unit 1 will be described with reference to FIGS. 7 and 8. FIG. 7 is a flowchart showing an example of processing up to the output of the first mode switching signal in the movement control executed by the processing unit 10 of the roadside unit 1, and FIG. 8 is a flowchart showing an example of processing for controlling the moving body 3 in the controlled mode. The processing unit 10 executes the processing of FIGS. 7 and 8 based on, for example, a program stored in the storage unit 11 or the like. The flows of the processing exemplified in FIGS. 7 and 8 each start the processing when the installed roadside unit 1 is activated, and then continue the processing during the operation of the roadside unit 1.

[0069] As illustrated in FIG. 7, in step S11, the positional information acquisition unit 112 acquires the positional information of the moving body 3 received via the wireless communication unit 13.

[0070] In step S12, the mode switching signal output processing unit 131 compares the positional information acquired in step S11 with the information indicating the position of the control target area C stored in the storage unit 11, and determines whether the moving body 3 has entered the control target area C. When it is determined that the moving body 3 has entered the control target area C (step S12; YES), the mode switching signal output processing unit 131 proceeds to step S13. On the other hand, when it is determined that the moving body 3 is located outside the control target area C (step S12; NO), the mode switching signal output processing unit 131 repeats the processing of step S11.

[0071] In step S13, the mode switching signal output processing unit 131 outputs the first mode switching signal for switching the moving body 3 to the controlled mode. Then, the first mode switching signal is transmitted to the moving body 3 by the wireless communication unit 13.

[0072] As illustrated in FIG. 8, in step S21, the prohib-

ited section information acquisition unit 120 extracts the prohibited section information from the storage unit 11.

[0073] In step S22, the positional information acquisition unit 112 acquires the positional information of the moving body 3 received via the wireless communication unit 13.

[0074] In step S23, the prohibition signal output processing unit 132 compares the prohibited section information acquired in step S21 with the positional information acquired in step S22, and determines whether or not the moving body 3 is located within the prohibited section A. When the prohibition signal output processing unit 132 determines that the moving body 3 is located within the prohibited section A (step S23; YES), the processing proceeds to step S24. On the other hand, when the prohibition signal output processing unit 132 determines that the moving body 3 is located outside the prohibited section A (step S23; NO), the processing of step S22 is repeated.

[0075] In step S24, the prohibition signal output processing unit 132 outputs the prohibition signal P for prohibiting the movement of the moving body 3 in the prohibited section A. Then, the prohibition signal P is transmitted to the moving body 3 by the wireless communication unit 13. Thereafter, the processing unit 10 returns the processing to step S22.

[0076] Next, a flow of processing of the movement control executed by the traffic control server 2 will be described with reference to FIG. 9. FIG. 9 is a flowchart illustrating an example of processing of the movement control executed by the processing unit 20 of the traffic control server 2. The processing unit 20 executes the processing of FIG. 9 based on, for example, a program stored in the storage unit 21 or the like. The flow of processing illustrated in FIG. 9 starts the processing when the traffic control server 2 installed is activated, and then continues the processing while the traffic control server 2 is operating.

[0077] As illustrated in FIG. 9, in step S31, the roadside unit information acquisition unit 210 acquires roadside unit information that is transmitted from each of the plurality of roadside units 1, and includes the output status of the prohibition signal P by each of the roadside units 1 and the positional information of the moving body 3.

[0078] In step S32, the mode switching signal output processing unit 240 determines whether or not the prohibition signal P is outputted by the roadside unit 1 based on the roadside unit information acquired in step S31. When it is determined that the prohibition signal P is outputted by the roadside unit 1 (step S32; YES), the mode switching signal output processing unit 240 causes the processing to proceed to step S33. On the other hand, when it is determined that the prohibition signal P is not outputted by the roadside unit 1 (step S32; NO), the mode switching signal output processing unit 240 returns the processing to step S31.

[0079] In step S33, the mode switching signal output processing unit 240 outputs the second mode switching signal. Then, the second mode switching signal is transmitted to the moving body 3 via the roadside unit 1 and the wireless communication unit 13 which outputted the prohibition signal P.

[0080] Next, a flow of processing of the movement control executed by the moving body 3 will be described with reference to FIGS. 10 and 11. FIG. 10 is a flowchart showing an example of processing executed by the moving body 3 until the movement mode is switched to the controlled mode, and FIG. 11 is a flowchart showing an example of processing executed by the moving body 3 in the controlled mode. It is to be noted that the moving body 3 at the start of the flow of FIG. 10 assumes that the movement mode is the non-controlled mode and the driving mode is the autonomous driving mode.

[0081] As illustrated in FIG. 10, in step S41, the self-position estimation unit 310 estimates the positional information indicating the position of the moving body 3 itself. The self-position estimation unit 310 estimates the positional information of the moving body 3 itself based on, for example, the map information received from the traffic control server 2 via the roadside unit 1 and point cloud data received from the sensor unit 33.

[0082] In step S42, the wireless communication unit 32 transmits the positional information of the moving body 3 estimated in step S41 to the roadside unit 1.

[0083] In step S43, the mode switching unit 330 determines whether or not the first mode switching signal has been received from the roadside unit 1. When it is determined that the first mode switching signal has been acquired by the signal acquisition unit 320 (step S43; YES), the mode switching unit 330 causes the processing to proceed to step S44. On the other hand, when it is determined that the signal acquisition unit 320 has not acquired the first mode switching signal (step S43; NO), the mode switching unit 330 returns the processing to step S31.

[0084] In step S44, the mode switching unit 330 switches the movement mode of the moving body 3 to the controlled mode.

[0085] As illustrated in FIG. 11, in step S51, the self-position estimation unit 310 estimates the positional information indicating the position of the moving body 3 itself. The self-position estimation unit 310 estimates the positional information of the moving body 3 itself based on, for example, the map information received from the traffic control server 2 via the roadside unit 1 and point cloud data received from the sensor unit 33.

[0086] In step S52, the wireless communication unit 32 transmits the positional information of the moving body 3 estimated in step S51 to the roadside unit 1.

[0087] In step S53, the movement control unit 340 determines whether or not the signal acquisition unit 320 has received the prohibition signal P. When it is determined that the prohibition signal P is acquired by the signal acquisition unit 320 (step S53; YES), the movement control unit 340 causes the processing to proceed

to step S54. On the other hand, when it is determined that the signal acquisition unit 320 has not acquired the prohibition signal P (step S53; NO), the movement control unit 340 returns the processing to step S51.

[0088] In step S54, the movement control unit 340 controls the driving unit 35 to stop the movement of the moving body 3.

[0089] In step S55, the processing unit 30 receives the second mode switching signal from the traffic control server 2. Then, the mode switching unit 330 switches the driving mode of the moving body 3 from the autonomous driving mode to the remote driving mode.

[0090] According to the embodiment described above, the following advantageous effects are obtained.

[0091] The processing unit 10 according to the present embodiment includes the positional information acquisition unit 112 that acquires positional information indicating the position of the moving body 3, and the signal output processing unit 130 that compares the positional information with the prohibited section information indicating the prohibited section A in which the movement of the moving body 3 is prohibited, and outputs the prohibition signal P that prohibits the movement of the moving body 3 in the prohibited section A based on the result of the comparison. The signal output processing unit 130 determines whether the moving body 3 exists in the prohibited section A based on the result of the comparison, and when it is determined that the moving body 3 exists in the prohibited section A, outputs the prohibition signal P. With such a configuration, it is possible to move the moving body 3 in a determined area by the simple processing of comparing the position of the moving body 3 with the prohibited section A. For example, by providing the prohibited section A in an area including the oncoming lane, the road side, and the sidewalk of the road 7, it is possible to prevent the moving body 3 from entering the area and causing an accident if an abnormality occurs in the control of the self-driving vehicle or if an elderly driver erroneously performs a driving operation. Therefore, it is possible to assist in the safe movement of the moving body 3 with a simple configuration and processing.

[0092] In addition, in the processing unit 10 according to the present embodiment, the prohibited section information includes information indicating the alarm area B set around the prohibited section A, and the signal output processing unit 130 determines whether the moving body 3 exists in the alarm area B based on a result of the comparison, and when it is determined that the moving body 3 exists in the alarm area B, outputs an alarm signal for causing the moving body 3 to execute the processing whereby the moving body 3 generates an alarm. With such a configuration, since an alarm is generated when the moving body 3 approaches the prohibited section A, the operator or the like of the moving body 3 can grasp the possibility of entry of the moving body 3 into the prohibited section A. Therefore, it is easy to avoid entry of the moving body 3 into the prohibited section A.

[0093] Further, in the processing unit 10 according to the present embodiment, the moving body 3 is the moving body 3 which is configured to move autonomously. With such a configuration, even if an abnormality occurs in the traveling of the self-driving vehicle, it is possible to suppress the traveling of the self-driving vehicle in the prohibited section A.

[0094] The roadside unit 1 according to the present embodiment is the roadside unit 1 which includes each constituent element of the processing unit 10, and is installed on the road 4 on which the moving body 3 moves or at the roadside of the road 4. With such a configuration, it is possible to assist in the safe movement of the moving body 3 traveling on the road 4 by a simple configuration and processing.

