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(54) CONVERGENCE-SUPPORTING DEVICE, CONVERGENCE-SUPPORTING METHOD, AND CONVERGENCE-SUPPORTING PROGRAM

(57) The merging support device is loaded on a movable body and acquires a current position of the movable body. The merging support device presents the recommended merging area when the movable body is on the merging lane. The recommended merging area is an area on the main lane where merging is recommended, and is preferably an area of a predetermined distance from an ending position of the merging lane.

FIG. 4A

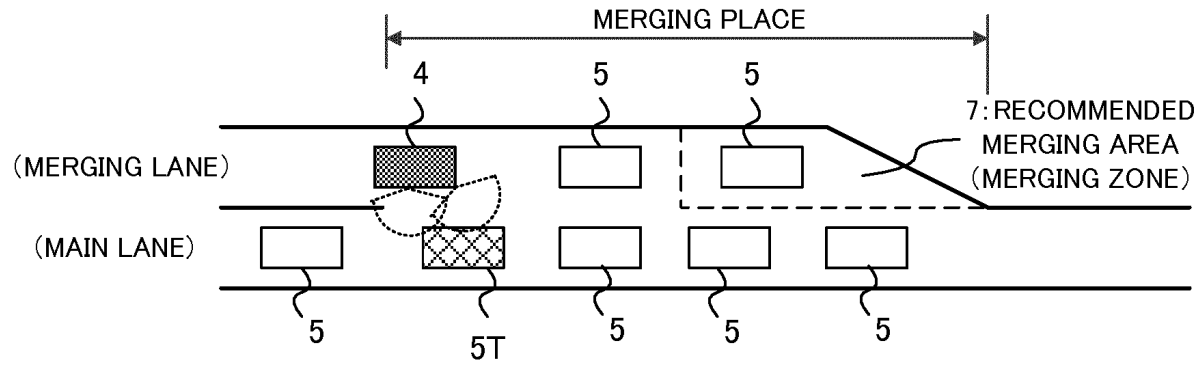

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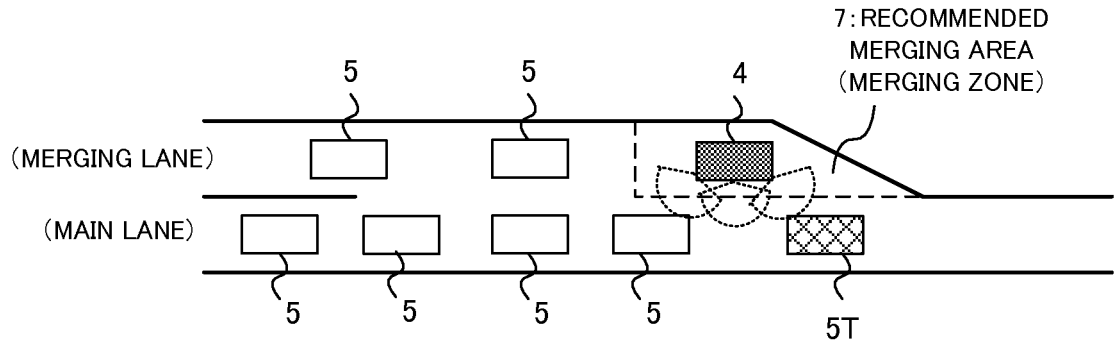
FIG. 4B


7: RECOMMENDED
MERGING AREA
(MERGING ZONE)
5
5
4
(MERGING LANE)
(MAIN LANE)
5
5
5
5
5T

Description

TECHNICAL FIELD

[0001] The present invention relates to driving support technique for a vehicle at the time of merging.

BACKGROUND TECHNIQUE

[0002] There is proposed a car navigation device which supports driving at the time of merging from a merging lane to a main lane. For example, Patent Reference 1 discloses a method in which, when a merging vehicle indicates intention of merging and a vehicle running on the main lane permits or allows the merging, it is notified to a driver of the merging vehicle.

[0003] Patent Reference 1: Japanese Patent Application Laid-open under No. 2012-118870

DISCLOSURE OF INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004] Patent Reference 1 does not disclose anything about a merging place on the merging lane. In addition, when the technique of Patent Reference 1 is executed, when a vehicle merges to a congested road for example, merging occurs at many positions on the merging lane and the main lane, resulting in further traffic congestion. Furthermore, when the merging occurs at many positions, the vehicle running on the main lane may become necessary to accept merging of many vehicles inconveniently or unfairly.

[0005] The above are examples of problems to be solved by the present invention. It is an object of the present invention to provide a merging support device capable of smoothing the traffic flow at the merging place by concentrating the merging points to a single point at the time of traffic congestion.

MEANS FOR SOLVING THE PROBLEM

[0006] One invention described in claims is a merging support device comprising: a current position acquiring means which acquires a current position of a movable body; and a presentation control means which performs control of presenting a recommended merging area on a merging lane where merging is recommended, when the current position is on the merging lane for merging to a specific road.

[0007] Another invention described in claims is a merging support method executed by a merging support device comprising: a current position acquiring process which acquires a current position of a movable body; and a presenting process which performs control of presenting a recommended merging area on a merging lane where merging is recommended, when the current position is on the merging lane for merging to a specific road.

[0008] Still another invention described in claims is a merging support program executed by a merging support device including a computer, the programmaking the computer to function as : a current position acquiring means which acquires a current position of a movable body; and a presentation control means which performs control of presenting a recommended merging area on a merging lane where merging is recommended, when the current position is on the merging lane for merging to a specific road.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a block diagram illustrating a schematic configuration of a merging support device according to an embodiment of the present invention.
FIG. 2 schematically illustrates recognition ranges of image sensors and radars.
FIG. 3 is a block diagram illustrating a configuration of a navigation device.
FIGS. 4A and 4B are diagrams for explaining a basic method of merging support.
FIG. 5 is a flowchart of merging support processing.
FIG. 6 is a flowchart of target vehicle selection processing.
FIG. 7 is a flowchart of target vehicle changing processing.
FIG. 8 is a flowchart of target vehicle changing processing.
FIGS. 9A to 9C illustrate an example of changing the target vehicle.
FIGS. 10A to 10C illustrates another example of changing the target vehicle.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] According to one aspect of the present invention, there is provided a merging support device comprising: a current position acquiring means which acquires a current position of a movable body; and a presentation control means which performs control of presenting a recommended merging area on a merging lane where merging is recommended, when the current position is on the merging lane for merging to a specific road.

[0011] The above merging support device is loaded on a movable body and acquires a current position of the movable body. The merging support device presents the recommended merging area when the movable body is on the merging lane. The recommended merging area is an area on the merging lane where merging is recommended, and is preferably an area of a predetermined distance from an ending position of the merging lane. By the merging support device, the recommended merging area is presented when the movable body is on the merging lane. Therefore, the movable bodies merge in the

recommended merging area in order, and the congestion at the merging place can be prevented.

[0012] In one mode of the above merging support device, the presentation control means performs control of presenting information prompting to start merging operation when the current position is in the recommended merging area. In this mode, when the current position of the movable body enters the recommended merging area, information prompting to start the merging operation, e.g., an instruction to output the turn signal is presented.

[0013] Another mode of the above merging support device further comprises a traffic congestion determining means which determines whether or not the merging lane is congested, wherein the presentation control means performs control of presenting the recommended merging area when the merging lane is determined to be congested. In this mode, the recommended merging area is presented when the merging lane is congested.

[0014] Still another mode of the above merging support device further comprises a designating unit which designates one other movable body running on the specific road as a target movable body, wherein the presentation control means performs control of presenting the information prompting to start the merging operation to merge behind the target movable body when the target movable body has been designated and the current position is in the recommended merging area. In this mode, a movable body running on the specific road subjected to the merging is designated as the target movable body. Then, when the movable body enters the recommended merging area, information to merge behind the target movable body is presented.

