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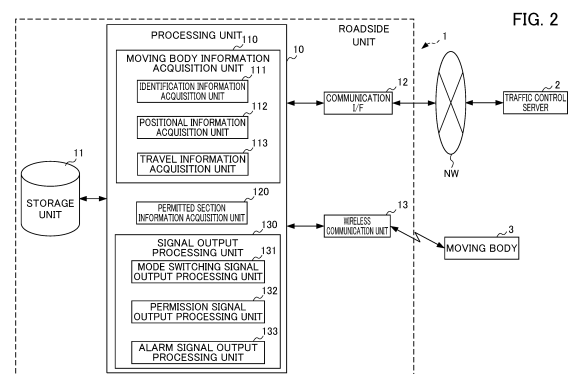
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(54) **SUPERVISION DEVICE, ROADSIDE MACHINE, MOVEMENT CONTROL SYSTEM, PROGRAM, MOVEMENT CONTROL METHOD, AND MOVING BODY**

(57) Provided are a supervision device, a roadside unit, a movement control system, a program, and a movement control method that can assist a moving body 3 in moving safely using a simple configuration and processing. A processing unit 10 is provided with: a location information acquisition unit 112 that acquires location information indicating the location of a moving body 3; and a signal output processing unit 130 that compares the location information with permitted zone information indicating a permitted zone A where the moving body 3 is permitted to move, and on the basis of the comparison result, outputs a permission signal P for permitting the moving body 3 to move in the permitted zone A. The signal output processing unit 130 determines whether or not the moving body 3 is located within the permitted zone A on the basis of the comparison result, and outputs the permission signal P if it is determined that the moving body 3 is located within the permitted zone A.



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Description

Means for Solving the Problems

TECHNICAL FIELD

[0006]

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

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 the 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 assist 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.

(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 permitted section information indicating a permitted section in which a movement of the moving body is permitted, and outputs, based on a result of the comparison, a permission signal that permits the movement of the moving body in the permitted section, in which the signal output processing unit determines whether the moving body exists in the permitted section based on the result of the comparison, and when it is determined that the moving body exists in the permitted section, outputs the permission signal.

(2) In the traffic control device as described in (1), the permitted section information includes information indicating an alarm area set at a periphery of the permitted 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 indicating that the moving body exists in the alarm area to the moving body.

(3) In the traffic control device as described in (1), the signal output processing unit outputs the permission signal to the 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), 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 permitted section information management unit that generates permitted section information indicating a permitted section in which a movement of the moving body is permitted, and transmits the permitted section information to each of the plurality of first traffic control devices, and 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 permitted section information received from the second traffic control device, and outputs, based on a result of the com-

parison, a permission signal that permits the movement of the moving body in the permitted section, and

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

(6) In the movement control system as described in (5), the permitted section information includes information indicating an alarm area set at a periphery of the permitted 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 indicating that the moving body exists in the alarm area to the moving body.

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

(8) 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 permitted section information indicating a permitted section in which a movement of the moving body is permitted, and outputs, based on a result of the comparison, a permission signal that permits the movement of the moving body in the permitted section, in which the signal output processing function determines whether the moving body exists in the permitted section based on the result of the comparison, and when it is determined that the moving body exists in the permitted section, outputs the permission signal.

(9) A movement control method is executed by a traffic control device, and the method 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 permitted section information indicating a permitted section in which a movement of the moving body is permitted, and outputs, based on a result of the comparison, a permission signal that permits the movement of the moving body in the permitted section, in which the signal output processing step further includes determining whether the moving body exists in the permitted section based on the result of the comparison, and when it is determined that the moving body exists in the permitted section, outputting the permission signal.

(10) A moving body includes: a wireless communi-

cation unit that performs communication with the traffic control device as described in any one of (1) to (4); a self-position estimation unit that estimates a self-position; a driving unit; and a movement control unit that controls 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 permission signal transmitted from the traffic control device, the movement control unit controls the driving unit to perform operation corresponding to the permission signal.

(11) In the moving body as described in (10), the wireless communication unit receives a plurality of permission signals relating to movement into a same permitted section from different traffic control devices.

(12) In the moving body as described in (11), when the wireless communication unit receives a predetermined number of permission signals, the movement control unit controls the driving unit to perform operation corresponding to the permission signals.

Effects of the Invention

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

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

FIG. 1 is a schematic diagram illustrating a movement control system according to an embodiment of the present invention and an example of a road to which this movement control system is applied;

FIG. 2 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. 3A is a schematic diagram showing a positional relationship between a permitted section and a control target area in the movement control system according to an embodiment of the present invention;

FIG. 3B is a schematic diagram showing a positional relationship between a permitted section and a control target area in the movement control system according to an embodiment of the present invention;

FIG. 4 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. 5 is a block diagram showing a configuration of hardware and functional blocks of a moving body in a

movement control system according to an embodiment of the present invention; FIG. 6 is a schematic diagram showing a movement control system according to one embodiment of the present invention and an example of a road to which this movement control system is applied, and is a diagram showing a state in which a moving body is located outside a permitted section;

FIG. 7 is a flowchart showing an example of movement control executed by the roadside unit according to an embodiment of the present invention;

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

FIG. 9 is a flowchart showing an example of movement control executed by a moving body 3;

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

FIG. 11 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. 12 is a schematic diagram showing 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 the moving body 3 so that the moving body 3 moves in a defined section on the road 4. The movement control system S includes a plurality of roadside units 1 that are installed on the road 4, or around or in the vicinity of the road 4 such as on 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 that is 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, each capable of performing wireless communication with the moving body 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] Each of the moving bodies 3 is a self-driving vehicle that can move autonomously, for example. The moving body 3 performs autonomous driving based on the estimated positional information of itself and map information around the moving body 3. 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 communication network, a MPLS (Multiprotocol Label Switching) network or the like is used as an example.

[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 shown in FIG. 1, the roadside units 1A, 1B, and 1C, which are 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 permitted section information stored in each roadside unit 1. As shown in FIG. 1,

the permitted section information is information relating to a permitted section A indicating a predetermined section on the road 4. Details of the permitted 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 and manages the permitted section information stored in each of the plurality of roadside units 1. The configuration of the traffic control server 2 and the permitted section information will be described in detail later.

<Configuration and Operation of Roadside Unit 1>

[0017] Next, the functional configuration of the roadside unit 1 in the movement control will be described. FIG. 2 is a block diagram illustrating a configuration of hardware and functional blocks of the roadside unit 1.

[0018] As illustrated in FIG. 2, the roadside unit 1 includes the 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, and 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 permitted section information acquisition unit 120, and a signal output processing unit 130. 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, permitted section information in the communicable area to be described later, and information indicating a position of an area to be a 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 com-

munication with surrounding devices wirelessly. The wireless communication unit 13 performs wireless communication with the 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 permitted section information acquisition unit 120 executes processing of acquiring the permitted section information. The permitted section information refers to information indicating the position of the permitted section A provided in the communicable area of the roadside unit 1 as shown in FIG. 1. The permitted section A refers to a geographical range on the road 4 in which the movement of the moving body 3 in the con-

trolled mode described later in detail is permitted. The permitted section information is indicated by, for example, latitude, longitude, altitude, or the like. In FIG. 1, the permitted section A indicated by the permitted section information of the roadside unit 1A is indicated by a one-dot chain line, the permitted section A indicated by the permitted section information of the roadside unit 1B is indicated by a broken line, and the permitted section A indicated by the permitted section information of the roadside unit 1C is indicated by a two-dot chain line. In the example of FIG. 1, the position of the permitted section A of each of the roadside units 1 is set to overlap at least the permitted section A of another roadside unit 1. In FIG. 1, the permitted section A on the lower side of the drawing shows the positional relationship of the permitted section A on the road 4, and the permitted 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 permitted section A by the processing unit 10 described later.

[0029] Further, the permitted section information includes information indicating the alarm area B set at the periphery of the permitted 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 permitted section A if the moving body 3 continues to move. In the present embodiment, as shown in FIG. 1, the alarm area B is provided on both edge portions in the direction orthogonal to the moving direction of the moving body 3 in the permitted section A in a plan view.

[0030] The permitted section information acquisition unit 120 executes processing of acquiring the permitted section information from the traffic control server 2 or the storage unit 11. In the present embodiment, when the permitted section information is received from the traffic control server 2, the permitted section information acquisition unit 120 updates the permitted section information stored in the storage unit 11 to the received permitted 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 permission 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 a mode switching signal based on the positional information of the moving body 3 and the permitted section information. The 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 permission signal P or an alarm signal transmitted from the roadside unit 1. The non-controlled mode refers to a mode in which the operation of the moving body 3 is not controlled by a control signal such as the permission signal P or the alarm signal transmitted from the roadside unit 1.