[0095] The movement control system S according to the present embodiment is configured to be able to perform wireless communication with the moving body 3, and includes the plurality of roadside units 1 each installed in a different area, and the traffic control server 2 communicably connected to the plurality of roadside units 1. The traffic control server 2 includes the prohibited section information management unit 230 that generates the prohibited section information indicating the prohibited section A in which the movement of the moving body 3 is prohibited and transmits the prohibited section information to each of the plurality of roadside units 1. The roadside unit 1 includes the positional information acquisition unit 112 that acquires positional information indicating the position of the moving body 3 and the signal output processing unit 130 that compares the positional information with the prohibited section information received from the traffic control server 2 and outputs the prohibition signal P that prohibits the movement of the moving body 3 in the prohibited section A based on a result of the comparison. The signal output processing unit 130 determines whether the moving body 3 exists in the prohibited section A based on the result of the comparison, and when it is determined that the moving body 3 exists in the prohibited section A, outputs the prohibition signal P. With such a configuration, it is possible to prevent the moving body 3 from moving in an area where there is a risk of danger, by simple processing of comparing the position of the moving body 3 with the prohibited section A. For example, by providing the prohibited section A in an area including the oncoming lane, the road side, and the sidewalk of the road 7, it is possible to prevent the moving body 3 from entering the area and causing an accident if an abnormality occurs in the control of the self-driving vehicle or if an elderly driver erroneously performs a driving operation. Therefore, it is possible to assist in the safe movement of the moving body 3 with a simple configuration and processing.

[0096] In addition, in the movement control system S according to the present embodiment, the prohibited section information includes information indicating the alarm area B set around the prohibited section A, and the signal output processing unit 130 of the roadside unit 1 determines whether the moving body 3 exists in the alarm

area B based on the result of the comparison, and when it is determined that the moving body 3 exists in the alarm area B, outputs an alarm signal for causing the moving body 3 to perform processing of generating an alarm. With such a configuration, since an alarm is generated when the moving body 3 approaches the prohibited section A, the operator or the like of the moving body 3 can grasp the possibility of entry of the moving body 3 into the prohibited section A. Therefore, it is easy to avoid entry of the moving body 3 into the prohibited section A.

[0097] In addition, in the movement control system S according to the present embodiment, the prohibited section information management unit 230 of the traffic control server 2 generates the prohibited section information which varies depending on a time period. With such a configuration, since the position, size, and the like of the prohibited section A can be changed in consideration of traffic conditions and the like that vary according to the time period, it is possible to move the moving body 3 more safely.

[0098] In the movement control system S according to the present embodiment, the moving body 3 is a moving body 3 that is configured to move autonomously. With such a configuration, even if an abnormality occurs in the traveling of the self-driving vehicle, it is possible to suppress the traveling of the self-driving vehicle in the prohibited section A.

[0099] Further, in the movement control system S according to the present embodiment, the moving body 3 has driving modes including the autonomous driving mode in which the vehicle autonomously travels along a set travel route and the remote driving mode in which the vehicle travels based on a remote operation signal for remotely operating the moving body 3. The traffic control server 2 further includes the mode switching signal output processing unit 240 that outputs a driving mode switching signal for switching the driving mode of the moving body 3 to the remote driving mode when the prohibition signal P is outputted by the signal output processing unit 130. With such a configuration, even when the moving body 3 enters the prohibited section A, it is possible to return the moving body 3 to outside of the prohibited section A by, for example, remote control, and it is possible to continue the safe movement of the moving body 3. Therefore, it is possible to move the moving body 3 safely without interfering with the movement of another moving body 3.

[0100] The program according to the present embodiment causes a computer included in the roadside unit 1 to execute: a positional information acquisition function of acquiring positional information indicating a position of the moving body 3; and a signal output processing function of comparing the positional information with prohibited section information indicating the prohibited section A in which the movement of moving body 3 is prohibited, and outputting the prohibition signal P for prohibiting the movement of moving body 3 in the prohibited section A based on a result of the comparison. The signal output processing function determines whether the moving body 3 exists in the prohibited section A based on the result of the comparison and, when it is determined that the moving body 3 exists in the prohibited section A, outputs the prohibition signal P. With such a configuration, it is possible to prevent the moving body 3 from moving in an area where there is a risk of danger by simple processing of comparing the position of the moving body 3 with the prohibited section A. For example, by providing the prohibited section A in an area including the oncoming lane, the road side, and the sidewalk of the road 7, it is possible to prevent the moving body 3 from entering the area and causing an accident if an abnormality occurs in the control of the self-driving vehicle or if the elderly driver erroneously performs the driving operation. Therefore, it is possible to assist the safe movement of the moving body 3 with a simple configuration and processing.

[0101] A movement control method according to the present embodiment is a movement control method executed by a roadside unit 1, and the method includes: a positional information acquisition step of acquiring positional information indicating a position of the moving body 3; and a signal output processing step of comparing the positional information with prohibited section information indicating the prohibited section A in which the movement of moving body 3 is prohibited, and outputting the prohibition signal P for prohibiting the movement of the moving body 3 based on a result of the comparison. The signal output processing step determines whether the moving body 3 exists in the prohibited section A based on the result of the comparison, and when it is determined that the moving body 3 exists in the prohibited section A, the signal output processing step outputs the prohibition signal P. With such a configuration, it is possible to prevent the moving body 3 from moving in an area where there is a risk of danger by simple processing of comparing the position of the moving body 3 with the prohibited section A. For example, by providing the prohibited section A in an area including the oncoming lane, the road side, and the sidewalk of the road 7, it is possible to prevent the moving body 3 from entering the area and causing an accident if an abnormality occurs in the control of the self-driving vehicle or if an elderly driver erroneously performs a driving operation. Therefore, it is possible to assist in the safe movement of the moving body 3 with a simple configuration and processing.

[0102] The moving body 3 according to the present embodiment includes the wireless communication unit 32 that communicates with the processing unit 10, the self-position estimation unit 310 that estimates a self-position, the driving unit 35, and the movement control unit 340 that controls driving of the driving unit 35. The self-position estimation unit 310 transmits the estimated self-positional information to the processing unit 10 using the wireless communication unit 32. The movement control unit 340 controls the driving unit 35 to perform operation corresponding to the prohibition signal P when the

movement control unit 340 receives the prohibition signal P transmitted from the processing unit 10 using the wireless communication unit 32. With such a configuration, it is possible to provide the moving body 3 which is managed and controlled by the roadside unit 1 including the processing unit 10. Therefore, it is possible to assist in the safe movement of the moving body 3 with a simple configuration and processing.

[0103] Although embodiments of the present invention have been described above, the present invention is not limited to the above-described embodiments, and can be appropriately modified.

[0104] Although the moving body 3 in the above embodiment is a self-driving vehicle, it may be a vehicle that does not have an autonomous driving function. Further, the vehicle may be a four-wheeled motor vehicle or a two-wheeled motor vehicle. Also, the moving body 3 is not limited to vehicles and may be an unmanned flying object, such as a drone. In particular, in a case of an unmanned flying object, 3D map information made mainly using latitude, longitude, and altitude information is used.

[0105] Here, the configuration of a movement control system S in a case in which the moving body 3 is an unmanned flying object will be described. FIG. 12 is a schematic diagram illustrating an example of a flight path of an unmanned flying object to which the movement control system S according to a modification of the present embodiment is applied.

[0106] The unmanned flying object is used for checking the state of electric wires 51 suspended by a steel tower 50, checking the state of a road or a wall surface in a tunnel, checking the state of a structure bridging over a river, a canal, a railway line, a road, or the like, checking a building, monitoring a river, a cliff, or a sea, and the like during a disaster. In the example shown in FIG. 12, the state of the electric wires 51 of the steel tower 50 is inspected using an autonomously movable unmanned flying object.

[0107] The prohibited section A in which the unmanned flying object can fly is defined by latitude, longitude, and altitude. In addition, in the example illustrated in FIG. 12, the shape of the prohibited section A is a prismatic shape, but is not limited to this shape, and various shapes such as a cylindrical shape can be considered. In the example shown in FIG. 12, the prohibited section A is set so as to surround the steel tower 50 and the electric wires 51.

[0108] In the example illustrated in FIG. 12, roadside units 1D, 1E, and 1F manage the prohibited section A. Each of the roadside units 1D, 1E, and 1F acquires the positional information from the unmanned flying object, compares the prohibited section information indicating the prohibited section A stored therein with the positional information of the unmanned flying object, and transmits the prohibition signal P to the unmanned flying object in a case in which the unmanned flying object is flying in the prohibited section A. In addition, when the unmanned flying object enters the prohibited section A, a drone autonomous evacuation program for landing outside the prohibited section A on a safe route may be operated, or an emergency landing on the side opposite to the steel tower 50 may be performed. This makes it possible to prevent the unmanned flying object from coming into contact with the steel tower 50 and the electric wires 51 during inspection of the electric wires 51.

[0109] The moving body 3 may also be a working robot. In this case, a prohibited section as an entry prohibited section may be set using 3D map information including information of latitude, longitude, and altitude. With such a configuration, for example, when the working robot enters the prohibited section, it is possible to perform safety assist to stop the operation of the robot. Further, the moving body 3 can set a V2X communication terminal of a pedestrian or worker, also called V2P (Vehicle-to-Pedestrian) as its target. In this case, for example, when the worker enters the prohibited section set as a dangerous area, an alarm can be issued to the worker from the V2X communication terminal.

[0110] In the above embodiment, each of the roadside units 1 includes the signal output processing unit 130, but the traffic control server 2 may acquire the positional information of the moving body 3 via each of the roadside units 1, and output the first mode switching signal, the prohibition signal P, and the alarm signal based on the comparison between the positional information and the prohibited section information.

[0111] In the above embodiment, the traffic control server 2 outputs the second mode switching signal for switching the operation mode of the moving body 3, but each of the roadside units 1 may output the mode switching signal for switching the operation mode of the moving body 3 between the autonomous driving mode and the remote driving mode.