[0015] According to another aspect of the present invention, there is provided a merging support method executed by a merging support device comprising: a current position acquiring process which acquires a current position of a movable body; and a presenting process which performs control of presenting a recommended merging area on a merging lane where merging is recommended, when the current position is on the merging lane for merging to a specific road. By this merging support method, the recommended merging area is presented when the movable body is on the merging lane.

[0016] According to still another aspect of the present invention, there is provided a merging support program executed by a merging support device including a computer, the programmaking the computer to function as: a current position acquiring means which acquires a current position of a movable body; and a presentation control means which performs control of presenting a recommended merging area on a merging lane where merging is recommended, when the current position is on the merging lane for merging to a specific road. By executing the program by the computer, the above merging support device can be realized. This merging support programmaybe handled in a manner stored in a storage medium.

EMBODIMENT

[0017] A Preferred embodiment of the present invention will be described below with reference to the attached drawings.

[0018] FIG. 1 illustrates a schematic configuration of a merging support device according to an embodiment of the present invention. The merging support device 100 is installed in a vehicle, and includes a navigation device 1, a front image sensor 15F, a side image sensor 15S, a rear image sensor 15R, a front radar 16F, a side radar 16S and a rear radar 16R. In the following description, when it is not necessary to discriminate the position, the front image sensor 15F, the side image sensor 15S and the rear image sensor 15R will be referred to as "the image sensor 15", and the front radar 16F, the side radar 16S and the rear radar 16R will be referred to as "the radar 16s".

[0019] The image sensor 15 includes an imaging device such as a camera, and captures images around the vehicle. As shown in FIG. 2, a pair of front image sensors 15F is mounted on the left and right positions of the front part of the vehicle 4, and each of the front sensors 15F captures the images of the range 17F. A pair of side image sensors 15S is mounted on the left and right positions of the side parts of the vehicle 4, and each of the side sensors 15S captures the images of the range 17S. A pair of rear image sensors 15R is mounted on the left and right positions of the rear part of the vehicle 4, and each of the rear sensors 15R captures the images of the range 17R. The detection results of the image sensors 15 are supplied to the navigation device 1.

[0020] The radar 16 may be a millimeter wave radar for example, and detects presence/absence of obstacles around the vehicle, the distance to the obstacle and the direction of the obstacle. As shown in FIG. 2, a pair of front radars 16F is mounted on the left and right positions of the front part of the vehicle 4, and each of the front radars 16F detects the obstacles in the range 17F. A pair of side radars 16S is mounted on the left and right positions of the side parts of the vehicle 4, and each of the side radars 16S detects the obstacles in the range 17S. A pair of rear radars 16R is mounted on the left and right positions of the rear part of the vehicle 4, and each of the rear radars 16R detects the obstacles in the range 17R. The detection results of the radars 16 are supplied to the navigation device 1.

[0021] FIG. 3 illustrates a configuration of the navigation device 1. As shown in FIG. 3, the navigation device 1 includes a stand-alone position measurement device 10, a GPS receiver 18, a system controller 20, a disc drive 31, a data storage unit 36, a communication interface 37, a communication device 38, a display unit 40, a sound output unit 50 and an input device 60.

[0022] The stand-alone position measurement device 10 includes an acceleration sensor 11, an angular velocity sensor 12 and a distance sensor 13. The acceleration sensor 11 includes a piezoelectric element, for example,

and detects the acceleration degree of the vehicle and outputs the acceleration data. The angular velocity sensor 12 includes a vibration gyroscope, for example, and detects the angular velocity of the vehicle at the time of changing the direction of the vehicle and outputs the angular velocity data and the relative direction data. The distance sensor 13 measures vehicle speed pulses including pulse signals generated by the wheel revolution of the vehicle.

[0023] The GPS receiver 18 receives an electric wave 19 for transmitting downlink data including position measurement data from plural GPS satellites. The position measurement data is used for detecting the absolute position (hereinafter referred to as "a current position") of the vehicle from longitude and latitude information.

[0024] The system controller 20 includes an interface 21, a CPU 22, a ROM (Read Only Memory) 23 and a RAM (Random Access Memory) 24, and controls the entire navigation device 1.

[0025] The interface 21 executes the interface operation with the acceleration sensor 11, the angular velocity sensor 12, the distance sensor 13 and the GPS receiver 18. Then, the interface 21 inputs the vehicle speed pulse, the acceleration data, the relative direction data, the angular velocity data, the GPS measurement data and the absolute direction data into the system controller 20. In addition, the interface 21 executes the interface operation with the image sensors 15 and the radars 16, and inputs the images captured by the image sensors 15 and the detection signals generated by the radars 16 to the systemcontroller 20.

[0026] The CPU 22 controls the entire system controller 20. The ROM 23 includes a non-volatile memory (not shown) in which a control program for controlling the system controller 20 is stored. The RAM 24 readably stores various kinds of data such as route data preset by the user via the input device 60, and provides a working area to the CPU 22.

[0027] The system controller 20, the disc drive 31 such as a CD-ROM drive or a DVD-ROM drive, the data storage unit 36, the communication interface 37, the display unit 40, the sound output unit 50 and the input device 60 are connected with each other via a bus line 30.

[0028] Under the control of the system controller 20, the disc drive 31 reads contents data such as sound data and picture data from the disc 33 such as a CD and a DVD to output the contents data.

[0029] The data storage unit 36 includes HDD, for example, and stores various kinds of data used for a navigation process such as map data. The communication device 38 acquires vehicle information 39 managed by an ECU (Electronic Control Unit) via an in-vehicle communication network.

[0030] The display unit 40 displays various kinds of display data on a display device such as a display under the control of the systemcontroller20. Specifically,thesystem controller20reads the map data from the data storage unit 36. The display unit 40 displays, on a display screen such as a display, the map data read from the data storage unit 36 by the system controller 20. The display unit 40 includes a graphic controller 41 for controlling the entire display unit 40 on the basis of the control data transmitted from the CPU 22 via the bus line 30, a buffer memory 42 for temporarily storing image information having a memory such as a VRAM (Video RAM) and immediately displayable, a display control unit 43 for controlling a display 44 such as a liquid crystal and a CRT (Cathode Ray Tube) on the basis of the image data outputted from the graphic controller 41, and the display 44. The display 44 is formed by a liquid crystal display device of the opposite angle 5-10 inches, and is mounted in the vicinity of a front panel of the vehicle.

[0031] The sound output unit 50 includes a D/A converter 51 for executing D/A conversion of the sound digital data transmitted from the disc drive 31 or the RAM 24 via the bus line 30 under the control of the system controller 20, an amplifier (AMP) 52 for amplifying an audio analog signal outputted from the D/A converter 51, and a speaker 53 for converting the amplified audio analog signal into the sound and outputting it to the vehicle compartment.

[0032] The input device 60 includes keys, switches, buttons, a remote controller and a speech input device, which are used for inputting various kinds of commands and data. The input device 60 is arranged in the vicinity of a front panel of a main body and the display 44 of an on-vehicle electric system installed in the vehicle. Additionally, in such a case that the display 44 is of a touch panel system, a touch panel provided on the display screen of the display 44 functions as the input device 60, too.

[0033] In the above-described configuration, the CPU 22 functions as the current position acquiring means, the presentation control means and the traffic congestion determining means.

[Merging Support Method]

(Basic Merging Support Method)

[0034] The merging support method of the embodiment is characterized by first setting a recommended merging area (hereinafter referred to as "the merging zone"), where it is recommended to start the merging operation of the movable body to the main lane, near the point where the merging lane ends, during traffic congestion. FIGS. 4A and 4B are diagrams for explaining the merging support method of the embodiment. Specifically, FIG. 4A schematically illustrates the situation that a driver' s vehicle 4 is going to merge from the merging lane to the main lane when the merging place is congested. In the following description, "the merging place" indicates an area on the main lane and the merging lane where the merging lane is provided along the main lane and the vehicle can change the lane. Also, "the recommended merging area (the merging zone)" indicates the ending

position of the merging lane in the merging place, i.e., an area of a predetermined distance (length) from the ending point of the merging lane.