[0033] Here, a relationship between an area which is a target of the controlled mode (hereinafter, referred to as a control target area C) and the permitted section A will be described. FIGS. 3A and 3B are diagrams for explaining the relationship between the control target area C and the permitted section A. In FIGS. 3A and 3B, the permitted 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. 3A, the control target area C is set to be at the inner side of the entrance and the exit of the permitted section A in the traveling direction of the moving body 3 on the road 4 and to be wider than the width of the permitted section 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 permitted section A and to be wider than the width of the permitted section 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 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 a mode switching signal for executing mode switching from the controlled mode to the non-controlled mode.

[0035] The permission signal output processing unit 132 executes processing of outputting the permission signal P for permitting the movement of the moving body 3 in the controlled mode. The permission signal output processing unit 132 compares the positional information of the moving body 3 with the permitted section information, and outputs the permission signal P based on the comparison result. Specifically, the permission signal output processing unit 132 determines whether or not the moving body 3 exists in the permitted section A based on the comparison result between the positional information of the moving body 3 and the permitted section information, and when it is determined that the moving body 3 exists in the permitted section A, outputs the permission signal P. For example, the permission signal output processing unit 132 may use the information relating to the size of the moving body 3, which is the identification information, and determine that the moving body 3 exists in the permitted section A only when the entire moving body 3 is located in the permitted section A. Alternatively, for example, the permission signal output processing unit 132 may determine that the moving body 3 exists in the permitted section A when at least a portion of the moving body 3 is located in the permitted section A.

Further, when the vehicle body center of the moving body 3 is located in the permitted section A, it may be determined that the moving body 3 exists in the permitted section A. For example, when the permission signal P is received in the controlled mode, the moving body 3 can continue traveling, and when the permission signal P is not received, the moving body 3 receives control for restricting the continuing traveling.

[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 permitted section information. The alarm signal refers to a control signal that includes instructions that 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 permitted 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. 4 is a block diagram illustrating a configuration of hardware and functional blocks of the traffic control server 2.

[0038] As illustrated in FIG. 4, 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 the roadside unit information acquisition unit 210, the map information management unit 220, and the permitted section information management unit 230. 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 may be realized by 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 move-

ment 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 permitted 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 and information relating to an event occurring on the road 4. Examples of the information relating to the event include a traffic accident, traffic congestion, 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.

[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 permitted section information management unit 230 executes processing of generating and managing permitted section information for each of the plurality of roadside units 1. Specifically, the permitted section information management unit 230 generates permitted 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 permitted section information management unit 230 transmits the generated permitted section information to the corresponding roadside unit 1. The permitted section information management unit 230 may generate different permitted section information depending on, for example, a time period. For example, the permitted section information management unit 230 may generate the permitted section information such that the size of the permitted section A in a time period such as morning or evening in which children go to (return from) school becomes smaller and the position of the permitted section A becomes closer to the center of the road 4. In addition, the permitted section information management unit 230 may generate different permitted section information based on information acquired from the outside. For example, the permitted section information management unit 230 may change the permitted section information based on the information relating to the event acquired from the roadside unit 1. More specifically, when acquiring information relating to the occurrence of a traffic accident on the road 4, the permitted section information management unit 230 may generate permitted section information to avoid an accident occurrence location. Further, for example, when acquiring information indicating that a maintenance vehicle is traveling on an expressway, the permitted section information management unit 230 may generate permitted section information for the maintenance vehicle to move.

<Configuration and Operation of Moving Body 3>

[0046] Next, a functional configuration of the moving body 3 will be described. FIG. 5 is a block diagram illustrating the configuration of hardware and functional blocks of the moving body 3.

[0047] As illustrated in FIG. 5, 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.

[0048] 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 realizes a function of movement control. In the present embodiment, the processing unit 30 executes data processing of each functional unit of the self-position estimation unit 310, the signal acquisition unit 320, the mode switching unit 330, the movement control unit 340, and the alarm control unit 350. The operation of each functional unit will be described later.

[0049] 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.

[0050] 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 mode switching signal, the permission 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.

[0051] 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, a 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 reception wave, or may be a camera or the like. In the present embodiment, as the sensor unit 33, a LIDAR is used which irradiates laser light around the moving body 3 and detects a surrounding object as point cloud data. According to the 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.

[0052] 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.

[0053] The driving unit 35 is a part related to driving of the moving body 3, such as an engine, a motor, or a brake.

[0054] Next, a functional configuration for the processing unit 30 to execute movement control of the moving body 3 will be described.

[0055] 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.

[0056] The signal acquisition unit 320 executes processing of acquiring various control signals such as a mode switching signal, a permission signal P, and an alarm signal from the roadside unit 1 via the wireless communication unit 32.

[0057] When the 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 a 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. Conversely, when a mode switching signal for executing 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.

[0058] The movement control unit 340 executes processing of controlling the movement of the moving body 3 based on the positional information or the like 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.

[0059] 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 permission signal P by the signal acquisition unit 320. When the wireless communication unit 32 receives the permission signal P transmitted from the processing unit 10 of the roadside unit 1, the movement control unit 340 controls the driving unit 35 to perform an operation corresponding to the permission signal P. For example, in a case where the permission signal P is received, the movement control unit 340 may control the driving unit 35 so as to continue the movement of the moving body 3 in the permitted section A. For example, when the signal acquisition unit 320 does not acquire the permission signal P within the determination period, the movement control unit 340 may execute control for stopping the moving body 3 or may control the movement of the moving body 3 so that the moving body 3 deviating from the permitted section A returns to the permitted section A. The length of the determination period is not particularly limited, and it is possible to set an appropriate length of the determination period according to the system based

on, for example, the type of the moving body 3, the design of the control target area C, the area requirement requiring more safety, and the like. For example, when it is assumed that the moving body 3 moves at a speed of 36 km/h (10 m/sec), for example, when the time taken to reciprocate information and signals between the moving body 3 and the processing unit 10 which is a traffic control device of the roadside unit 1 is 80 milliseconds (40 milliseconds per road), and the length of a determination period in the processing unit 10 is 20 milliseconds, a total value for these values is 100 milliseconds. In this case, the total value of 100 milliseconds (0.1 second) is the time from the transmission of the positional information by the moving body 3 to the reception of the permission signal P, and corresponds to the time when the moving body 3 moves by 1 m. In this way, it is possible to design the length of the determination period between the moving body 3 and the processing unit 10 of the roadside unit 1 or within the processing unit 10, which is suitable for the control service of the movement control system S. The intervals at which the moving body 3 and the roadside unit 1 transmit signals can be designed according to the moving body 3 or the structure of the control target area C, and may be, for example, every 100 milliseconds or less. In addition, in a case where traffic congestion of vehicles occurs in the vicinity of the roadside unit 1 and communication of many vehicles is concentrated, a mode may be considered in which the moving body 3 as a control service target (the moving body 3 requiring the permission signal P) preferentially performs transmission at short intervals, and the roadside unit 1 also preferentially performs transmission at short intervals to the moving body 3 which is prioritized by way of a communication algorithm. At this time, the moving body 3 other than the control service target may determine that the priority is low and transmit the permission signal P from the roadside unit 1 at an interval longer than 100 milliseconds. Further, the control for stopping the moving body 3 may be, for example, control for stopping after decelerating to a predetermined speed. In addition, for example, the movement control unit 340 may execute control for stopping the moving body 3 or control for returning to the permitted section A, when a predetermined number or more of permission signals P from the roadside unit 1 are not acquired within the determination period.

[0060] 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 of 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 departing from the permitted 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.

[0061] 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 6. FIG. 6 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 permitted section A.

[0062] The roadside units 1A to 1C shown in FIG. 1 compare the positional information of the moving body 3 with the permitted section information. As shown in FIG. 1, the permission signal output processing unit 132 of each of the roadside units 1A and 1B transmits the permission signal P to the moving body 3 because the moving body 3 is located in the permitted section A. On the other hand, in the roadside unit 1C, the permission signal P is not transmitted because the moving body 3 is outside the communicable area and the processing of comparing the position of the moving body 3 with the position of the permitted section A cannot be executed.

[0063] In the state shown in FIG. 6, the center of the vehicle body of the moving body 3 deviates from the permitted sections A in the communicable areas of the roadside unit 1A and the roadside unit 1B. Therefore, the permission signal output processing unit 132 of each of the roadside units 1A and 1B determines that the moving body 3 does not exist in the permitted section A, and does not output the permission signal P. As a result, the moving body 3 decelerates and stops as shown in FIG. 6.

[0064] 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 used as appropriate.

[0065] 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 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 continues the processing during the operation of the roadside unit 1.

[0066] 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.

[0067] 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 makes the processing proceed 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.

[0068] In step S13, the mode switching signal output processing unit 131 outputs the mode switching signal for switching the moving body 3 to the controlled mode. Then, the mode switching signal is transmitted to the moving body 3 by the wireless communication unit 13.

[0069] As illustrated in FIG. 8, in step S21, the permitted section information acquisition unit 120 extracts the permitted section information from the storage unit 11.