[0112] The movement control system S is not limited to the above-described configuration, and may have another configuration. FIG. 13 is a schematic diagram illustrating a movement control system S according to a modification of the present embodiment and an example of a road 4 to which the movement control system S is applied. The movement control system S includes a plurality of roadside units 1 including roadside units 1G and 1H which are installed on the road 4, or around or in the vicinity of the road 4 such as at the roadside of the road 4, and are capable of performing wireless communication with the moving body 3, which is a vehicle traveling on the road 4, and a traffic control server 2 communicably connected to each of the plurality of roadside units 1 via a communication network NW. The roadside units 1G and the roadside units 1H have the same configuration. The plurality of roadside units 1G are disposed at predetermined intervals along the road 4. Each of the roadside units 1H is disposed at a position opposite to a corresponding one of the roadside unit 1G across the road 4. Further, the plurality of roadside units 1G and the plurality of roadside units 1H may be disposed along the road 4 so as to cover the entire length of the prohibited section A, or one or a plurality of roadside units 1G and 1H

may be disposed along the road 4 only at a specific place. The specific place refers to, for example, any place designated by the operator, such as a construction site. In the above description, the prohibited section A of each of the plurality of roadside units 1 is set in such a manner that the entire prohibited sections A are overlapped with each other, but the present invention is not limited thereto, and the prohibited section A of each of the plurality of roadside units 1 is set in such a manner that the prohibited sections A are partially overlapped with each other. With such a configuration, when the moving body 3 is located in the overlapping prohibited sections A, the moving body 3 receives a plurality of prohibition signals P.

[0113] The wireless communication unit 32 of the moving body 3 receives a plurality of prohibition signals P relating to movement into the same prohibited section A from different roadside units 1. In the example illustrated in FIG. 13, the moving body 3 transmits the positional information to each of the roadside units 1G and the roadside units 1H. The roadside unit 1G transmits the positional information received from the moving body 3 to the traffic control server 2. Further, the roadside unit 1H transmits the positional information received from the moving body 3 to the traffic control server 2.

[0114] The traffic control server 2 generates a prohibition signal PG if the moving body 3 exists in the prohibited section A based on the positional information received from the roadside unit 1G, and transmits the generated prohibition signal PG to the roadside unit 1G. Then, the roadside unit 1G transmits the prohibition signal PG to the moving body 3. In addition, the traffic control server 2 generates a prohibition signal PH if the moving body 3 exists in the prohibited section A based on the positional information received from the roadside unit 1H, and transmits the generated prohibition signal PH to the roadside unit 1H. Then, the roadside unit 1H transmits the prohibition signal PH to the moving body 3.

[0115] The wireless communication unit 32 of the moving body 3 receives the plurality of prohibition signals P related to restriction of movement into the same prohibited section A from different processing units 10. In the example illustrated in FIG. 13, the wireless communication unit 32 receives, from the roadside unit 1G and the roadside unit 1H, the prohibition signals P related to restriction of movement into the same prohibited section A. The prohibition signal P may be generated by the roadside unit 1. In this configuration, the traffic control server 2 transmits, to each roadside unit 1 at a predetermined timing, information of the latest prohibited section A adapted to the place where each roadside unit 1 is disposed. Based on the positional information received from the moving body 3, the roadside unit 1G and the roadside unit 1H each generate the prohibition signal P if the moving body 3 exists in the prohibited section A, and transmit the generated prohibition signal P to the moving body 3.

[0116] When the wireless communication unit 32 receives a predetermined number of prohibition signals P, the movement control unit 340 of the moving body 3 may control the driving unit 35 to perform operation corresponding to the prohibition signals P. Specifically, when the predetermined number is "1", the movement control unit 340 of the moving body 3 controls the driving unit 35 to be driven when the prohibition signal PG or the prohibition signal PH is received. When the predetermined number is "2", the movement control unit 340 of the moving body 3 may control the driving unit 35 to be driven when the prohibition signal PG and the prohibition signal PH are received. In this way, with such a configuration in which each of the roadside units 1 is disposed at a position opposite to a corresponding one of the roadside unit 1 across the road 4, even when, for example, the moving body 3 runs in parallel with a large-sized moving body (for example, a truck or the like), it is possible for the movement control system S to reliably acquire the positional information of the moving body 3, which is the target, by the roadside unit 1 disposed on one side, and achieve a blind spot countermeasure. In addition, since the plurality of roadside units 1 are disposed at different positions with respect to the same prohibited section A, even when any one of the roadside units 1 fails, it is still possible for the movement control system S to reliably acquire the positional information of the target moving body 3 by another roadside unit 1, and achieve a countermeasure against the failure of the device.

EXPLANATION OF REFERENCE NUMERALS

[0117]

1 Roadside unit
2 Traffic control server
3 Moving body
10 Processing unit (traffic control device, first traffic control device)
20 Processing unit (traffic control device, second traffic control device)
32 Wireless communication unit
35 Driving unit
112 Positional information acquisition unit
130 Signal output processing unit
230 Prohibited section information management unit
310 Self-position estimation unit
340 Movement control unit
A Prohibited section
P Prohibition signal
S Movement control system

Claims

1. A traffic control device comprising:

a positional information acquisition unit that acquires positional information indicating a position of a moving body; and

a signal output processing unit that compares the positional information with prohibited section information indicating a prohibited section in which a movement of the moving body is prohibited, and outputs, based on a result of the comparison, a prohibition signal that prohibits the movement of the moving body in the prohibited section,
wherein the signal output processing unit determines whether the moving body exists in the prohibited section based on the result of the comparison, and when it is determined that the moving body exists in the prohibited section, outputs the prohibition signal.

2. The traffic control device according to claim 1, wherein

the prohibited section information includes information indicating an alarm area set around the prohibited section, and
the signal output processing unit determines whether the moving body exists in the alarm area based on the result of the comparison, and when it is determined that the moving body exists in the alarm area, outputs an alarm signal that causes the moving body to execute processing of generating an alarm.

3. The traffic control device according to claim 1, wherein the moving body is a moving body that is configured to move autonomously.

4. A roadside unit comprising each component of the traffic control device according to any one of claims 1 to 3, the roadside unit being installed on a road on which the moving body moves or on a roadside of the road.

5. A movement control system that is configured to wirelessly communicate with a moving body, the movement control system comprising:

a plurality of first traffic control devices each installed in a different area; and
a second traffic control device that is communicably connected to the plurality of first traffic control devices,
wherein the second traffic control device includes a prohibited section information management unit that generates prohibited section information indicating a prohibited section in which a movement of the moving body is prohibited, and transmits the prohibited section information to each of the plurality of first traffic control devices,
the first traffic control device includes:
a positional information acquisition unit that acquires positional information indicating a position of the moving body, and
a signal output processing unit that compares the positional information with the prohibited section information received from the second traffic control device, and outputs, based on a result of the comparison, a prohibition signal that prohibits the movement of the moving body in the prohibited section, and
the signal output processing unit determines whether the moving body exists in the prohibited section based on the result of the comparison, and when it is determined that the moving body exists in the prohibited section, outputs the prohibition signal.

6. The movement control system according to claim 5, wherein

the prohibited section information includes information indicating an alarm area set around the prohibited section, and
the signal output processing unit of the first traffic control device determines whether the moving body exists in the alarm area based on the result of the comparison, and when it is determined that the moving body exists in the alarm area, outputs an alarm signal that causes the moving body to execute processing of generating an alarm.

7. The movement control system according to claim 6, wherein the prohibited section information management unit of the second traffic control device generates the prohibited section information which varies depending on a time period.

8. The movement control system according to any one of claims 5 to 7, wherein the moving body is a moving body that is configured to move autonomously.

9. The movement control system according to claim 8, wherein

the moving body has driving modes including an autonomous driving mode for traveling autonomously along a set traveling route, and a remote driving mode for traveling based on a remote operation signal for remotely operating the moving body, and
the second traffic control device further includes a mode switching signal output processing unit that, when the signal output processing unit outputs the prohibition signal, outputs a driving mode switching signal that switches the driving mode of the moving body to the remote driving

mode.

10. A program that causes a computer included in a traffic control device to execute:

a positional information acquisition function that acquires positional information indicating a position of a moving body; and
a signal output processing function that compares the positional information with prohibited section information indicating a prohibited section in which a movement of the moving body is prohibited, and outputs, based on a result of the comparison, a prohibition signal that prohibits the movement of the moving body in the prohibited section,
wherein the signal output processing function determines whether the moving body exists in the prohibited section based on the result of the comparison, and when it is determined that the moving body exists in the prohibited section, outputs the prohibition signal.

11. A movement control method executed by a traffic control device, the method comprising:

a positional information acquisition step of acquiring positional information indicating a position of a moving body; and
a signal output processing step of comparing the positional information with prohibited section information indicating a prohibited section in which a movement of the moving body is prohibited, and outputs, based on a result of the comparison, a prohibition signal that prohibits the movement of the moving body in the prohibited section,
wherein the signal output processing step further includes determining whether the moving body exists in the prohibited section based on the result of the comparison, and when it is determined that the moving body exists in the prohibited section, outputting the prohibition signal.

12. A moving body comprising:

a wireless communication unit that performs communication with the traffic control device according to claim 1;
a self-position estimation unit that estimates a self-position;
a driving unit; and
a movement control unit that performs control of driving of the driving unit,
wherein the self-position estimation unit transmits estimated self-position information to the traffic control device using the wireless communication unit, and
when the wireless communication unit receives a prohibition signal transmitted from the traffic control device, the movement control unit controls the driving unit to perform operation corresponding to the prohibition signal.

13. The moving body according to claim 12, wherein the wireless communication unit receives a plurality of prohibition signals relating to restriction of movement into a same prohibited section from different traffic control devices.