[0035] In the example of FIG. 4A, plural vehicles 5 exist ahead of the vehicle 4 on the merging lane. Also, the main lane is congested, and plural vehicles 5 exist in line. When the merging place is congested like this, if the plural vehicles on the merging lane try to merge to the main lane at different positions respectively, the merging operation occurs at plural positions. As a result, smooth merging becomes difficult, and the congestion of the main lane may get worse.

[0036] In this view, the merging support device 100 sets the merging zone 7 of a predetermined distance at the ending position of the merging lane, i.e., the point near the ending point of the merging lane, and present it to the driver to guide the driver to merge to the main lane at the merging zone 7. Thereby, since the vehicles running on the merging lane merge to the main lane, in order, at the merging zone 7 which is the ending position of the merging lane, the merging to the main lane becomes smooth and the congestion on the main lane does not get worse.

[0037] Further, the merging support device 100 selects the vehicle 5, which is presumed to exist on the main lane at the position neighboring the driver's vehicle 4 when the driver's vehicle 4 enters the merging zone 7, as a target vehicle 5T, and performs the merging guidance utilizing the target vehicle 5T as a mark. Namely, the merging support device 100 guides the driver to merge to the main lane at the position behind the target vehicle 5T when the driver's vehicle 4 enters the merging zone 7. Specifically, when the driver's vehicle 4 is running on the merging lane as shown in FIG. 4A, the merging support device 100 selects the vehicle 5, which is existing on the main lane and neighboring the driver's vehicle 4, as the target vehicle 5T. Then, when the driver's vehicle 4 enters the merging zone 7 as shown in FIG. 4B, the merging support device 100 guides the driver to merge to the main lane at the position behind the target vehicle 5T. Thus, it becomes possible to minimize the influence that the driver's vehicle 4 gives to the vehicle flow on the main lane at the time of merging.

[0038] Further, the merging support device 100 changes the target vehicle 5T as necessary until the driver's vehicle 4 enters the merging zone 7. Namely, if the speeds of the vehicle flow on the merging lane and the main lane are different and it is presumed that the current target vehicle 5T will move away from the driver' s vehicle 4 when the driver's vehicle 4 actually enters the merging zone 7, the merging support device 100 changes to the target vehicle 5T to one other vehicle ahead of or behind the current target vehicle 5T. Thereby, it becomes possible to perform the merging guidance using the target vehicle 5T of the appropriate position as the target when the driver's vehicle 4 actually enters the merging zone 7.

(Merging Support Processing)

[0039] Next, merging support processing according to the embodiment will be described in detail. FIG. 5 is a flowchart of the merging support processing. This merging support processing is achieved by the CPU 22 of the navigation device 1 constituting the merging support device 100 which executes program prepared in advance.

[0040] In FIG. 5, first the navigation device 1 confirms the road situation in the travelling direction (step S10). Specifically, the navigation device 1 acquires information such as a current position of the vehicle, a speed of the vehicle, map data, traffic information, a speed of the vehicle running ahead captured by the front image sensor 15F and the front radar 16F, and road signs (signboard).

[0041] Next, the navigation device 1 determines whether or not the road on which the driver's vehicle 4 is running is congested, based on the speed of the vehicle, the traffic information, the images captured by the front image sensor 15F and the result of detecting the obstacles by the front radar 16F (step S11). When the running road is not congested (step S11: No), the navigation device ends the processing.

[0042] Meanwhile, when the running road is congested (step S11: Yes), the navigation device 1 determines whether or not the lane the driver's vehicle 4 is currently running is going to reduce, i.e., the lane currently running is the merging lane (step S12). When the lane is not going to reduce (step S12 : No), the lane currently running is not the merging lane, and the navigation device 1 ends the processing.

[0043] Meanwhile, when the lane is going to reduce (step S12: Yes), it means that the driver's vehicle 4 is running on the merging lane. Therefore, the navigation device 1 sets the merging zone 7, and presents it to the driver (step S13). Specifically, the navigation device 1 sets the area of the predetermined distance (length) from the ending position of the currently running merging lane to the merging zone 7. Basically, the length of the merging zone 7 maybe determined in advance as the distance that is necessary for one vehicle of regular size to merge to the main lane. Further, the flow of the vehicles on the merging lane, i.e., the speed of the vehicles running on the merging lane may be estimated based on the speed of the driver' s vehicle 4, and the length of the merging zone 7 may be changed in accordance with the estimated speed. For example, the merging zone 7 may be long when the vehicle flow on the merging lane is fast, and the merging zone may be short when the vehicle flow on the merging lane is slow.

[0044] Then, the navigation device 1 presents the merging zone 7 to the driver by coloring the merging zone 7 on the map displayed on the display 44 and/or outputting the distance from the current position of the driver's vehicle 4 to the merging zone 7 by sound of voice. For example, the navigation device 1 outputs the voice announcement "Merge at the merging zone 100m ahead!".

[0045] In this way, by setting the merging zone 7 and

prompts the driver to merge at the merging zone 7, it is possible to create the situation that plural vehicles on the merging lane merge to the main lane within the merging zone 7 in order, thereby preventing the congestion at the merging place from getting worse.

[0046] When the merging zone 7 is set in this way, next the navigation device 1 selects the target vehicle 5T (step S14). FIG. 6 illustrates a flowchart of target vehicle selection processing.

[0047] First, the navigation device 1 determines whether or not there is a vehicle neighboring the driver's vehicle 4 on the main lane based on the outputs from the side image sensor 15S and the side radar 16S (step S30). When there is no vehicle (step S30: No), the process goes to step S34. When there is a vehicle (step S30: Yes), the navigation device 1 determines whether or not the main lane includes two or more lanes based on the map data (step S31).

[0048] When the main lane does not include two or more lanes (step S31:No), the main lane includes one lane and there is a vehicle neighboring the driver's vehicle 4 on the main lane, and therefore the navigation device 1 selects the vehicle detected in step S30 as the target vehicle 5T (step S33). If plural vehicles are detected in step S30, the navigation device 1 selects the vehicle nearest to the driver's vehicle 4 as the target vehicle 5T.

[0049] Meanwhile, when the main lane include two or more lanes (step S31: Yes), the navigation device 1 determines whether or not the distance from the driver's vehicle 4 to the neighboring vehicle detected in step S30 is equal to or larger than one lane (step S32). When the distance to the detected vehicle is not equal to or larger than one lane (step S32: No), the detected vehicle is on the neighboring lane, and the navigation device 1 selects the detected vehicle as the target vehicle 5T (step S33).

[0050] Meanwhile, when the distance to the detected vehicle is equal to or larger than one lane (step S32: Yes), the detected vehicle is not on the neighboring lane to which the driver' s vehicle 4 is going to merge. Therefore, the navigation device 1 does not select the detected vehicle as the target vehicle 5T, and the process goes to step S34.

[0051] In step S34, the navigation device 1 determines whether or not there are foregoing vehicles on the neighboring lane based on the outputs of the front image sensor 15F and the forward radar 16F. When there are foregoing vehicles on the neighboring lane (step S34 : Yes), the navigation device 1 selects the nearest vehicle of the detected foregoing vehicles as the target vehicle 5T (step S35).

[0052] Meanwhile, when there is no foregoing vehicle on the neighboring lane (step S34 : No), the navigation device 1 determines whether or not there are following vehicles on the neighboring lane (step S36). When there are following vehicles on the neighboring lane (step S36: Yes), the navigation device selects the nearest vehicle of the detected following vehicle as the target vehicle 5T (step S37).