[0070] 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.

[0071] In step S23, the permission signal output processing unit 132 compares the permitted 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 permitted section A. When the permission signal output processing unit 132 determines that the moving body 3 is located within the permitted section A (step S23; YES), the processing is made to proceed to step S24. On the other hand, when the permission signal output processing unit 132 determines that the moving body 3 is located outside the permitted section A (step S23; NO), the processing of step S22 is repeated.

[0072] In step S24, the permission signal output processing unit 132 outputs a permission signal P for permitting the movement of the moving body 3. Then, the permission 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.

[0073] Next, a flow of processing of the movement control executed by the moving body 3 will be described with reference to FIGS. 9 and 10. FIG. 9 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. 10 is a flowchart showing an example of processing executed by the moving body 3 in the controlled mode.

[0074] As illustrated in FIG. 9, in step S31, 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.

[0075] In step S32, the wireless communication unit 32

transmits the positional information of the moving body 3 estimated in step S31 to the roadside unit 1.

[0076] In step S33, the mode switching unit 330 determines whether or not the mode switching signal has been received from the roadside unit 1. When the mode switching unit 330 determines that the mode switching signal has been acquired by the signal acquisition unit 320 (step S33; YES), the processing is made to proceed to step S34. On the other hand, when it is determined that the signal acquisition unit 320 has not acquired the mode switching signal (step S33; NO), the mode switching unit 330 makes the processing return to step S31.

[0077] In step S34, the mode switching unit 330 switches the movement mode of the moving body 3 to the controlled mode.

[0078] As illustrated in FIG. 10, in step S41, the self-position estimation unit 310 estimates positional information indicating the position of the moving body 3 itself in step S41. 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.

[0079] 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.

[0080] In step S43, the movement control unit 340 determines whether or not the signal acquisition unit 320 has received the permission signal P within the determination period. When it is determined that the signal acquisition unit 320 has acquired the permission signal P within the determination period (step S43; YES), the movement control unit 340 returns the processing to step S41. On the other hand, when the movement control unit 340 determines that the signal acquisition unit 320 has not acquired the permission signal P within the determination period (step S43; NO), the processing is made to proceed to step S44.

[0081] In step S44, the movement control unit 340 controls the driving unit 35 to stop the movement of the moving body 3.

[0082] According to the embodiment described above, the following advantageous effects are obtained.

[0083] The traffic control device 10 according to the present embodiment includes: the positional information acquisition unit 112 that acquires positional information indicating a position of the moving body 3; and the signal output processing unit 130 that compares the positional information with the permitted section information indicating the permitted section A in which a movement of the moving body 3 is permitted, and outputs, based on a result of the comparison, the permission signal P that permits the movement of the moving body 3 in the permitted section A. The signal output processing unit 130 determines whether the moving body 3 exists in the permitted section A based on the result of the comparison, and when it is determined that the moving body 3 exists in the permitted section A, outputs the permission

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 permitted section A. Therefore, it is possible to assist in the safe movement of the moving body 3 with a simple configuration and processing.

[0084] Further, in the traffic control device 10 according to the present embodiment, the permitted section information includes information indicating the alarm area B set at a periphery of the permitted section A, and the signal output processing unit 130 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 indicating that the moving body 3 exists in the alarm area B to the moving body 3. This makes it possible to grasp the possibility that the operator or the like of the moving body 3 may move out of the permitted section A.

[0085] Further, in the traffic control device 10 according to the present embodiment, the signal output processing unit 130 outputs the permission signal P to the moving body 3 that is configured to move autonomously. With such a configuration, it is possible for a self-driving vehicle and the like to reliably travel a predetermined traveling route.

[0086] 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 on the roadside of the road 4. With such a configuration, it is possible to assist the safe movement of the moving body 3 traveling on the road 4 by a simple configuration and processing.

[0087] The movement control system S according to the present embodiment is configured to wirelessly communicate with the moving body 3, the movement control system S including: the plurality of processing units 10 each installed in a different area; and the processing unit 20 that is communicably connected to the plurality of roadside units 1. The processing unit 20 includes the permitted section information management unit 230 that generates permitted section information indicating the permitted section A in which a movement of the moving body 3 is permitted, and transmits the permitted section information to each of the plurality of roadside units 1, and the plurality of processing units 10 each include the positional information acquisition unit 112 that acquires positional information indicating a position of the moving body 3, and the signal output processing unit 130 that compares the positional information with the permitted section information received from the processing unit 20, and outputs, based on a result of the comparison, the permission signal P that permits the movement of the moving body 3 in the permitted section A, and the signal output processing unit 130 determines whether the moving body 3 exists in the permitted section A based on the result of the comparison, and when it is determined that

the moving body 3 exists in the permitted section A, outputs the permission signal P. This allows the moving body 3 to move in a defined area by simple processing of comparing the position of the moving body 3 with the permitted section A. Therefore, it is possible to assist in the safe movement of the moving body 3 with a simple configuration and processing.

[0088] Further, in the movement control system S according to the present embodiment, the permitted section information includes information indicating the alarm area B set at a periphery of the permitted section A, and the signal output processing unit 130 of each of the plurality of processing units 10 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 indicating that the moving body 3 exists in the alarm area B to the moving body 3. This makes it possible to grasp the possibility that the operator or the like of the moving body 3 will move out of the permitted section A.

[0089] In addition, in the movement control system S according to the present embodiment, the permitted section information management unit 230 of the processing unit 20 generates permitted section information which differs depending on a time period. With such a configuration, since the position, size, and the like of the permitted 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.

[0090] The program according to the present embodiment causes a computer included in each of the plurality of processing units 10 to execute: the positional information acquisition function that acquires positional information indicating a position of the moving body 3; and the signal output processing function that compares the positional information with permitted section information indicating the permitted section A in which a movement of the moving body 3 is permitted, and outputs, based on a result of the comparison, the permission signal P that permits the movement of the moving body 3 in the permitted section A. The signal output processing function determines whether the moving body 3 exists in the permitted section A based on the result of the comparison, and when it is determined that the moving body 3 exists in the permitted section A, outputs the permission signal P. This allows the moving body 3 to move in a defined area by simple processing of comparing the position of the moving body 3 with the permitted section A. Therefore, it is possible to assist in the safe movement of the moving body 3 with a simple configuration and processing.

[0091] The movement control method according to the present embodiment is executed by each of the plurality of processing units 10, the method including: the positional information acquisition step of acquiring positional information indicating a position of the moving body 3;

and the signal output processing step of comparing the positional information with permitted section information indicating the permitted section A in which a movement of the moving body 3 is permitted, and outputs, based on a result of the comparison, the permission signal P that permits the movement of the moving body 3 in the permitted section A. The signal output processing step further includes determining whether the moving body 3 exists in the permitted section A based on the result of the comparison, and when it is determined that the moving body 3 exists in the permitted section A, outputting the permission signal P. This allows the moving body 3 to move in a defined area by simple processing of comparing the position of the moving body 3 with the permitted section A. Therefore, it is possible to assist in the safe movement of the moving body 3 with a simple configuration and processing.

[0092] 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 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 permission signal P when the movement control unit 340 receives the permission 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.

[0093] 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.

[0094] 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 mainly using latitude, longitude, and altitude information is used.

[0095] 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. 11 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.

[0096] The unmanned flying object is used for checking the state of an electric wire 51 suspended in 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. 11, the state of the electric wires 51 of the steel tower 50 is inspected using an autonomously movable unmanned flying object.

[0097] The permitted 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. 11, the shape of the permitted 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. 11, the permitted section A is set at an interval of several meters from the electric wire 51.

[0098] In the example illustrated in FIG. 11, the roadside units 1D, 1E, and 1F manage the permitted section A. Each of the roadside units 1D, 1E, and 1F acquires the positional information from the unmanned flying object, compares the permitted section information indicating the permitted section A stored therein with the positional information of the unmanned flying object, and transmits the permission signal P to the unmanned flying object in a case in which the unmanned flying object is flying in the permitted section A. In addition, when the unmanned flying object deviates from the permitted section A, a drone autonomous evacuation program for landing on a safe route may be operated, or an emergency landing may be performed on the side opposite to the tower 50.

[0099] The moving body 3 may also be a working robot. In this case, 3D map information made using information of latitude, longitude, and altitude may be used to set a permitted section in a place other than the entry prohibited area. With such a configuration, for example, when the working robot deviates from the permitted 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 exits from the permitted section set as a safe area located at an area other than dangerous areas, an alarm can be issued to the worker from the V2X communication terminal.

[0100] In the above embodiment, although each of the roadside units 1 includes the signal output processing unit 130, 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 mode switching signal, the permission signal P, and the alarm signal based on the comparison between the positional information and the section information.

[0101] For example, the traffic control server 2 may include a remote control unit that remotely controls the moving body 3 so as to move within the permitted section based on the positional information of the moving body 3 and the map information acquired by the roadside unit information acquisition unit 210, when the permission

signal P is not outputted from the roadside unit 1 within the determination period.