14. The moving body according to claim 13, wherein, when the wireless communication unit receives a predetermined number of prohibition signals, the movement control unit controls the driving unit to perform operation corresponding to the prohibition signals.

FIG. 1

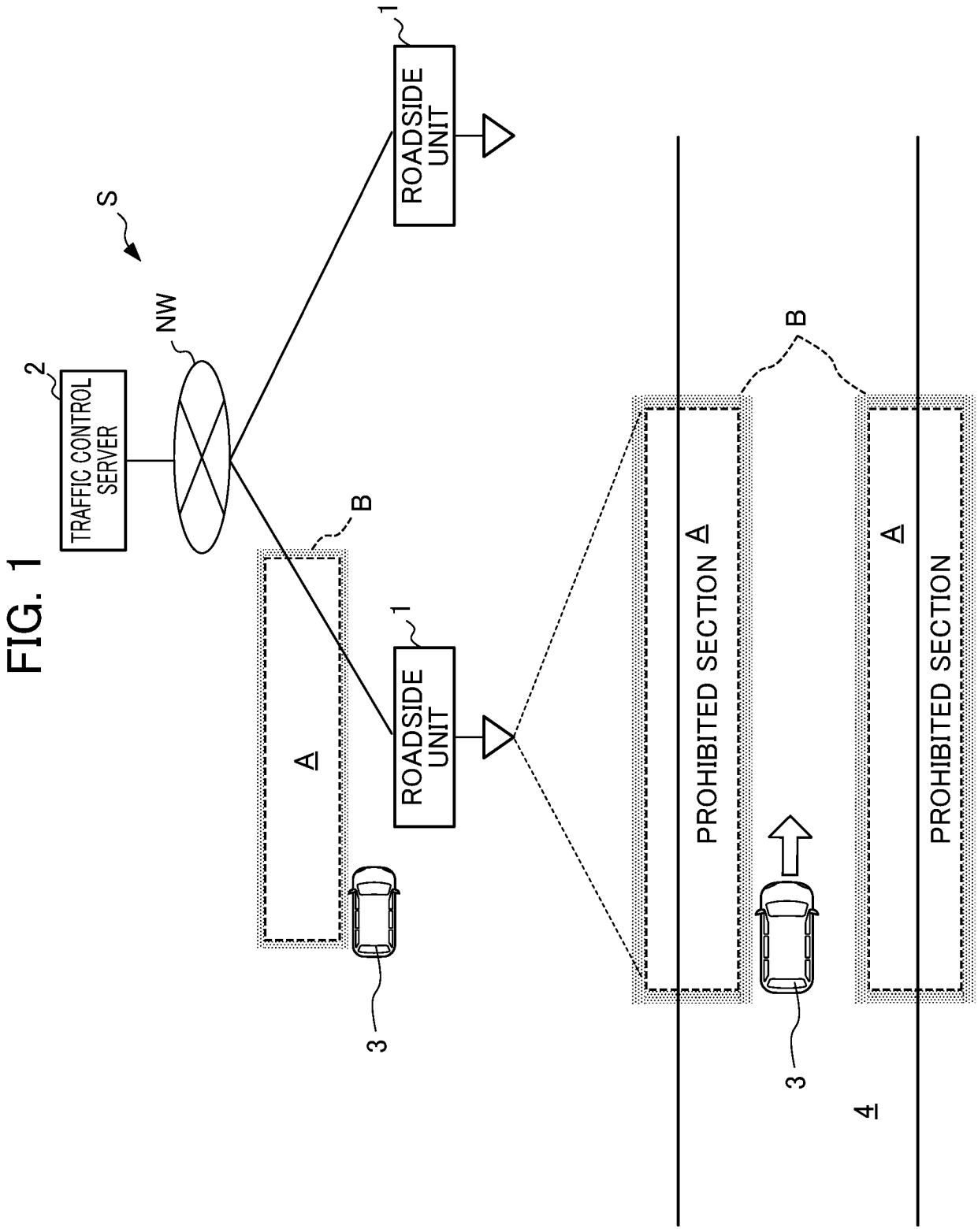

S
NW
2
TRAFFIC CONTROL SERVER
1
ROADSIDE UNIT
1
ROADSIDE UNIT
B
A
3
B
A
PROHIBITED SECTION
A
PROHIBITED SECTION
3
4

FIG. 2

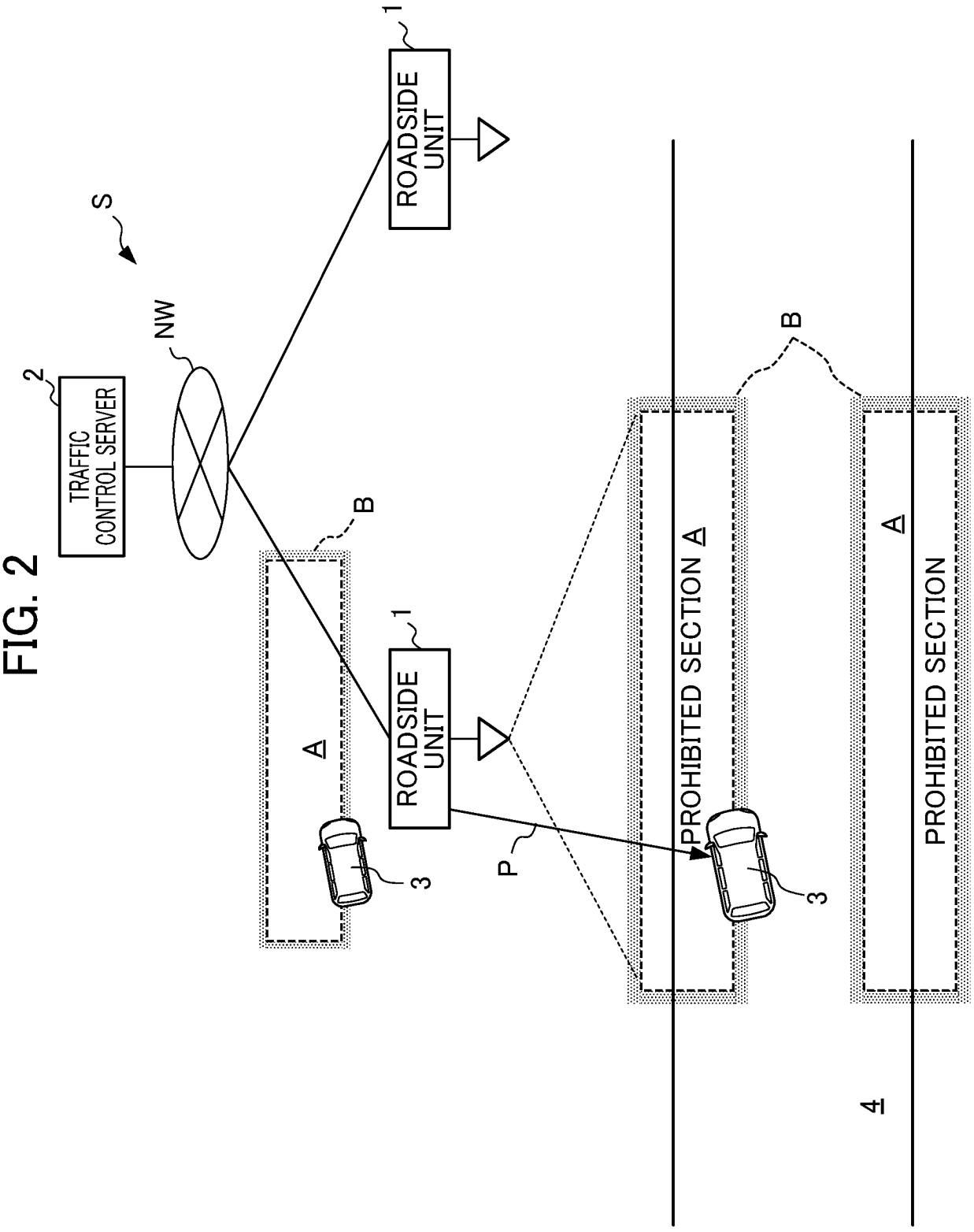

S
NW
2
TRAFFIC CONTROL SERVER
1
ROADSIDE UNIT
1
ROADSIDE UNIT
B
A
3
P
PROHIBITED SECTION A
B
A
PROHIBITED SECTION
3
4

FIG. 3

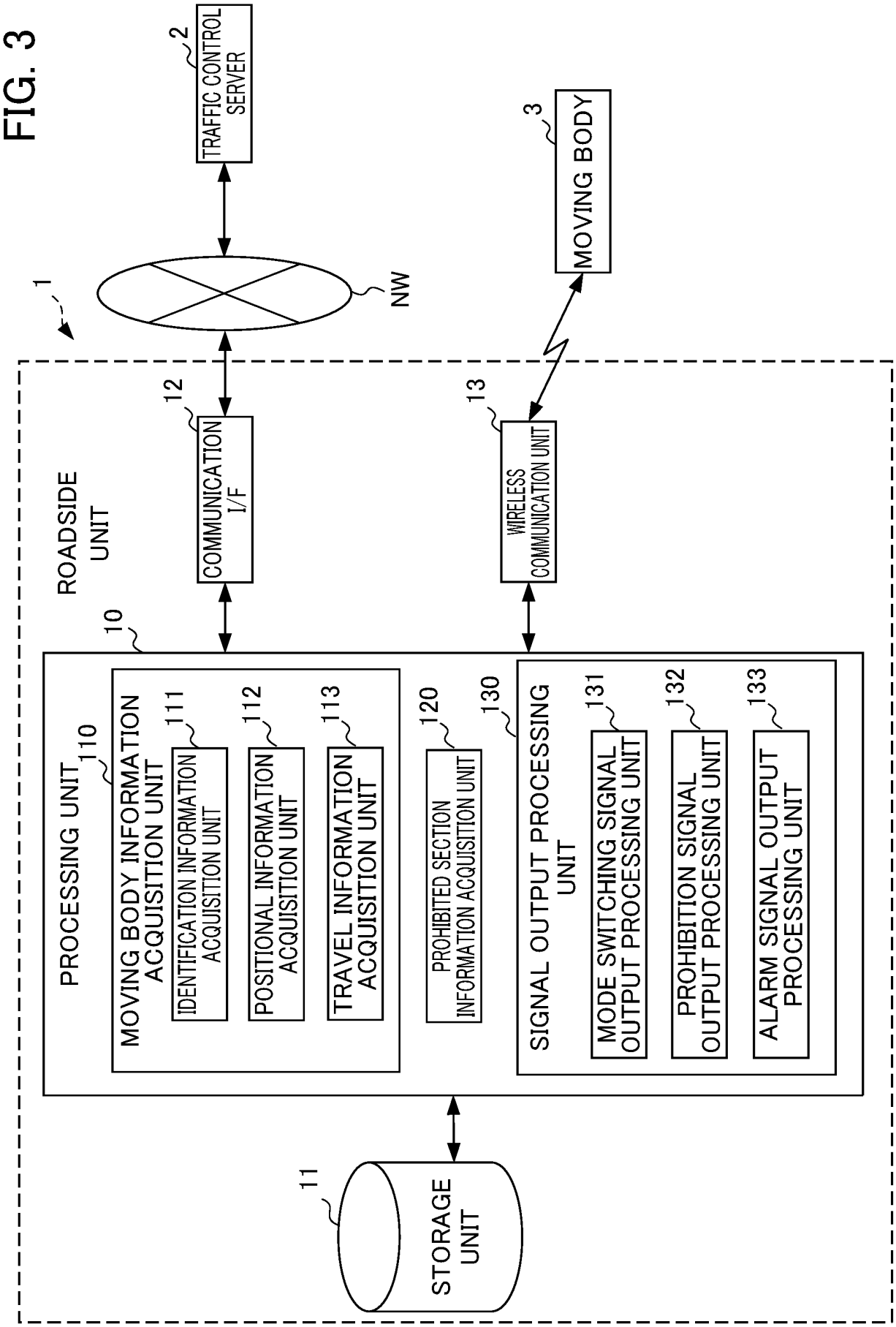

1
2
TRAFFIC CONTROL SERVER
NW
3
MOVING BODY
ROADSIDE UNIT
10
12
COMMUNICATION I/F
13
WIRELESS COMMUNICATION UNIT
PROCESSING UNIT
110
MOVING BODY INFORMATION ACQUISITION UNIT
111
IDENTIFICATION INFORMATION ACQUISITION UNIT
112
POSITIONAL INFORMATION ACQUISITION UNIT
113
TRAVEL INFORMATION ACQUISITION UNIT
120
PROHIBITED SECTION INFORMATION ACQUISITION UNIT
130
SIGNAL OUTPUT PROCESSING UNIT
131
MODE SWITCHING SIGNAL OUTPUT PROCESSING UNIT
132
PROHIBITION SIGNAL OUTPUT PROCESSING UNIT
133
ALARM SIGNAL OUTPUT PROCESSING UNIT
11
STORAGE UNIT