[0053] Meanwhile, when there is no following vehicle on the neighboring lane (step S36: No), there is no vehicle on the neighboring lane. Therefore, the navigation device 1 determines whether or not the driver's vehicle 4 enters the merging zone 7 (step S38). When the driver's vehicle 4 does not enter the merging zone yet (step S38: No), the process returns to step S30, and the navigation device 1 repeats the process of steps S30 to S37 for searching the target vehicle 5T until the driver's vehicle 4 enters the merging zone 7. Meanwhile, when the driver's vehicle 4 enters the merging zone 7 (step S38: Yes), the navigation device 1 guides the driver to output the turn signal (step S39), checks the backward direction by the rear image sensor 15R and the rear radar 16R (step S40), and instructs the driver to merge (step S41). Thus, the driver performs merging, and the merging support processing ends. In this case, the target vehicle 5T is not selected, and the navigation device 1 performs the merging support without using the target vehicle 5T.

[0054] When the target vehicle 5T is selected in steps S33, S35 or S37, the process returns to the main routine shown in FIG. 5, and goes to step S15. In step S15, the navigation device 1 detects the distance and the speed difference between the driver's vehicle 4 and the target vehicle 5T by the image sensor 15 and the radar 16). Specifically, the navigation device 1 can detect the distance between the driver's vehicle 4 and the target vehicle 5T by the radar 16. Also, the navigation device 1 can detects the speed difference between the driver's vehicle 4 and the target vehicle 5T by detecting the change of the relative positional relation between the driver's vehicle 4 and the target vehicle 5T by the image sensor 15 and the radar 16.

[0055] After determining the target vehicle 5T, the navigation device 1 can track the target vehicle 5T by detecting the color of the target vehicle 5T based on the output of the image sensor 15 and detecting the change of the distance to the target vehicle 5T based on the output of the radar 16. For example, the navigation device 1 can determine that the target vehicle 5T has gone away if the flow of the neighboring lane suddenly becomes fast and a vehicle of the color different from that of the target vehicle 5T comes out next to the driver's vehicle 4, or if the distance to the target vehicle 5T becomes far and other nearer vehicle is detected.

[0056] Next, the navigation device 1 determines whether or not the current target vehicle 5T coincides with the target vehicle 5T when the driver's vehicle 4 enters the merging zone 7 (hereinafter referred to as "the final target vehicle") based on the distance and the speed difference between the driver's vehicle 4 and the target vehicle 5T (step S16).

[0057] In one method for this determination, the navigation device 1 calculates an expected distance between the driver's vehicle 4 and the target vehicle 5 when the driver's vehicle 4 enters the merging zone 7 based on the distance and the speed difference between the driver's vehicle 4 and the target vehicle 5T, and predicts

whether or not there exists other vehicle nearer than the expected distance. Then, the navigation device 1 determines that the current target vehicle 5T does not coincide with the final target vehicle when it is predicted that there exists other vehicle nearer than the expected distance, and determines that the current target vehicle 5T coincides with the final target vehicle when it is predicted that there exists no vehicle nearer than the expected distance.

[0058] In another method, the navigation device 1 calculates an expected distance between the driver's vehicle 4 and the target vehicle 5T when the driver's vehicle 4 enters the merging zone 7, and determines that the current target vehicle 5T does not coincide with the final target vehicle if the expected distance is longer than a predetermined distance. Since the merging support processing according to the embodiment is executed when the merging place is congested, there may exist other vehicles in front of and behind the current target vehicle 5T with a normal inter-vehicle distance. Therefore, if the expected distance becomes equal to or larger than the distance of a single average vehicle, the navigation device 1 may presume that the vehicle in front of or behind the current target vehicle 5T becomes nearer to the driver' s vehicle 4 than the current target vehicle 5T, and may determine that the current target vehicle 5T does not coincide with the final target vehicle.

[0059] When it is determined that the current target vehicle 5T does not coincide with the final target vehicle (step S16: No), the navigation device 1 executes the target vehicle changing processing (step S17). The target vehicle changing processing will be specifically described later. Meanwhile, when it is determined that the current target vehicle 5T coincides with the final target vehicle (step s16: Yes), it is assumed that the current target vehicle 5T will be an appropriate target vehicle 5T even when the driver' s vehicle 4 enters the merging zone 7. Therefore, the navigation device 1 determines whether or not the driver's vehicle 4 has entered the merging zone 7 (step S18). When the driver's vehicle 4 has not entered the merging zone 7 (step S18: No), the process returns to step S15. Then, until the driver's vehicle 4 enters the merging zone 7, steps S15 to S17 are repeated to change the target vehicle 5T as necessary.

[0060] Meanwhile, when the driver's vehicle 4 has entered the merging zone 7 (step S18: Yes), the navigation device 1 determines whether or not the target vehicle 5T at that time (which will be the final target vehicle) exists at the side of the driver's vehicle 4 or ahead of the driver's vehicle 4 on the neighboring lane (step S19).

[0061] When the target vehicle 5T does not exist at the side of the driver's vehicle 4 or ahead of the driver's vehicle on the neighboring lane (step S19: No), the target vehicle 5T exists behind the driver's vehicle 4, and hence the navigation device 1 instructs the driver to decelerate the driver's vehicle 4 (step S20). Thus, the navigation device 1 performs the guidance such that the driver's vehicle 4 can merge behind the target vehicle 5T. Then, the process returns to step S19.

[0062] When the target vehicle 5T exists at the side of the driver' s vehicle 4 or ahead of the driver's vehicle 4 on the neighboring lane (step S19: Yes), the navigation device 1 guides the driver to output the turn signal to start the merging operation (step S21). Then, the navigation device 1 confirms that there is a predetermined space behind the target vehicle 5T, i. e., the vehicle immediately behind the target vehicle 5T has created a space from the target vehicle 5T to allow the merging of the driver's vehicle 4 in response to the output of the turn signal by the driver's vehicle 4 (step S22), and instructs the driver to merge (step S23) . In response, the driver merges the driver's vehicle 4 to the main lane. Thus, the merging support processing ends.

[0063] In this way, according to the embodiment, by setting the target vehicle 5T and instructing the merging with using the target vehicle 5T as the target, it is possible to clearly notify the driver of the merging timing. Also, by letting the driver's vehicle 4 merge behind the target vehicle 5T, the vehicle flow on the main lane can be prioritized, and it is possible to prevent the traffic congestion at the merging place from getting worse.

[0064] Next, the target vehicle changing processing in step S17 will be described. FIGS. 7 and 8 are flowcharts of the target vehicle changing processing. In FIG. 7, first the navigation device 1 determines whether or not the target vehicle 5T has changed the lane based on the outputs from the image sensor 15 and the radar 16 (step S50). For example, when the distance to the target vehicle 5T becomes equal to or larger than one lane, the navigation device 1 can determine that the target vehicle 5T has changed the lane.

[0065] When the target vehicle 5T has not changed the lane (step S50: No), the navigation device 1 determines whether or not the vehicle presumed to be neighboring the driver's vehicle 4 when the driver's vehicle 4 enters the merging zone 7 (hereinafter referred to as "presumed vehicle") is present on the main lane, based on the outputs of the image sensor 15 and the radar 16 (step S51). When the presumed vehicle is present on the main lane (step S51: Yes), the navigation device 1 changes the target vehicle 5T to the presumed vehicle (step S52). Then, the process returns to the main routine of FIG. 5.

[0066] Meanwhile, when the presumed vehicle is not present on the main lane (step S51: No), the navigation device 1 determines whether or not there is a vehicle between the current target vehicle 5T and the side position of the driver' s vehicle 4 when the driver' s vehicle 4 enters the merging zone 7 (step S53). When there is a vehicle between the current target vehicle 5T and the side position of the driver's vehicle 4 when the driver's vehicle 4 enters the merging zone 7 (step S53), the navigation device 1 determines whether or not there are a plurality of such vehicles (step S54). When there are not a plurality of such vehicles (step S54: No), i.e., such a vehicle is only one, the navigation device 1 changes the target vehicle 5T to that one vehicle. Then, the process

returns to the main routine of FIG. 5.