[0102] The movement control system S is not limited to the above-described configuration, and may have another configuration. FIG. 12 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 on 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 permitted 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 permitted section A of each of the plurality of roadside units 1 is set in such a manner that the entirety of the permitted sections A are overlapped with each other, but the present invention is not limited thereto, and the permitted section A of each of the plurality of roadside units 1 is set in such a manner that the permitted sections A are partially overlapped with each other. With such a configuration, when the moving body 3 is located in the overlapping permitted sections A, the moving body 3 receives a plurality of permission signals P.

[0103] The wireless communication unit 32 of the moving body 3 receives a plurality of permission signals P relating to movement into the same permitted section A from different roadside units 1. In the example illustrated in FIG. 12, 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.

[0104] The traffic control server 2 generates a permission signal PG if the moving body 3 exists in the permitted section A based on the positional information received from the roadside unit 1G, and transmits the generated permission signal PG to the roadside unit 1G. Then, the roadside unit 1G transmits the permission signal PG to the moving body 3. In addition, the traffic control server 2

generates a permission signal PH if the moving body 3 exists in the permitted section A based on the positional information received from the roadside unit 1H, and transmits the generated permission signal PH to the roadside unit 1H. Then, the roadside unit 1H transmits the permission signal PH to the moving body 3.

[0105] The wireless communication unit 32 of the moving body 3 receives a plurality of permission signals P relating to the movement in the same permitted section A from different processing units 10. In the example illustrated in FIG. 12, the wireless communication unit 32 receives the permission signal P relating to the movement in the same permitted section A from the roadside unit 1G and the roadside unit 1H. The permission 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, the latest information of the permitted section A adapted to the location 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 permission signal P if the moving body 3 exists in the permitted section A, and transmit the generated permission signal P to the moving body 3.

[0106] When the wireless communication unit 32 receives a predetermined number of permission signals P, the movement control unit 340 of the moving body 3 may control the driving unit 35 to perform operation corresponding to the permission 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 permission signal PG or the permission 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 permission signal PG and the permission 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 a 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 permitted 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

[0107]

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 Permitted section information management unit
310 Self-position estimation unit
340 Movement control unit
A Permitted section
P Permission 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 permitted section information indicating a permitted section in which a movement of the moving body is permitted, and outputs, based on a result of the comparison, a permission signal that permits the movement of the moving body in the permitted section,
wherein the signal output processing unit determines whether the moving body exists in the permitted section based on the result of the comparison, and when it is determined that the moving body exists in the permitted section, outputs the permission signal.

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

the permitted section information includes information indicating an alarm area set at a periphery of the permitted 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 indicating that the moving body exists in the alarm area to the moving body.

3. The traffic control device according to claim 1, wherein the signal output processing unit outputs the permission signal to the 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 permitted section information management unit that generates permitted section information indicating a permitted section in which a movement of the moving body is permitted, and transmits the permitted section information to each of the plurality of first traffic control devices, and
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 permitted section information received from the second traffic control device, and outputs, based on a result of the comparison, a permission signal that permits the movement of the moving body in the permitted section,
wherein the signal output processing unit determines whether the moving body exists in the permitted section based on the result of the comparison, and when it is determined that the moving body exists in the permitted section, outputs the permission signal.

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

the permitted section information includes information indicating an alarm area set at a periphery of the permitted 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 indicating that the mov-

ing body exists in the alarm area to the moving body.

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

8. 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 permitted section information indicating a permitted section in which a movement of the moving body is permitted, and outputs, based on a result of the comparison, a permission signal that permits the movement of the moving body in the permitted section,
wherein the signal output processing function determines whether the moving body exists in the permitted section based on the result of the comparison, and when it is determined that the moving body exists in the permitted section, outputs the permission signal.

9. 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 permitted section information indicating a permitted section in which a movement of the moving body is permitted, and outputs, based on a result of the comparison, a permission signal that permits the movement of the moving body in the permitted section,
wherein the signal output processing step further includes determining whether the moving body exists in the permitted section based on the result of the comparison, and when it is determined that the moving body exists in the permitted section, outputting the permission signal.

10. 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 controls the driving
unit,
wherein the self-position estimation unit trans- 5
mits estimated self-position information to the
traffic control device using the wireless commu-
nication unit, and
when the wireless communication unit receives 10
a permission signal transmitted from the traffic
control device, the movement control unit con-
trols the driving unit to perform operation corre-
sponding to the permission signal.

11. The moving body according to claim 10, wherein the 15
wireless communication unit receives a plurality of
permission signals relating to movement into a same
permitted section from different traffic control de-
vices.

12. The moving body according to claim 11, wherein, 20
when the wireless communication unit receives a
predetermined number of permission signals, the
movement control unit controls the driving unit to
perform operation corresponding to the permission 25
signals.