FIG. 4A

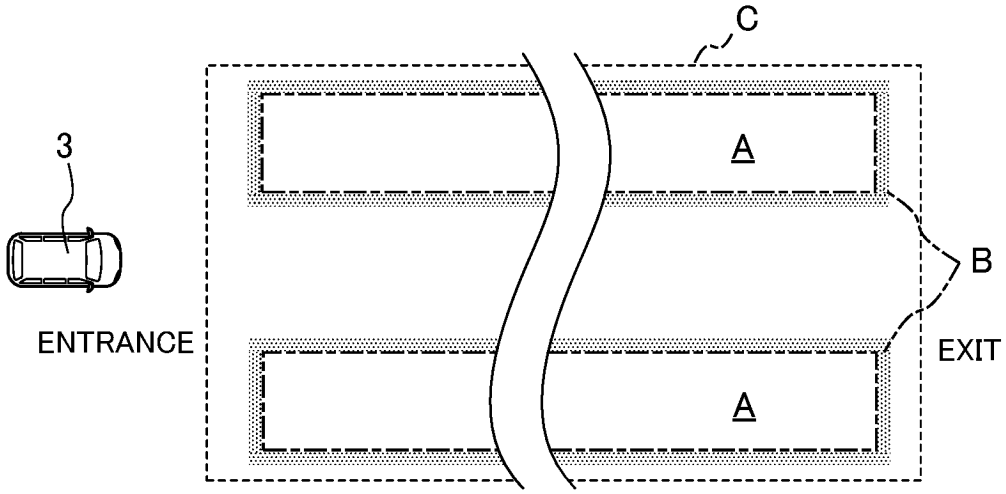


FIG. 4B

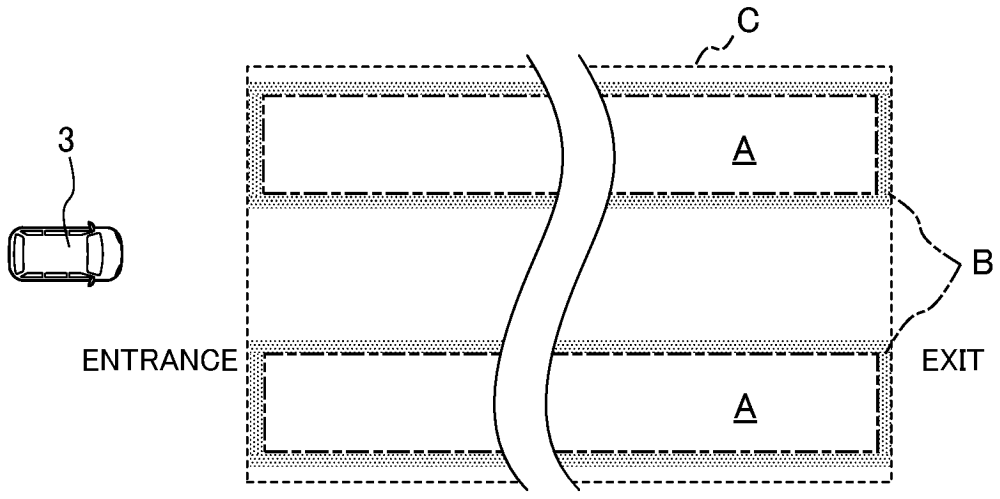


FIG. 5

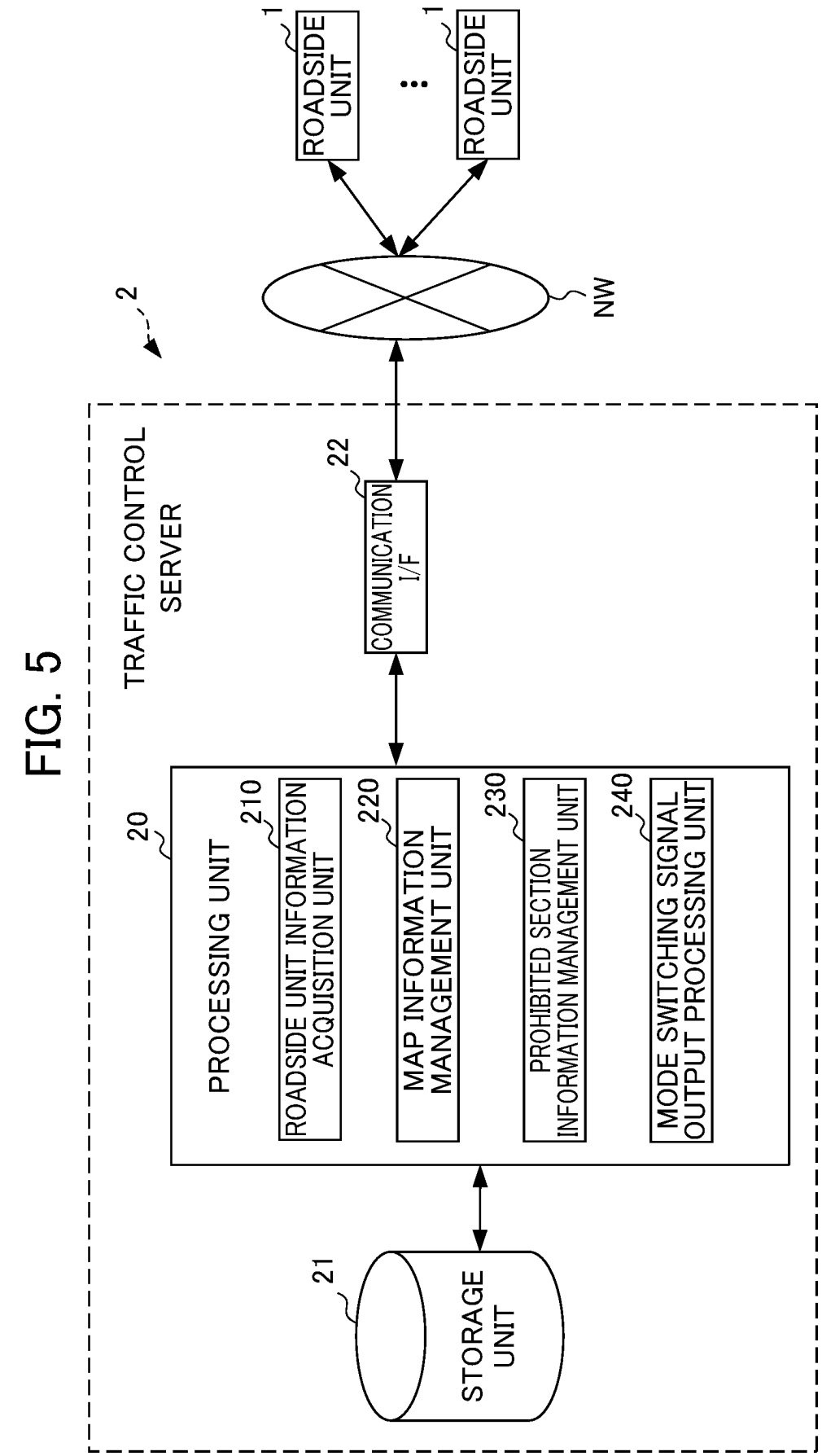

1
ROADSIDE UNIT
1
ROADSIDE UNIT
NW
2
TRAFFIC CONTROL SERVER
22
COMMUNICATION I/F
20
PROCESSING UNIT
210
ROADSIDE UNIT INFORMATION ACQUISITION UNIT
220
MAP INFORMATION MANAGEMENT UNIT
230
PROHIBITED SECTION INFORMATION MANAGEMENT UNIT
240
MODE SWITCHING SIGNAL OUTPUT PROCESSING UNIT
21
STORAGE UNIT

FIG. 6

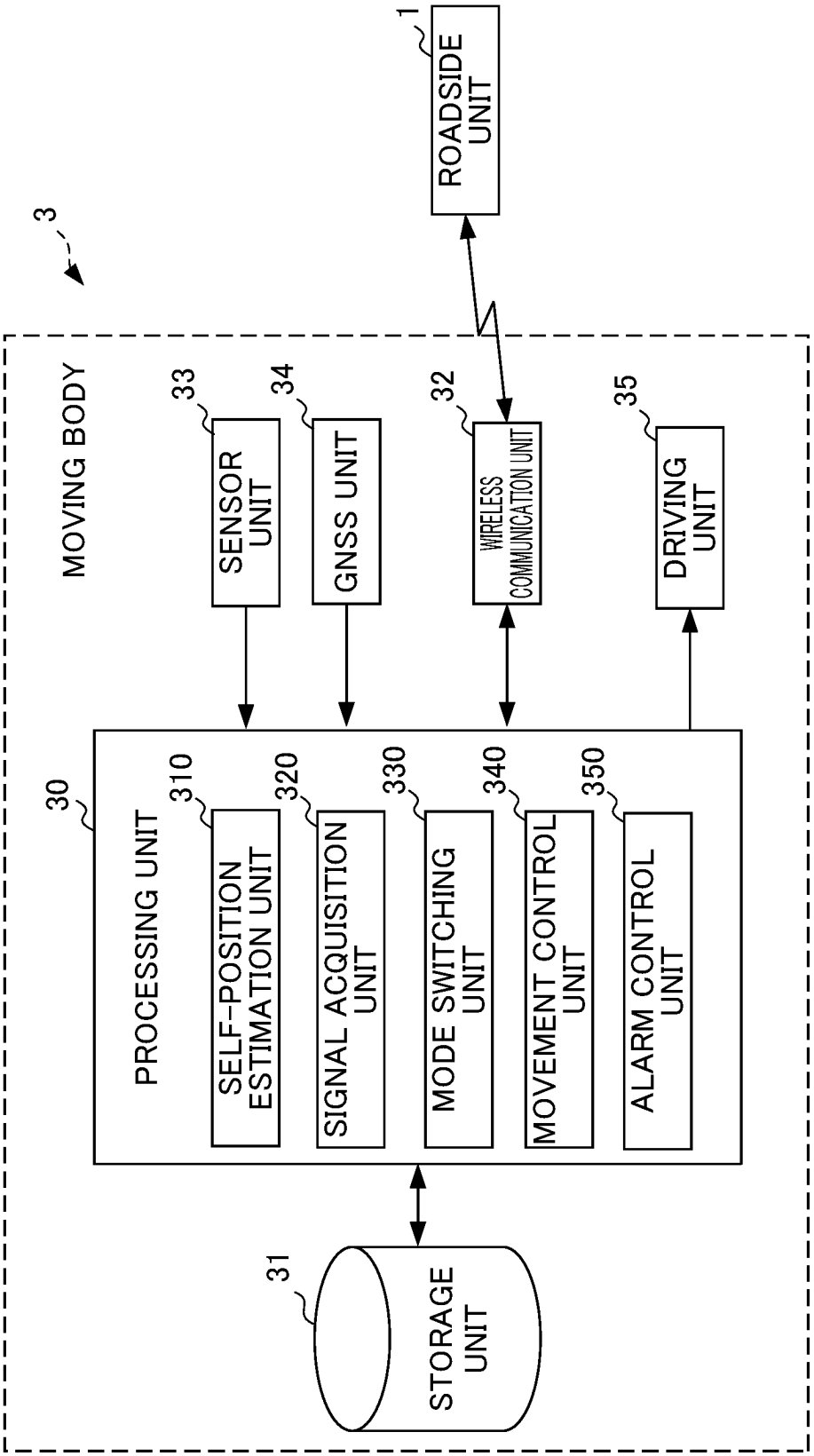

1
ROADSIDE UNIT
3
MOVING BODY
33
SENSOR UNIT
34
GNSS UNIT
32
WIRELESS COMMUNICATION UNIT