[0067] Meanwhile, when there are a plurality of such vehicle (step S54: Yes), the navigation device 1 changes the target vehicle 5T to the vehicle, out of those plurality of vehicles, nearest to the side position of the driver's vehicle 4 when the driver's vehicle 4 enters the merging zone 7 (step S56). Then, the process returns to the main routine of FIG. 5.

[0068] When there is no vehicle between the current target vehicle 5T and the side position of the driver' s vehicle 4 when the driver' s vehicle 4 enters the merging zone 7 (step S53: No), the navigation device 1 does not change the target vehicle 5T (step S57). Then, the process returns to the main routine of FIG. 5.

[0069] In step S50, when the target vehicle has changed the lane (step S50: Yes), the navigation device 1 changes the target vehicle basically by the same method as the target vehicle changing processing shown in FIG. 6. Namely, in FIG. 8, first the navigation device 1 determines whether or not there is a vehicle neighboring the driver's vehicle 4 (step S61), and when there is a vehicle (step S61: Yes), the navigation device 1 changes the target vehicle 5T to the neighboring vehicle (step S62). Then, the process returns to the main routine of FIG. 5.

[0070] When there is no vehicle neighboring the driver's vehicle 4 (step S61: No), the navigation device 1 determines whether or not there is a foregoing vehicle on the neighboring lane (step S63), and when there is a vehicle (step S63: Yes), the navigation device 1 changes the target vehicle 5T to the foregoing vehicle (step S64). Then, the process returns to the main routine of FIG. 5.

[0071] When there is no foregoing vehicle on the neighboring lane (step S63: No), the navigation device 1 determines whether or not there is a following vehicle on the neighboring lane (step S65), and when there is a vehicle (step S65: Yes), the navigation device 1 changes the target vehicle 5T to the following vehicle on the neighboring lane (step S66). Then, the process returns to the main routine of FIG. 5.

[0072] When there is no following vehicle on the neighboring lane (step S65: No), the navigation device 1 determines whether or not the driver's vehicle 4 has entered the merging zone 7 (step S67) . When the driver's vehicle 4 has not entered the merging zone 7 (step S67: No), the process returns to step S61, and steps S61 to S66 for searching the target vehicle are repeated until the driver's vehicle 4 enters the merging zone 7.

[0073] Meanwhile, when the driver's vehicle 4 has entered the merging zone 7 (step S67: Yes), it means that the target vehicle 5T that has been set moved to another lane by and there is no alterative vehicle to become the target vehicle on the neighboring lane after that. Therefore, the navigation device 1 performs the merging guidance without using the target vehicle 5T. Specifically, the navigation device 1 guides the driver to output the turn signal (step S68), checks the backward direction by the rear image sensor 15R and the rear radar 16R (step S69), and instructs the driver to merge (step S70). In response, the driver merges to the main lane, and the merging support processing ends.

[0074] As described above, in the embodiment, once the target vehicle 5T is set, the target vehicle 5T is changed according to the flow of the driver's vehicle 4 and the vehicles on the main lane until the driver's vehicle 4 actually enters the merging zone 7. Thereby, the driver's vehicle 4 can merge behind the appropriate target vehicle 5T.

(Example of Changing Target Vehicle)

[0075] Next, the description will be given of examples of changing the target vehicle by the above-described target vehicle changing processing. FIGS. 9A to 9C show an example of changing the target vehicle when the driver's vehicle 4 is faster than the target vehicle 5T. As shown in FIG. 9A, it is now assumed that the driver's vehicle 4 enters the merging lane and the vehicle 5d neighboring the driver' s vehicle 4 on the main lane is set to the target vehicle 5T.

[0076] The navigation device 1 calculates the distance and the speed difference between the driver's vehicle 4 and the target vehicle 5T by the image sensor 15 and the radar 16. Also, the navigation device 1 calculates an estimated required time for the driver's vehicle 4 to enter the merging zone 7 and an estimated required time for the target vehicle 5T to enter the merging zone 7 based on the current position and speed of the driver's vehicle 4 and the distance to the merging zone 7. Now, it is estimated that the driver's vehicle 4 will enter the merging zone 7 in five seconds and the target vehicle 5T will reach the side of the merging zone 7 in ten seconds. In this case, the navigation device 1 regards the speed of the current target vehicle 5T as the speed of the vehicle flow on the main lane, and determines the vehicle 5c preceding the current target vehicle 5T (5d) by 5 seconds as the new target vehicle 5T as shown in FIG. 9B. Namely, the navigation device 1 changes the target vehicle 5T from the vehicle 5d to the vehicle 5c.

[0077] Thereafter, since the new target vehicle 5T (5c) is neighboring the driver's vehicle 4 on the main lane as shown in FIG. 9C, the navigation device 1 performs the guidance to merge behind the target vehicle 5T (5c).

[0078] In the above-described example, if there is no vehicle at the position five seconds preceding the current target vehicle 5T, the navigation device 1 determines, as the new target vehicle 5T, the vehicle that exists between the current target vehicle 5T and the position five seconds preceding the current target vehicle 5T and that is nearer to the position five seconds preceding the current target vehicle 5T. Also, if there is no vehicle between the current target vehicle 5T and the position five seconds preceding the current target vehicle 5T, the navigation device 1 does not change the target vehicle 5T and continues to use the current target vehicle 5T.

[0079] FIGS. 10A to 10C show the example of chang-

ing the target vehicle when the driver's vehicle 4 is slower than the target vehicle 5T. As shown in FIG. 10A, it is now assumed that the driver's vehicle 4 enters the merging lane 7 and the vehicle 5c neighboring the driver' s vehicle 4 on the main lane is set to the target vehicle 5T.

[0080] Similarly to the case of FIGS. 9A to 9C, the navigation device 1 calculates an estimated required time for the driver's vehicle 4 to enter the merging zone 7 and an estimated required time for the target vehicle 5T to enter the merging zone 7. Now, it is estimated that the driver's vehicle 4 will enter the merging zone 7 in ten seconds and the target vehicle 5T will reach the side of the merging zone 7 in five seconds. In this case, the navigation device 1 regards the speed of the current target vehicle 5T as the speed of the vehicle flow on the main lane, and determines the vehicle 5dbehind the current target vehicle 5T (5c) by 5 seconds as the new target vehicle 5T as shown in FIG. 10B. Namely, the navigation device 1 changes the target vehicle 5T from the vehicle 5c to the vehicle 5d.

[0081] Thereafter, since the new target vehicle 5T (5d) is neighboring the driver's vehicle 4 on the main lane as shown in FIG. 10C, the navigation device 1 performs the guidance to merge behind the target vehicle 5T (5d).

[0082] In the above-described example, if there is no vehicle at the position five seconds behind the current target vehicle 5T, the navigation device 1 determines, as the new target vehicle 5T, the vehicle that exists between the current target vehicle 5T and the position five seconds behind the current target vehicle 5T and that is nearer to the position five seconds behind the current target vehicle 5T. Also, if there is no vehicle between the current target vehicle 5T and the position five seconds behind the current target vehicle 5T, the navigation device 1 does not change the target vehicle 5T and continues to use the current target vehicle 5T.

[Modified Examples]

[0083] In the above-described embodiment, the merging support device 100 presents the merging zone 7 when the merging lane is congested. However, the merging support device may also present the merging zone 7 when the merging lane is not congested.

[0084] In the above-described embodiment, the merging support device 100 is constituted by the on-vehicle navigation device 1. However, the present invention may be applied to the case where the navigation device is constituted by a portable terminal such as a smartphone which executes navigation application.