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FIG. 1

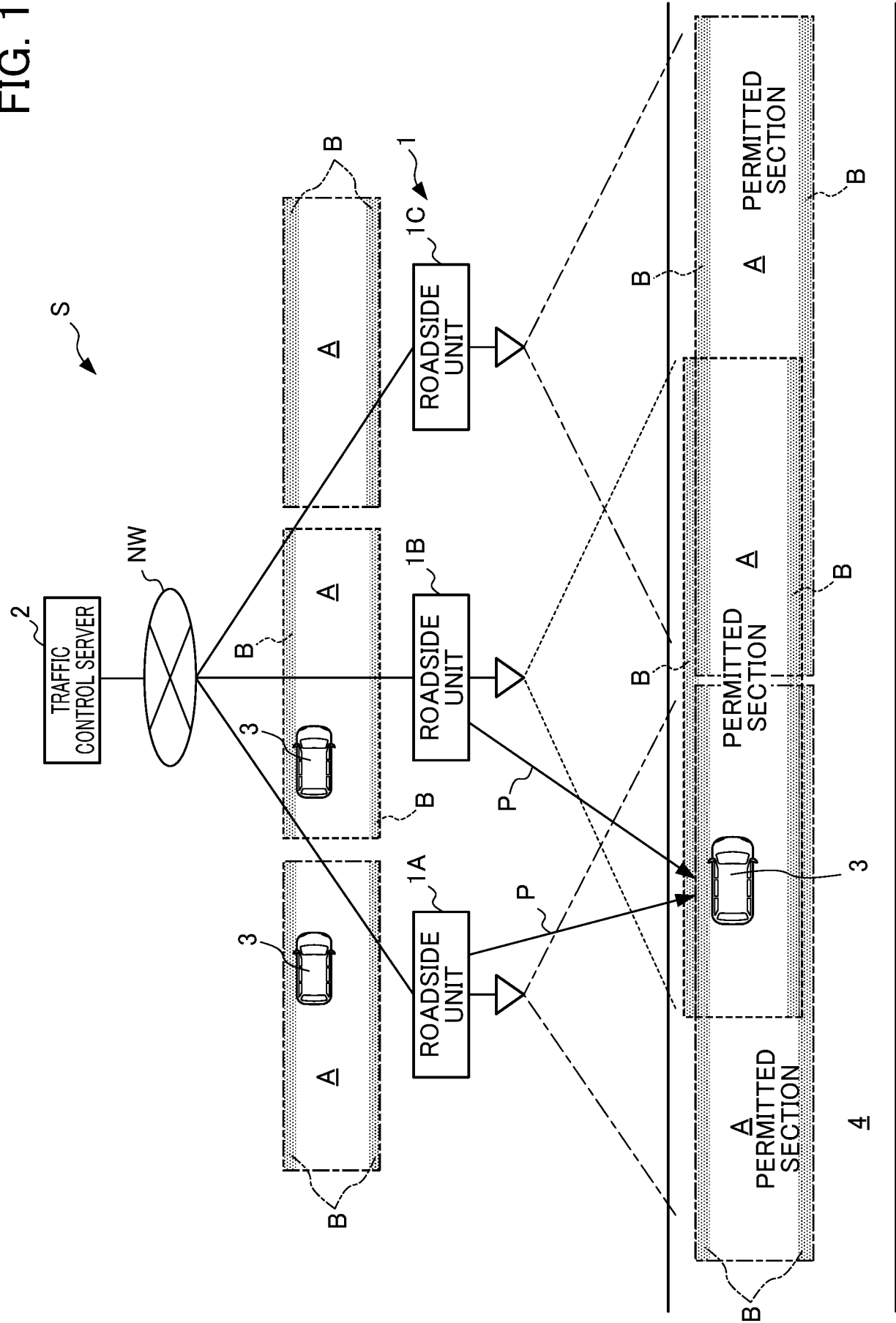


FIG. 2

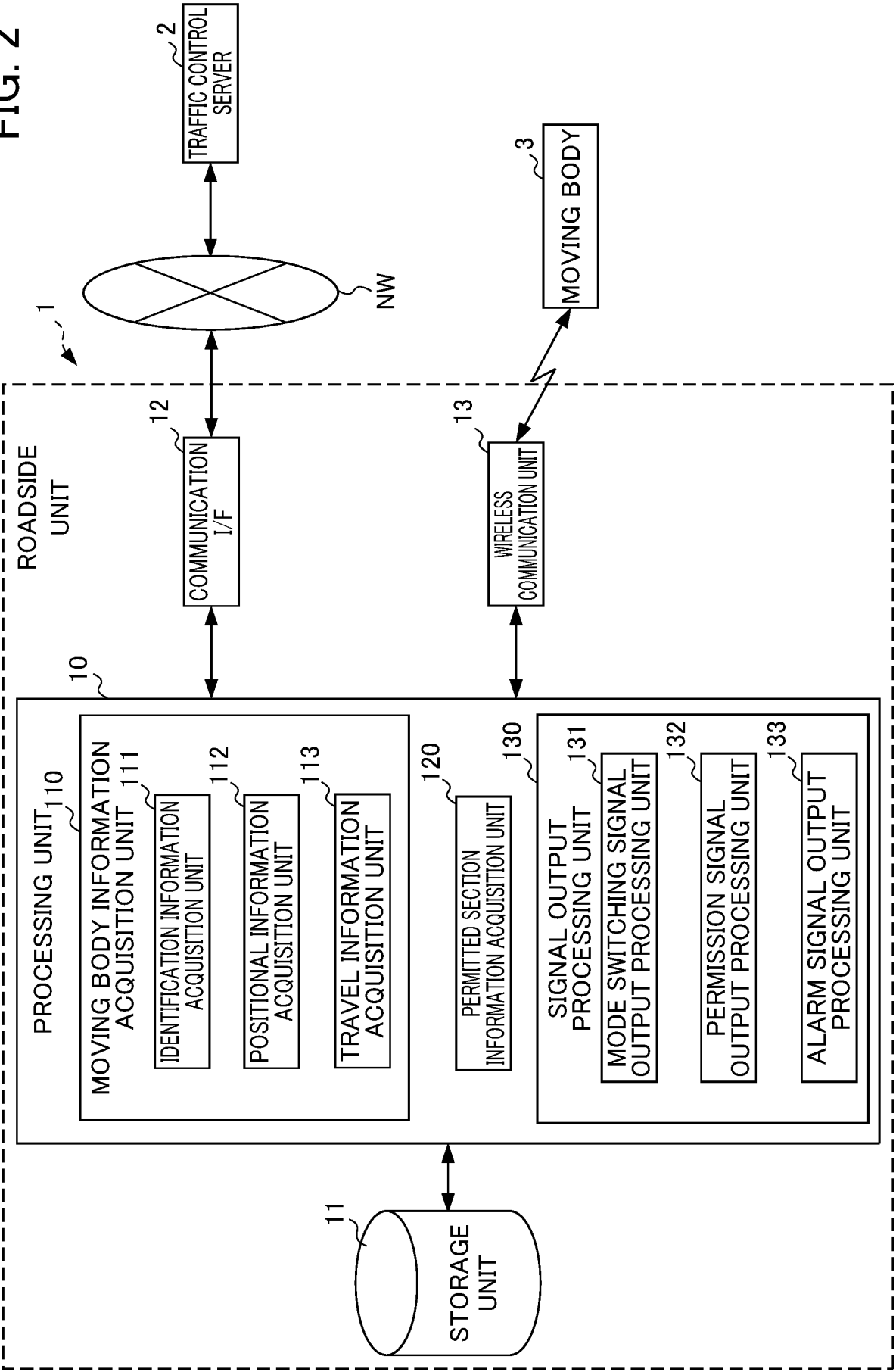


FIG. 3A

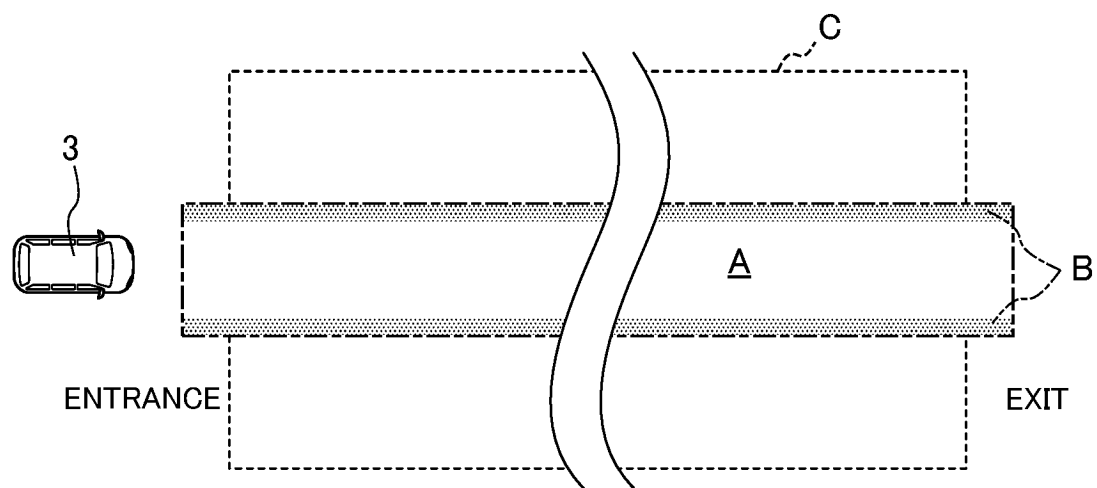


FIG. 3B

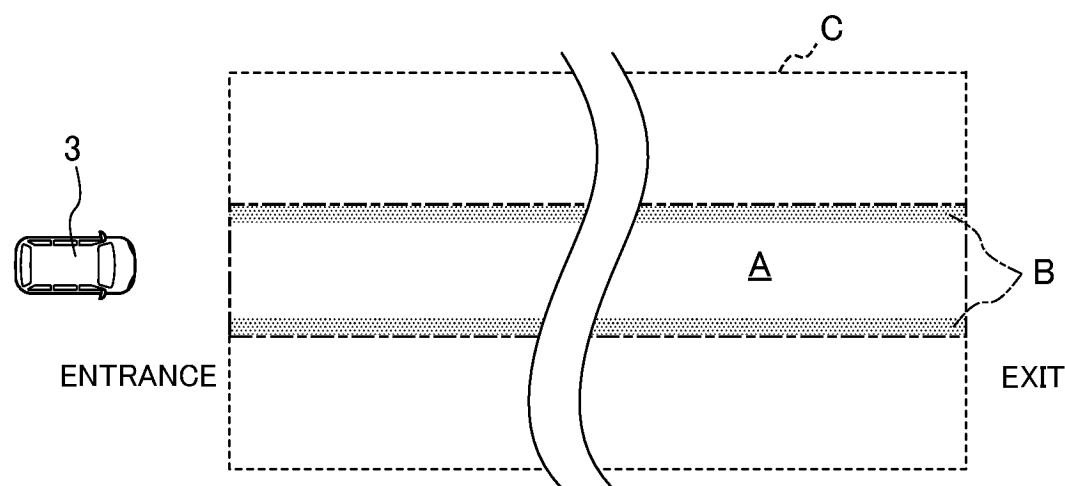


FIG. 4

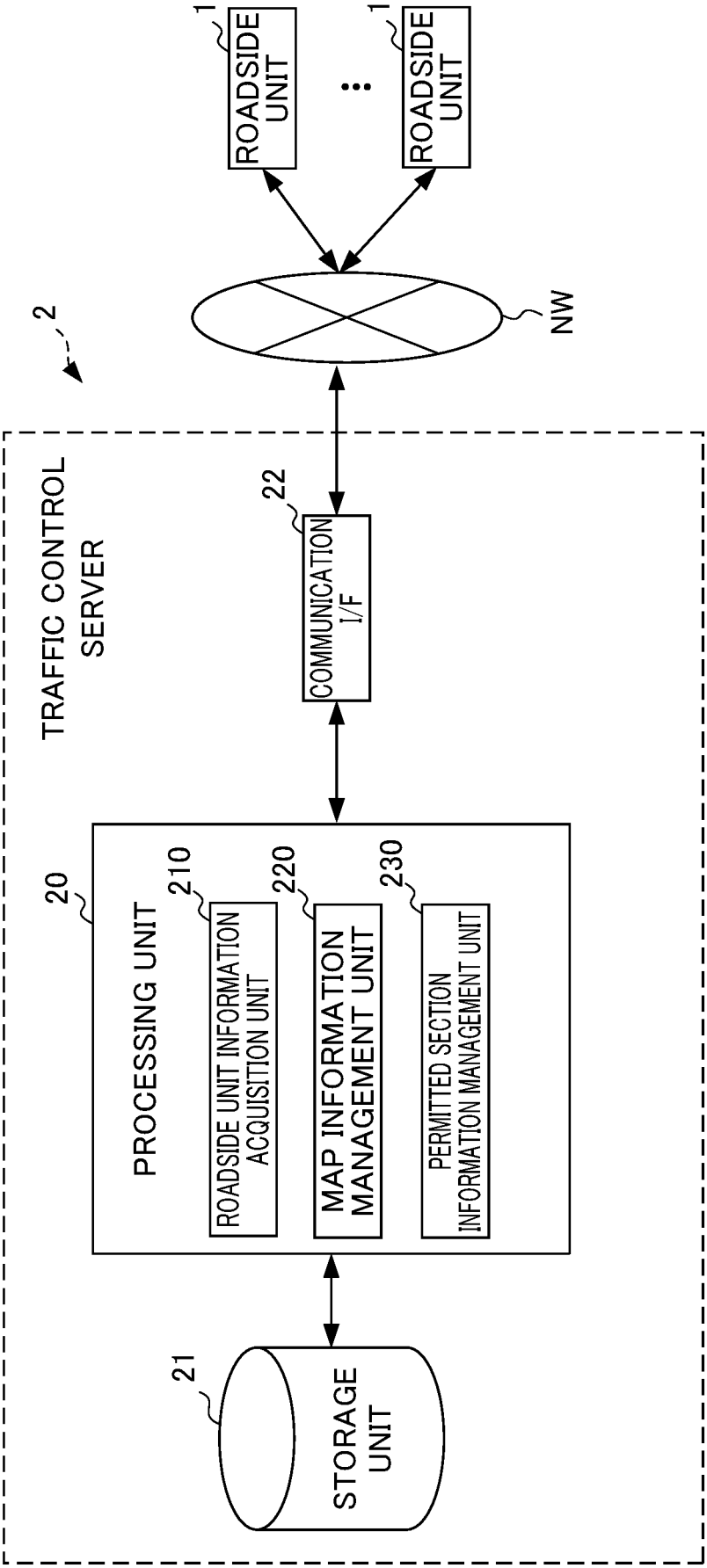


FIG. 5

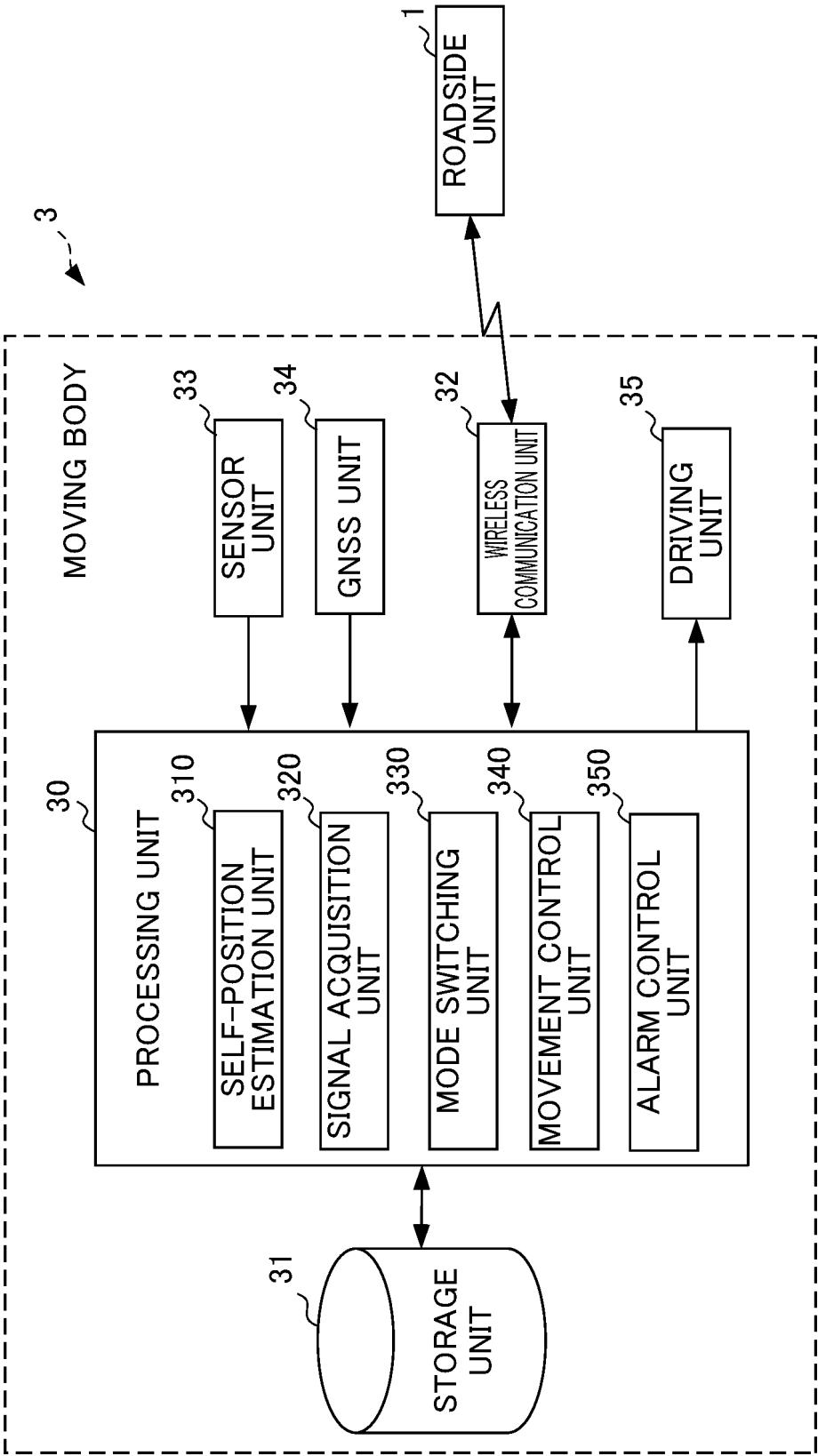


FIG. 6

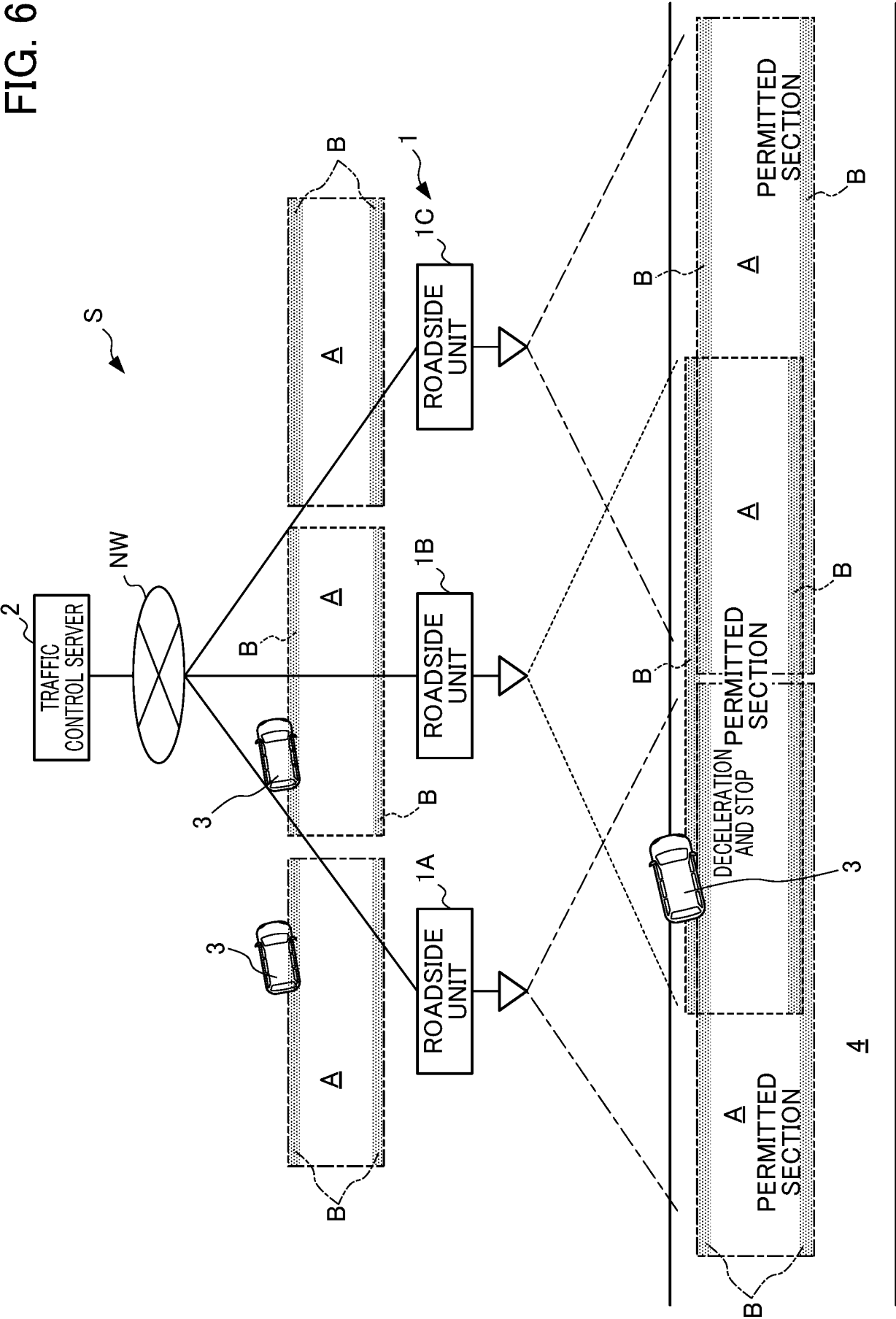


FIG. 7

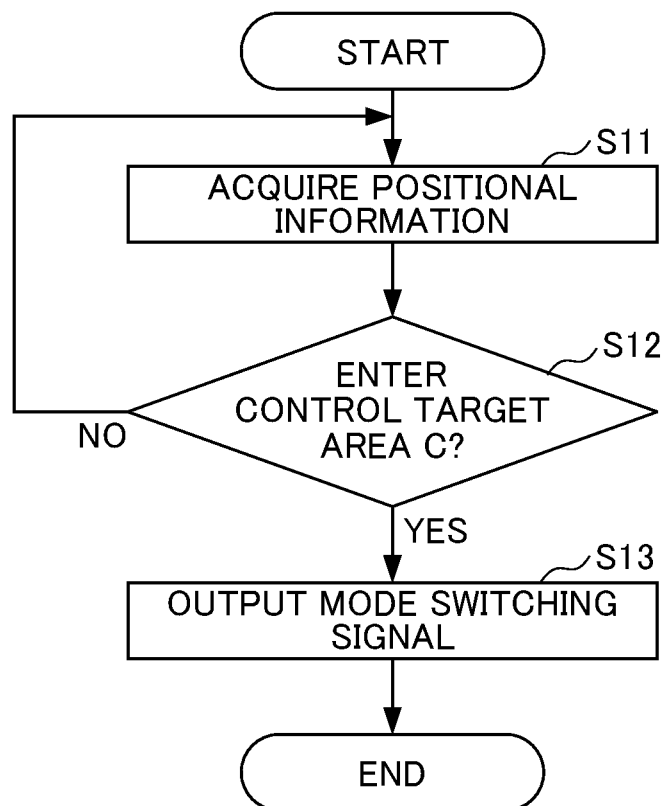


FIG. 8