35
DRIVING UNIT
30
PROCESSING UNIT
310
SELF-POSITION ESTIMATION UNIT
320
SIGNAL ACQUISITION UNIT
330
MODE SWITCHING UNIT
340
MOVEMENT CONTROL UNIT
350
ALARM CONTROL UNIT
31
STORAGE UNIT

FIG. 7

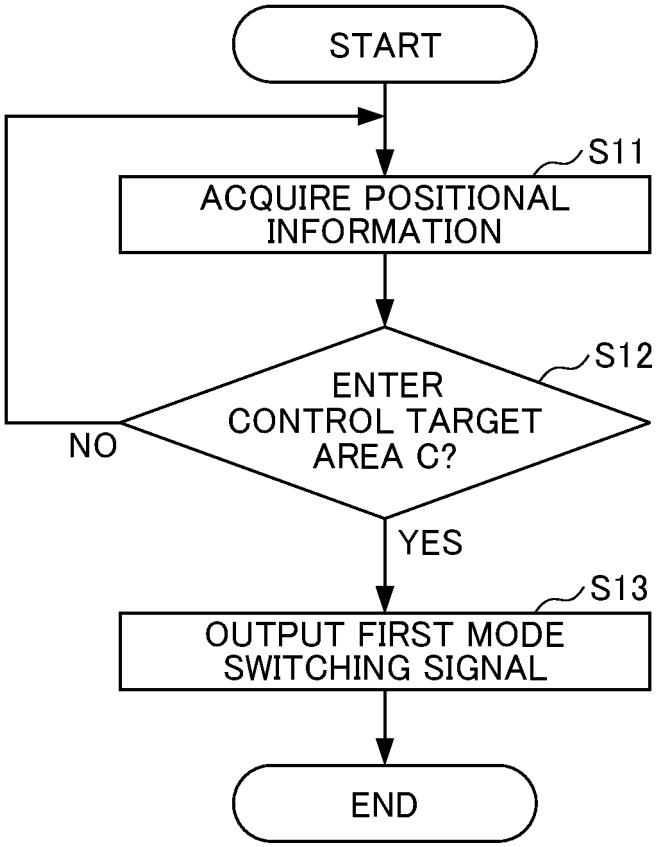

START
S11
ACQUIRE POSITIONAL INFORMATION
S12
ENTER CONTROL TARGET AREA C?
NO
YES
S13
OUTPUT FIRST MODE SWITCHING SIGNAL
END

FIG. 8

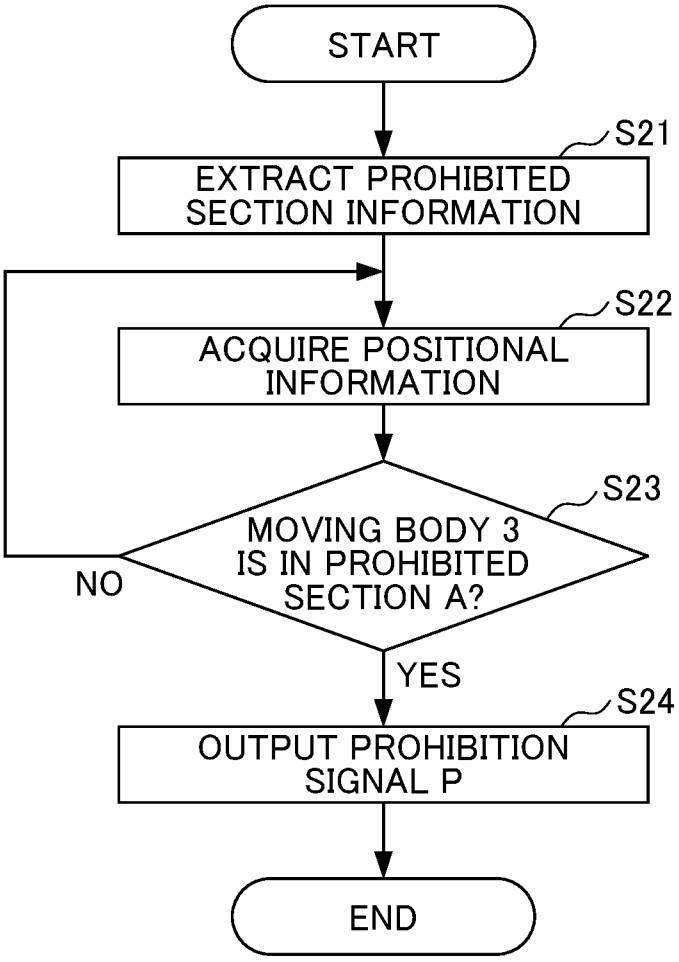

START
S21
EXTRACT PROHIBITED SECTION INFORMATION
S22
ACQUIRE POSITIONAL INFORMATION
S23
MOVING BODY 3 IS IN PROHIBITED SECTION A?
NO
YES
S24
OUTPUT PROHIBITION SIGNAL P
END