INDUSTRIAL APPLICABILITY

[0085] This invention can be used for an on-vehicle navigation device, and a navigation device of a portable terminal such as a smartphone.

BRIEF DESCRIPTION OF REFERENCE NUMBERS

[0086]

1	Navigation device
4	Driver's vehicle
5,	5a to 5e Vehicle
5T	Target vehicle
7	Merging zone
15	Image sensor
16	Radar
20	System controller

Claims

1. A merging support device comprising:

a current position acquiring means which acquires a current position of a movable body; and a presentation control means which performs control of presenting a recommended merging area on a merging lane where merging is recommended, when the current position is on the merging lane for merging to a specific road.

2. The merging support device according to claim 1, wherein the presentation control means determines an area of a predetermined distance from an ending position of the merging lane as the recommended merging area.

3. The merging support device according to claim 1 or 2,
wherein the presentation control means performs control of presenting information prompting to start merging operation when the current position is in the recommended merging area.

4. The merging support device according to any one of claims 1 to 3, further comprising a traffic congestion determining means which determines whether or not the merging lane is congested,
wherein the presentation control means performs control of presenting the recommended merging area when the merging lane is determined to be congested.

5. The merging support device according to any one of claims 1 to 4, further comprising a designating unit which designates one other movable body running on the specific road as a target movable body,
wherein the presentation control means performs control of presenting the information prompting to start the merging operation to merge behind the target movable body when the target movable body has been designated and the current position is in the recommended merging area.

6. A merging support method executed by a merging support device comprising:

a current position acquiring process which acquires a current position of a movable body; and a presenting process which which performs control of presenting a recommended merging area on a merging lane where merging is recommended, when the current position is on the merging lane for merging to a specific road.

7. A merging support program executed by a merging support device including a computer, the program making the computer to function as:

a current position acquiring means which acquires a current position of a movable body; and a presentation control means which performs control of presenting a recommended merging area on a merging lane where merging is recommended, when the current position is on the merging lane for merging to a specific road.

8. A storage medium on which the merging support program according to claim 7 is stored.

FIG. 1

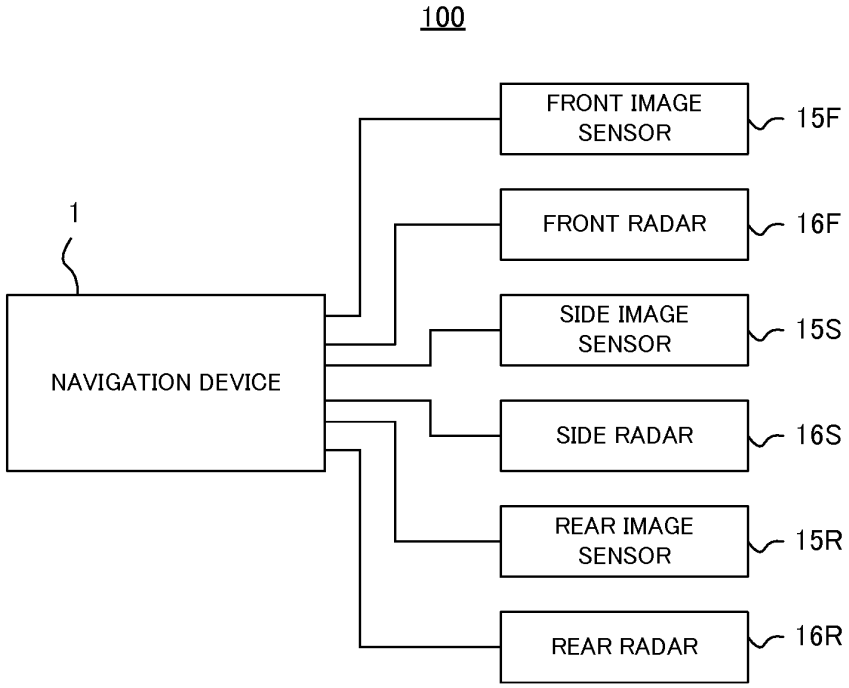

100
1
NAVIGATION DEVICE
FRONT IMAGE SENSOR
15F
FRONT RADAR
16F
SIDE IMAGE SENSOR
15S
SIDE RADAR
16S
REAR IMAGE SENSOR
15R
REAR RADAR
16R