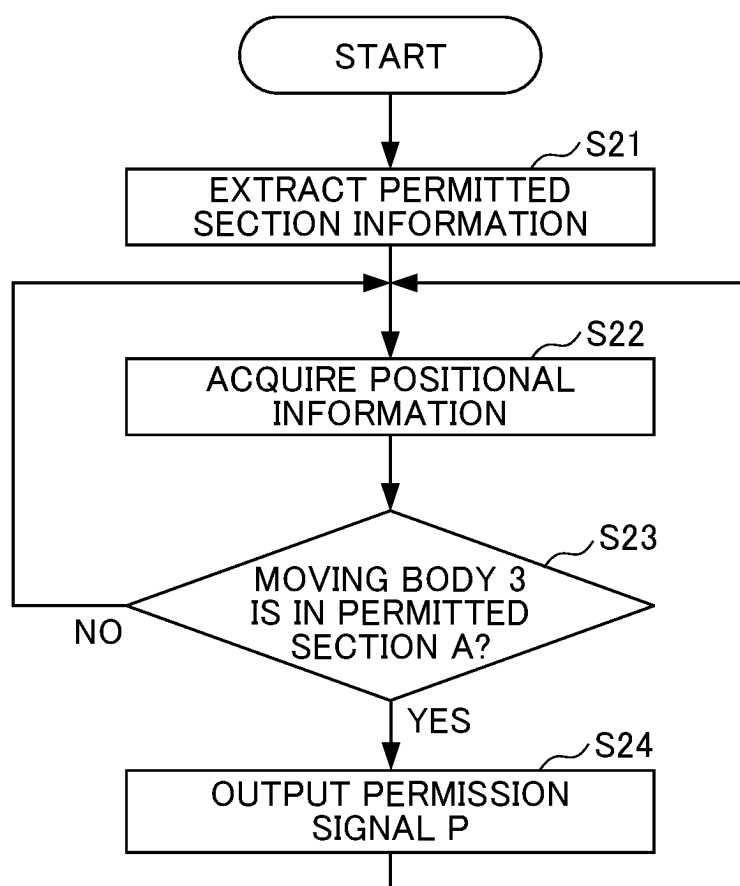


FIG. 9

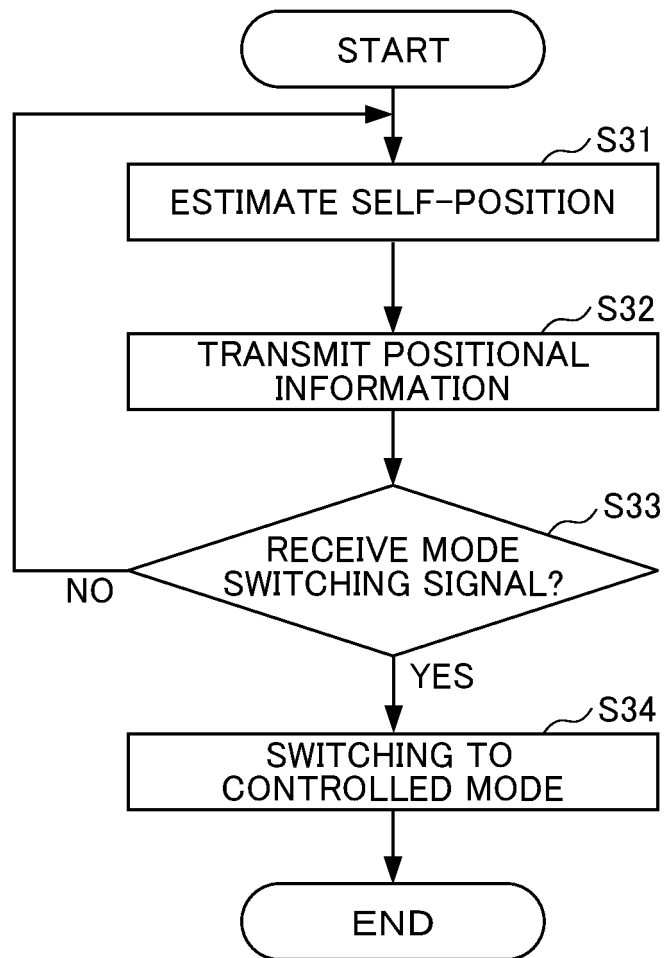


FIG. 10

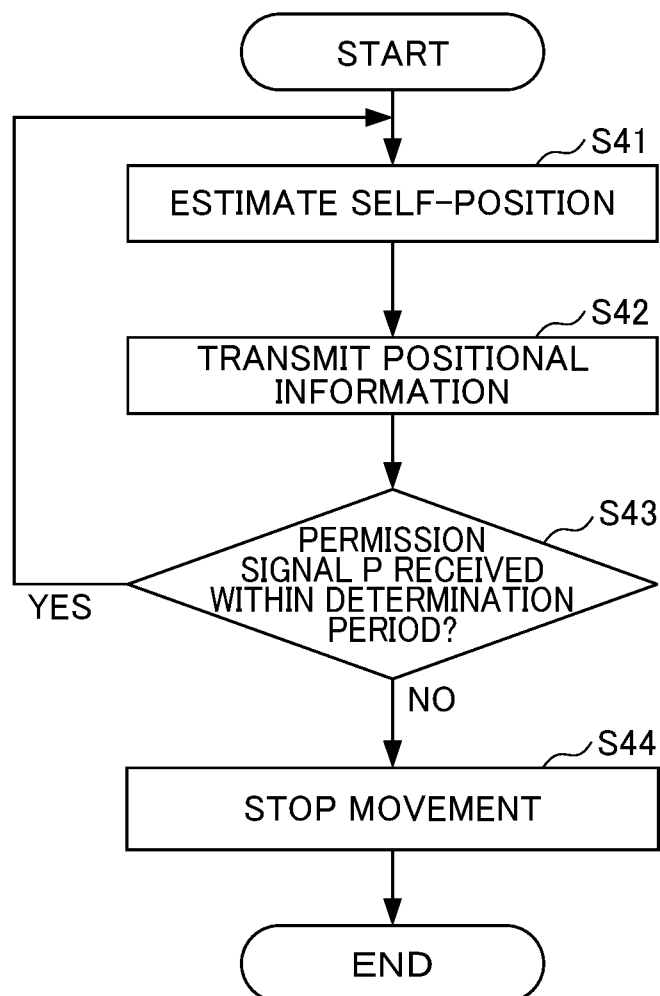


FIG. 11

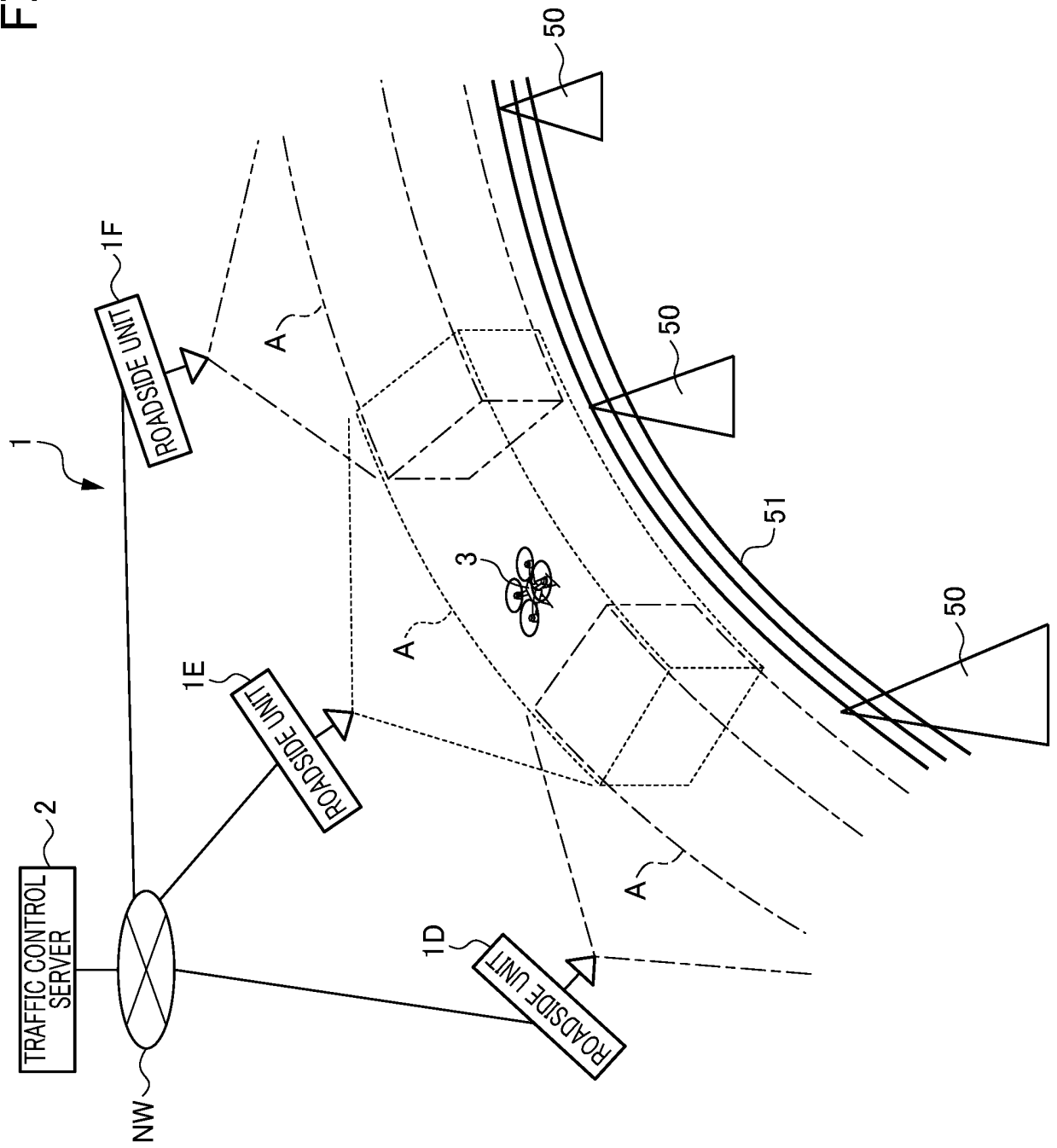
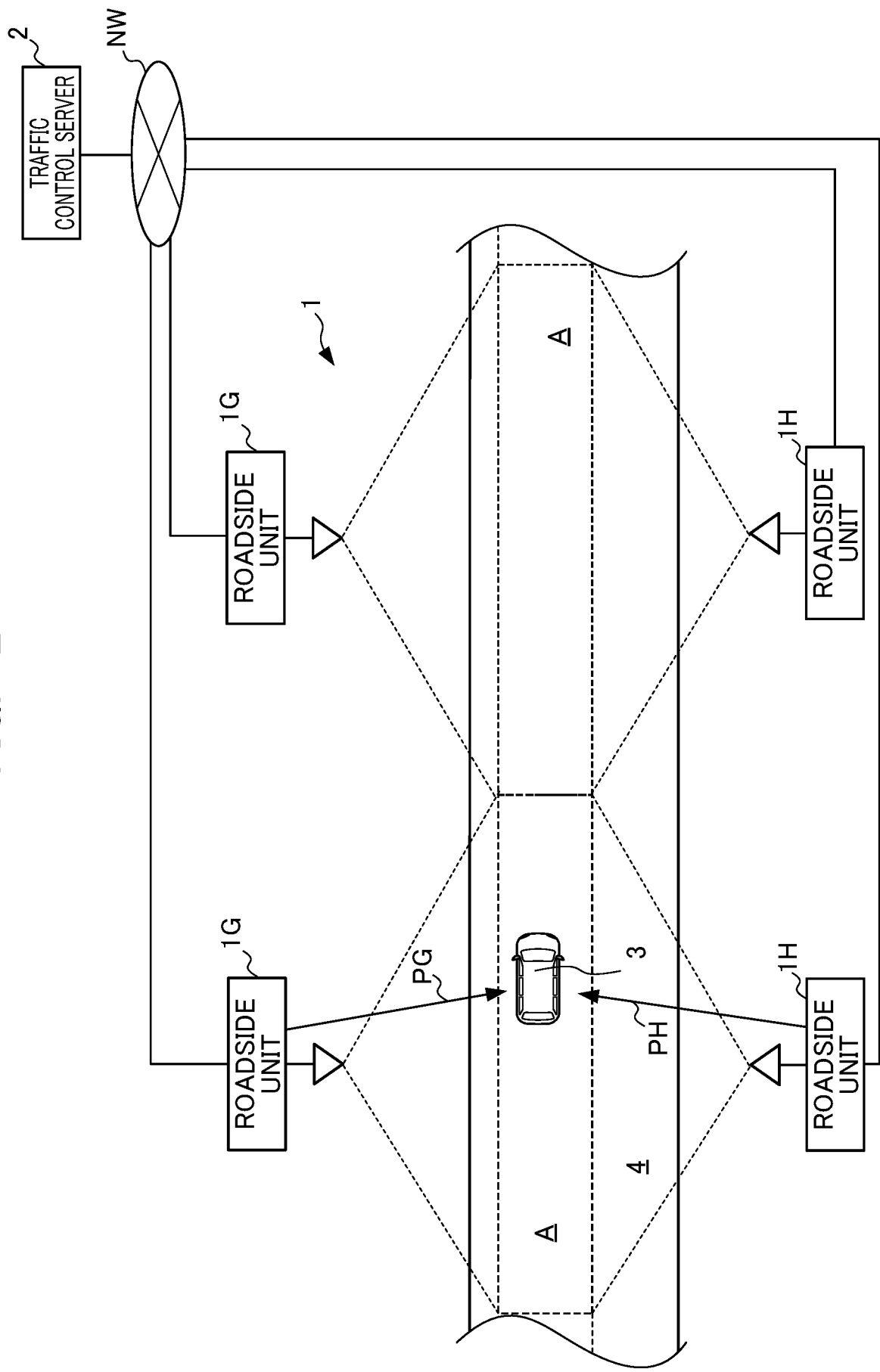


FIG. 12



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2023/016292

A. CLASSIFICATION OF SUBJECT MATTER**G08G 1/16**(2006.01)i; **G08G 1/00**(2006.01)i; **G08G 1/09**(2006.01)i

FI: G08G1/16 A; G08G1/09 F; G08G1/00 J

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)

G08G1/16; G08G1/00; G08G1/09

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	JP 2001-128302 A (MITSUBISHI HEAVY IND LTD) 11 May 2001 (2001-05-11) paragraphs [0002]-[0003], [0007]-[0008], [0011]-[0014], fig. 1	1-12
A	JP 2021-162976 A (HITACHI CONSTRUCTION MACHINERY CO., LTD.) 11 October 2021 (2021-10-11)	1-12

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

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“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

14 June 2023

Date of mailing of the international search report

04 July 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.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/016292

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)		Publication date (day/month/year)
JP	2001-128302	A	11 May 2001	(Family: none)		
JP	2021-162976	A	11 October 2021	EP	4130920	A1
				CN	115298719	A

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2016181031 A [0003]