FIG. 9

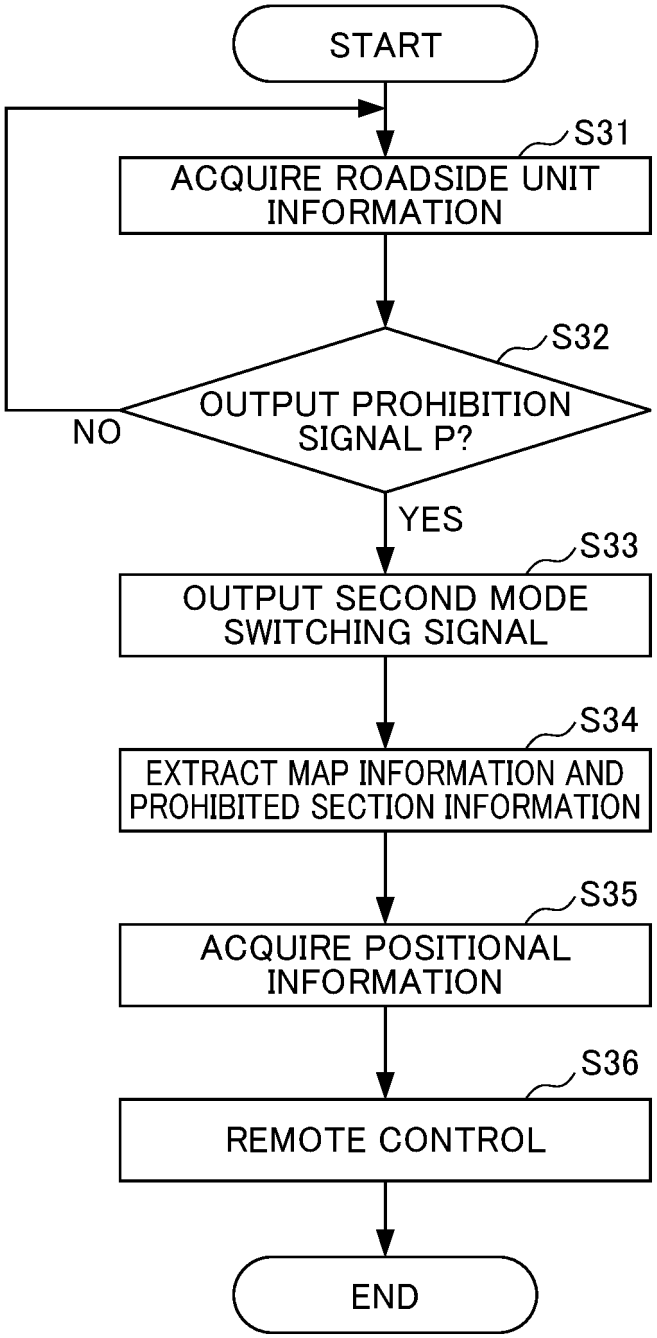

START
S31
ACQUIRE ROADSIDE UNIT INFORMATION
S32
OUTPUT PROHIBITION SIGNAL P?
NO
YES
S33
OUTPUT SECOND MODE SWITCHING SIGNAL
S34
EXTRACT MAP INFORMATION AND PROHIBITED SECTION INFORMATION
S35
ACQUIRE POSITIONAL INFORMATION
S36
REMOTE CONTROL
END

FIG. 10

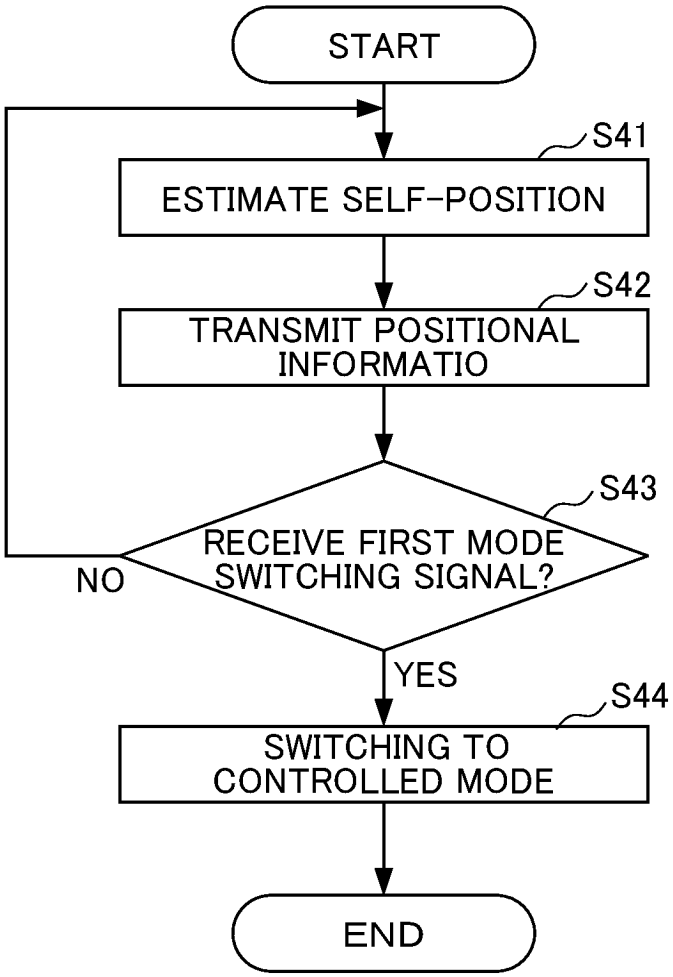

START
S41
ESTIMATE SELF-POSITION
S42
TRANSMIT POSITIONAL INFORMATIO
S43
RECEIVE FIRST MODE SWITCHING SIGNAL?
NO
YES
S44
SWITCHING TO CONTROLLED MODE
END

FIG. 11

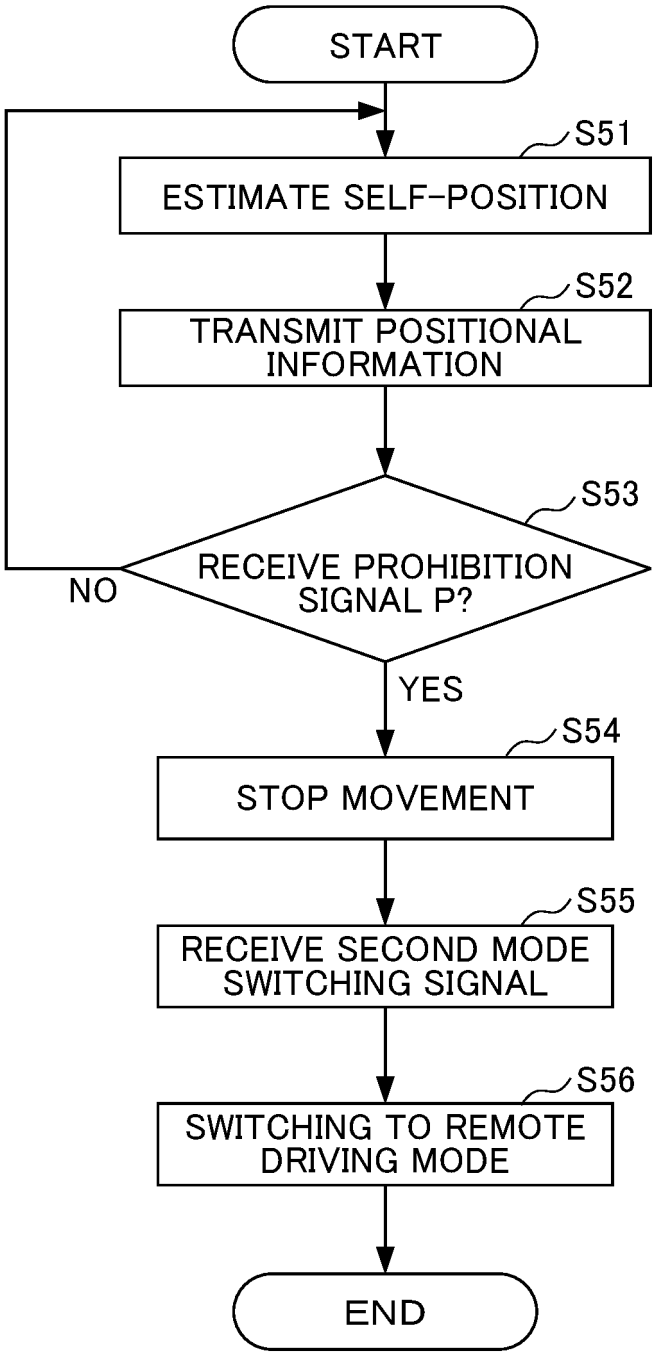

START
S51
ESTIMATE SELF-POSITION
S52
TRANSMIT POSITIONAL INFORMATION
S53
RECEIVE PROHIBITION SIGNAL P?
NO
YES
S54
STOP MOVEMENT
S55
RECEIVE SECOND MODE SWITCHING SIGNAL
S56
SWITCHING TO REMOTE DRIVING MODE
END