FIG. 2

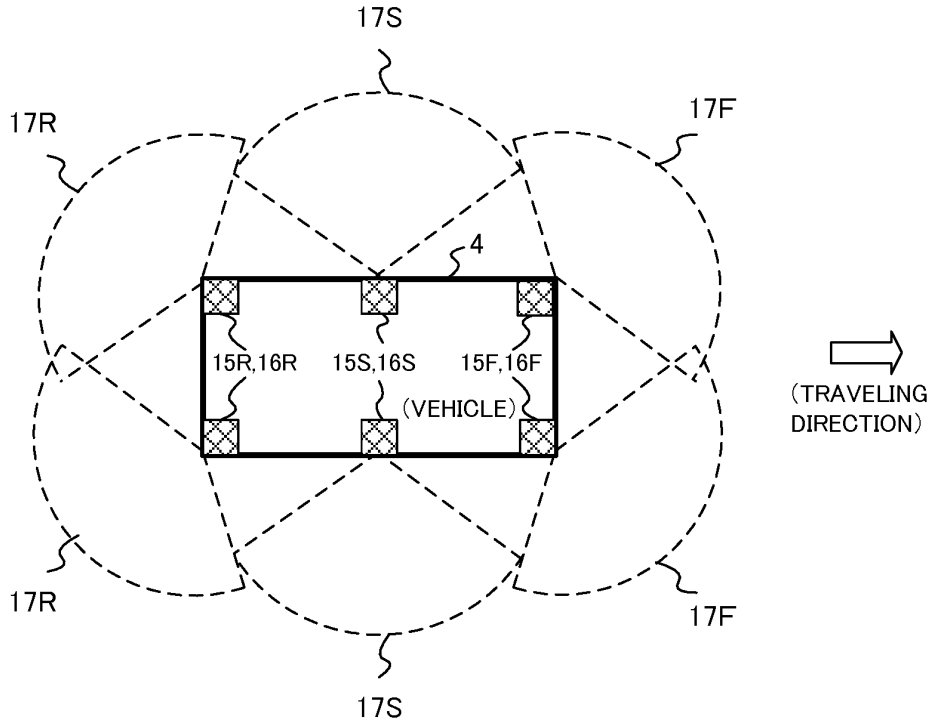

17S
17R
17F
4
15R,16R
15S,16S
15F,16F
(VEHICLE)
(TRAVELING DIRECTION)
17R
17F
17S

FIG. 3

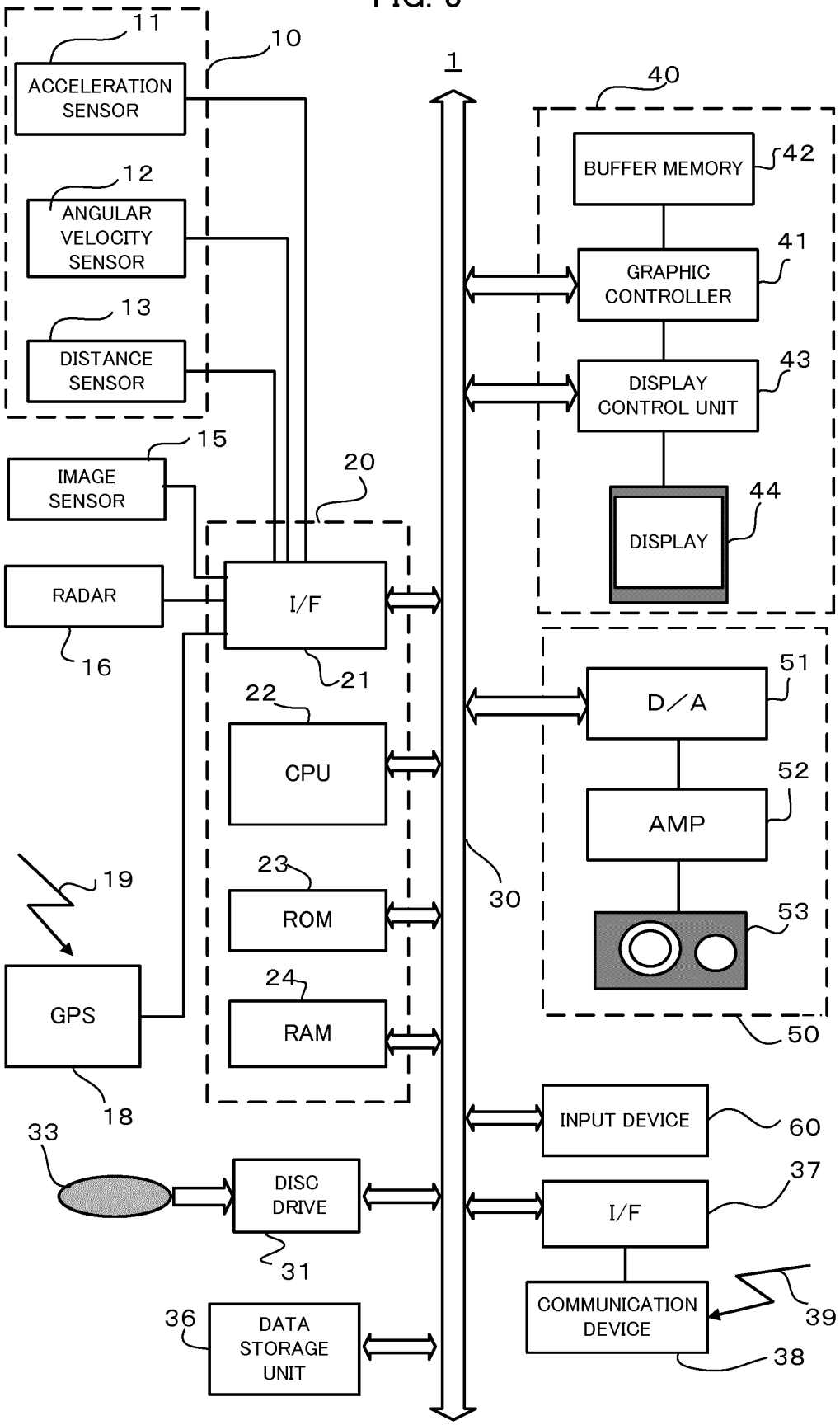

11
10
ACCELERATION SENSOR
12
ANGULAR VELOCITY SENSOR
13
DISTANCE SENSOR
15
IMAGE SENSOR
20
RADAR
I/F
16
21
22
CPU
23
ROM
24
RAM
19
GPS
18
33
DISC DRIVE
31
36
DATA STORAGE UNIT
1
30
40
BUFFER MEMORY
42
41
GRAPHIC CONTROLLER
43
DISPLAY CONTROL UNIT
44
DISPLAY
51
D/A
52
AMP
53
50
INPUT DEVICE
60
37
I/F
COMMUNICATION DEVICE
39
38