FIG. 12

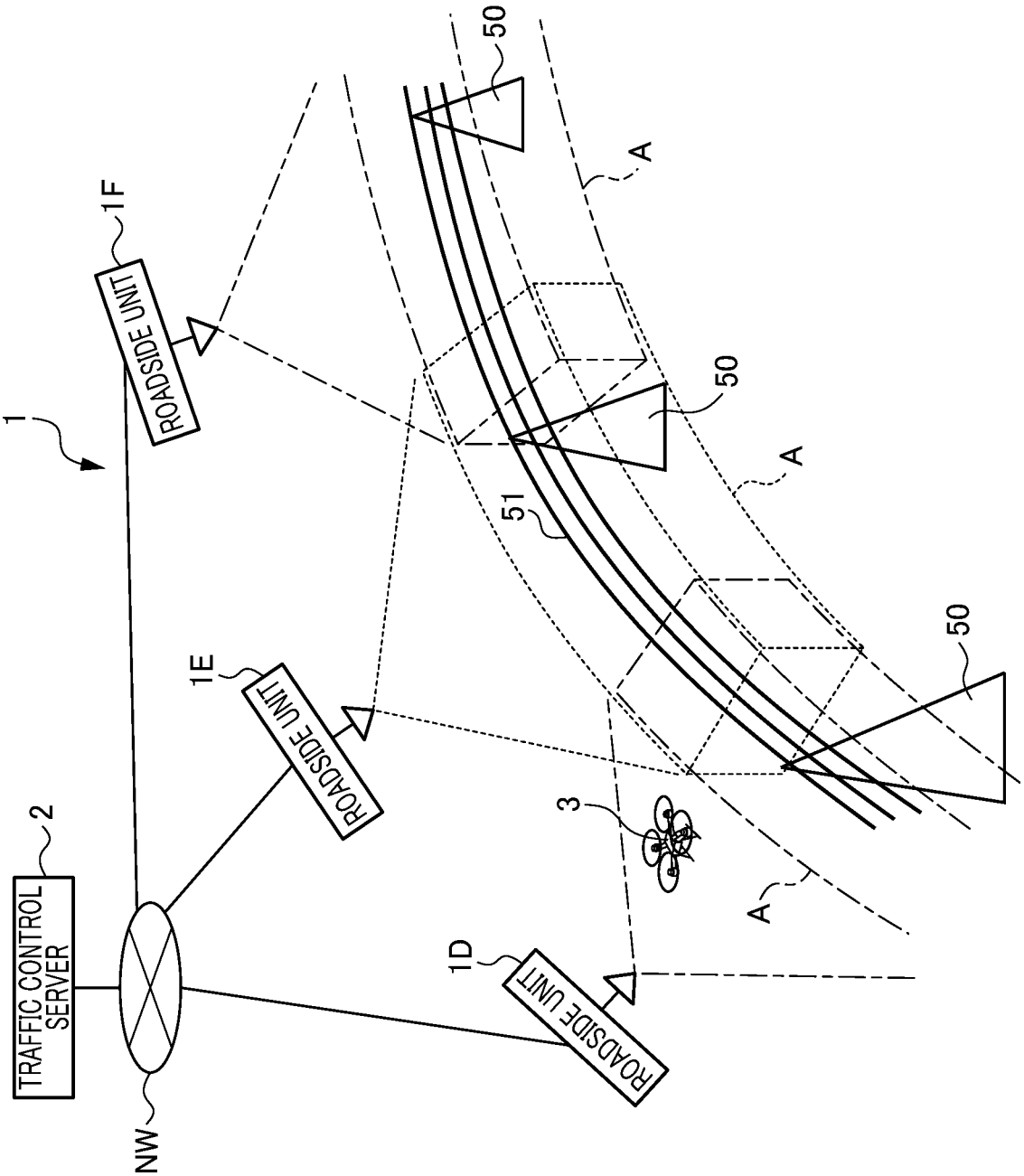
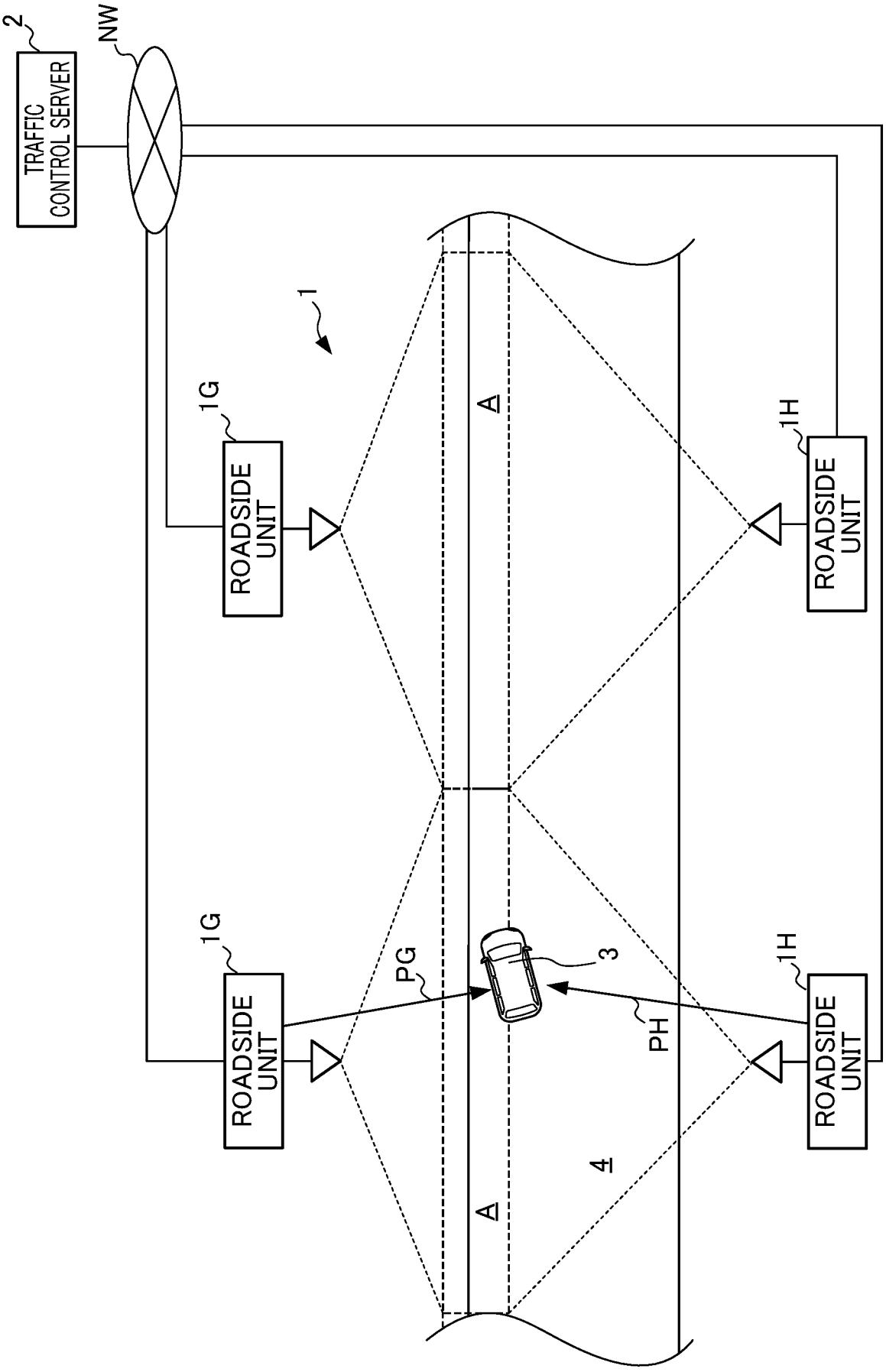

1
1F
ROADSIDE UNIT
1E
ROADSIDE UNIT
1D
ROADSIDE UNIT
2
TRAFFIC CONTROL SERVER
NW
3
50
50
50
51
A
A
A

FIG. 13


2
TRAFFIC CONTROL SERVER
NW
1
1G
ROADSIDE UNIT
1H
ROADSIDE UNIT
A
PG
3
PH
1G
ROADSIDE UNIT
1H
ROADSIDE UNIT
4
A

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/016290

A. CLASSIFICATION OF SUBJECT MATTER

G08G 1/16(2006.01)i; ***G08G 1/09***(2006.01)i; ***G08G 5/00***(2006.01)i
FI: G08G1/16 A; G08G1/09 F; G08G5/00 A

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G08G5/00; G08G1/09; G08G1/16

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2020/189651 A1 (KOMATSU LTD.) 24 September 2020 (2020-09-24) paragraphs [0008]-[0063]	1-8, 10-11
A	paragraphs [0008]-[0063]	9, 12-14
A	JP 2018-185675 A (KYOCERA CORP.) 22 November 2018 (2018-11-22) paragraphs [0012]-[0165]	1-14
A	JP 2016-181031 A (DENSO CORP.) 13 October 2016 (2016-10-13) entire text, all drawings	1-14

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

* Special categories of cited documents:
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

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

Date of the actual completion of the international search	Date of mailing of the international search report
29 May 2023	**13 June 2023**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/016290

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2020/189651 A1	24 September 2020	US 2022/0114510 A1 paragraphs [0007]-[0079]	
JP 2018-185675 A	22 November 2018	US 2020/0047659 A1 entire text, all drawings	
JP 2016-181031 A	13 October 2016	(Family: none)	

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2016181031 A **[0003]**