FIG. 4A

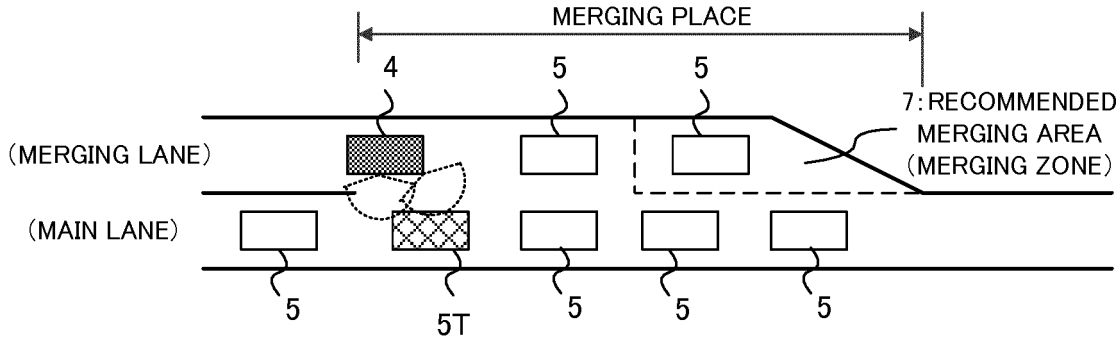

MERGING PLACE
4
5
5
7:RECOMMENDED
MERGING AREA
(MERGING ZONE)
(MERGING LANE)
(MAIN LANE)
5
5T
5
5
5

FIG. 4B

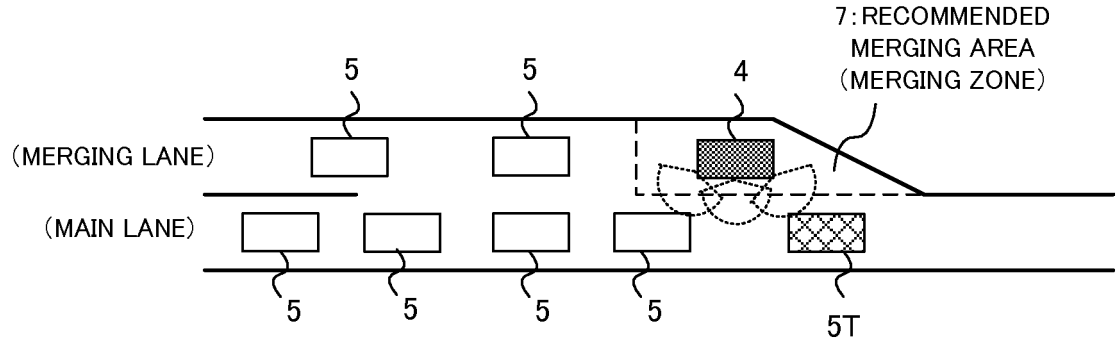

7:RECOMMENDED
MERGING AREA
(MERGING ZONE)
5
5
4
(MERGING LANE)
(MAIN LANE)
5
5
5
5
5T

FIG. 5

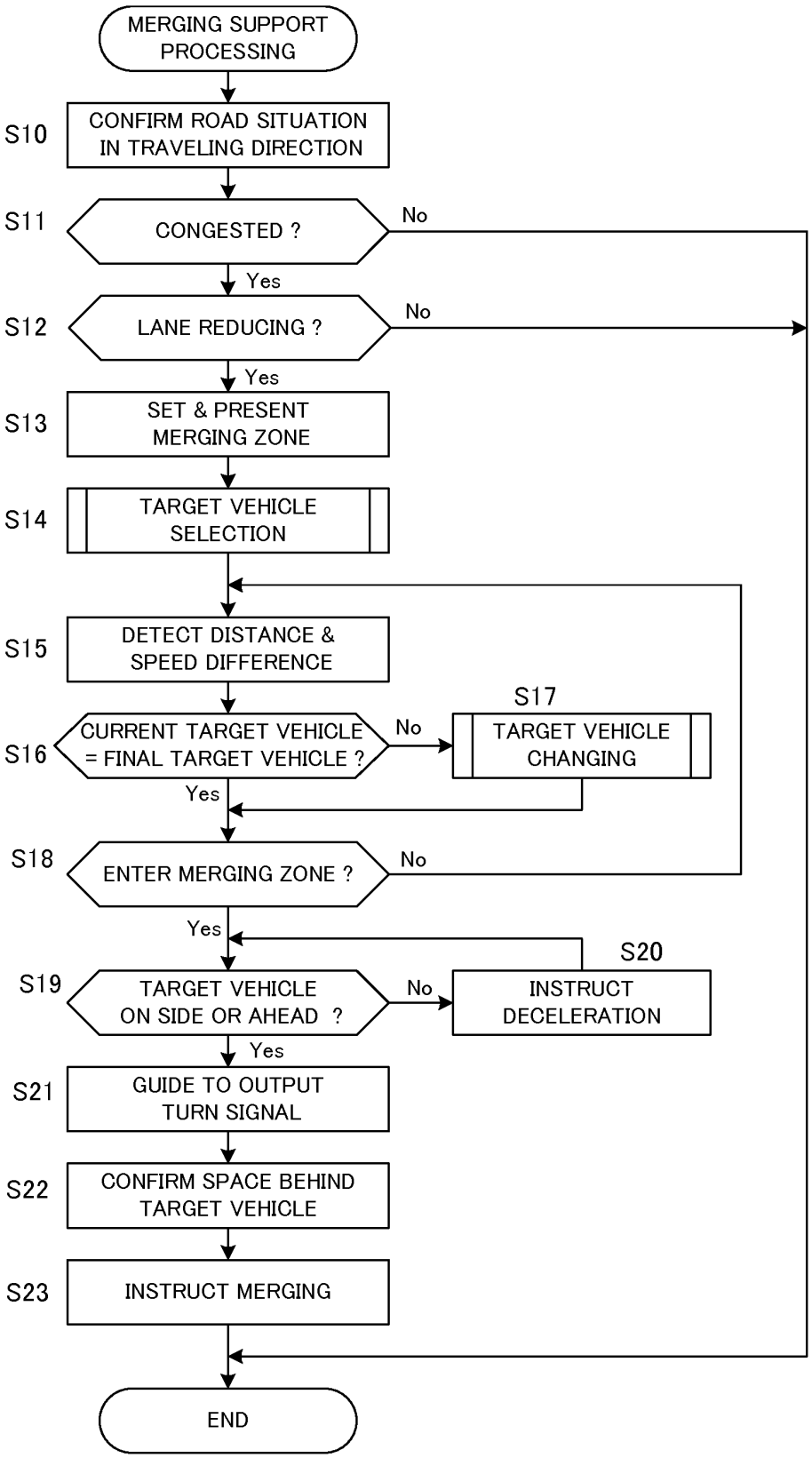

MERGING SUPPORT PROCESSING
S10
CONFIRM ROAD SITUATION IN TRAVELING DIRECTION
S11
CONGESTED ?
No
Yes
S12
LANE REDUCING ?
No
Yes
S13
SET & PRESENT MERGING ZONE
S14
TARGET VEHICLE SELECTION
S15
DETECT DISTANCE & SPEED DIFFERENCE
S16
CURRENT TARGET VEHICLE = FINAL TARGET VEHICLE ?
No
S17
TARGET VEHICLE CHANGING
Yes
S18
ENTER MERGING ZONE ?
No
Yes
S19
TARGET VEHICLE ON SIDE OR AHEAD ?
No
S20
INSTRUCT DECELERATION
Yes
S21
GUIDE TO OUTPUT TURN SIGNAL
S22
CONFIRM SPACE BEHIND TARGET VEHICLE
S23
INSTRUCT MERGING
END

FIG. 6

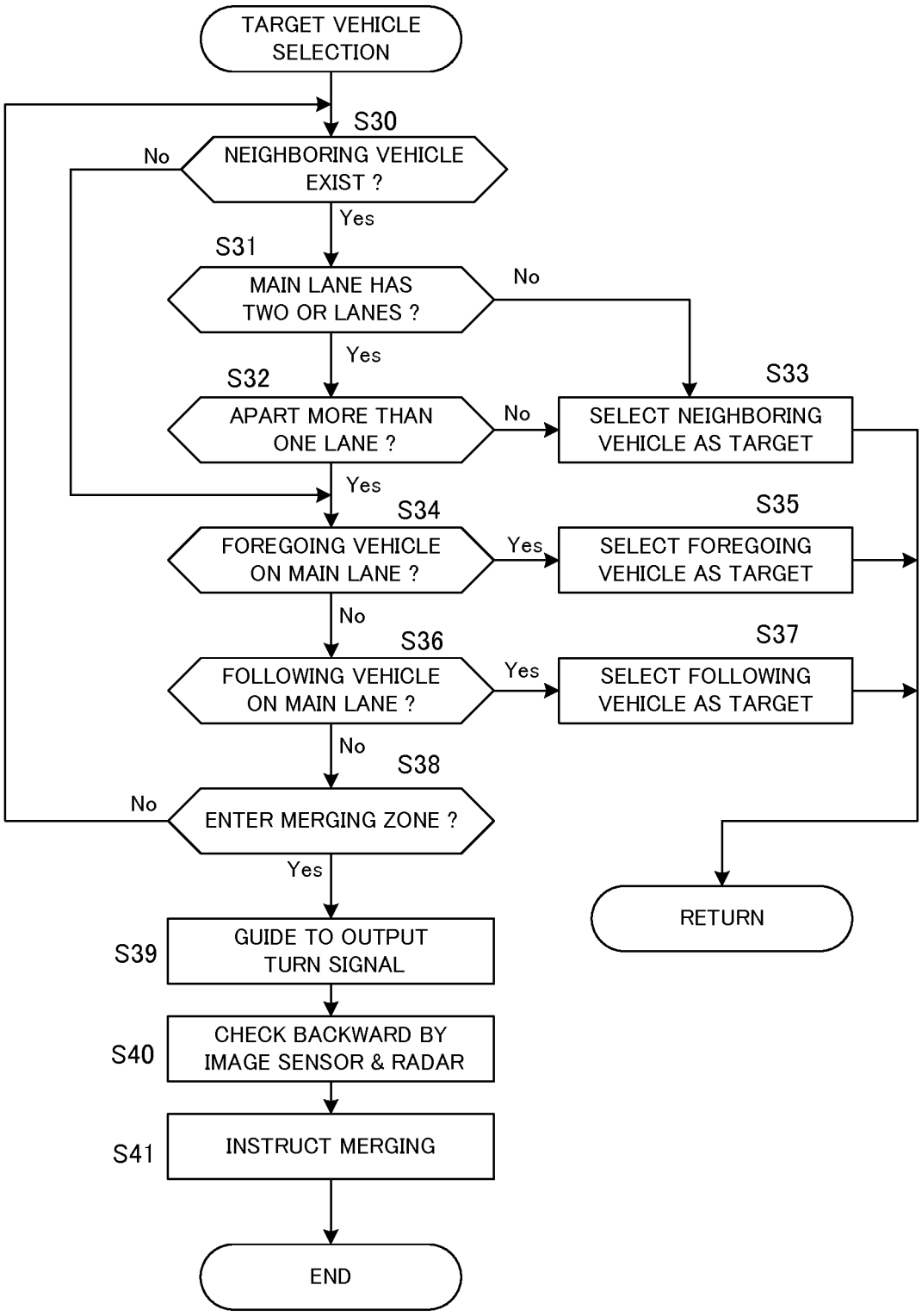

TARGET VEHICLE SELECTION
S30
NEIGHBORING VEHICLE EXIST ?
No
Yes
S31
MAIN LANE HAS TWO OR LANES ?
No
Yes
S32
APART MORE THAN ONE LANE ?
No
S33
SELECT NEIGHBORING VEHICLE AS TARGET
Yes
S34
FOREGOING VEHICLE ON MAIN LANE ?
Yes
S35
SELECT FOREGOING VEHICLE AS TARGET
No
S36
FOLLOWING VEHICLE ON MAIN LANE ?
Yes
S37
SELECT FOLLOWING VEHICLE AS TARGET
No
S38
ENTER MERGING ZONE ?
No
Yes
RETURN
S39
GUIDE TO OUTPUT TURN SIGNAL
S40
CHECK BACKWARD BY IMAGE SENSOR & RADAR
S41
INSTRUCT MERGING
END

FIG. 7

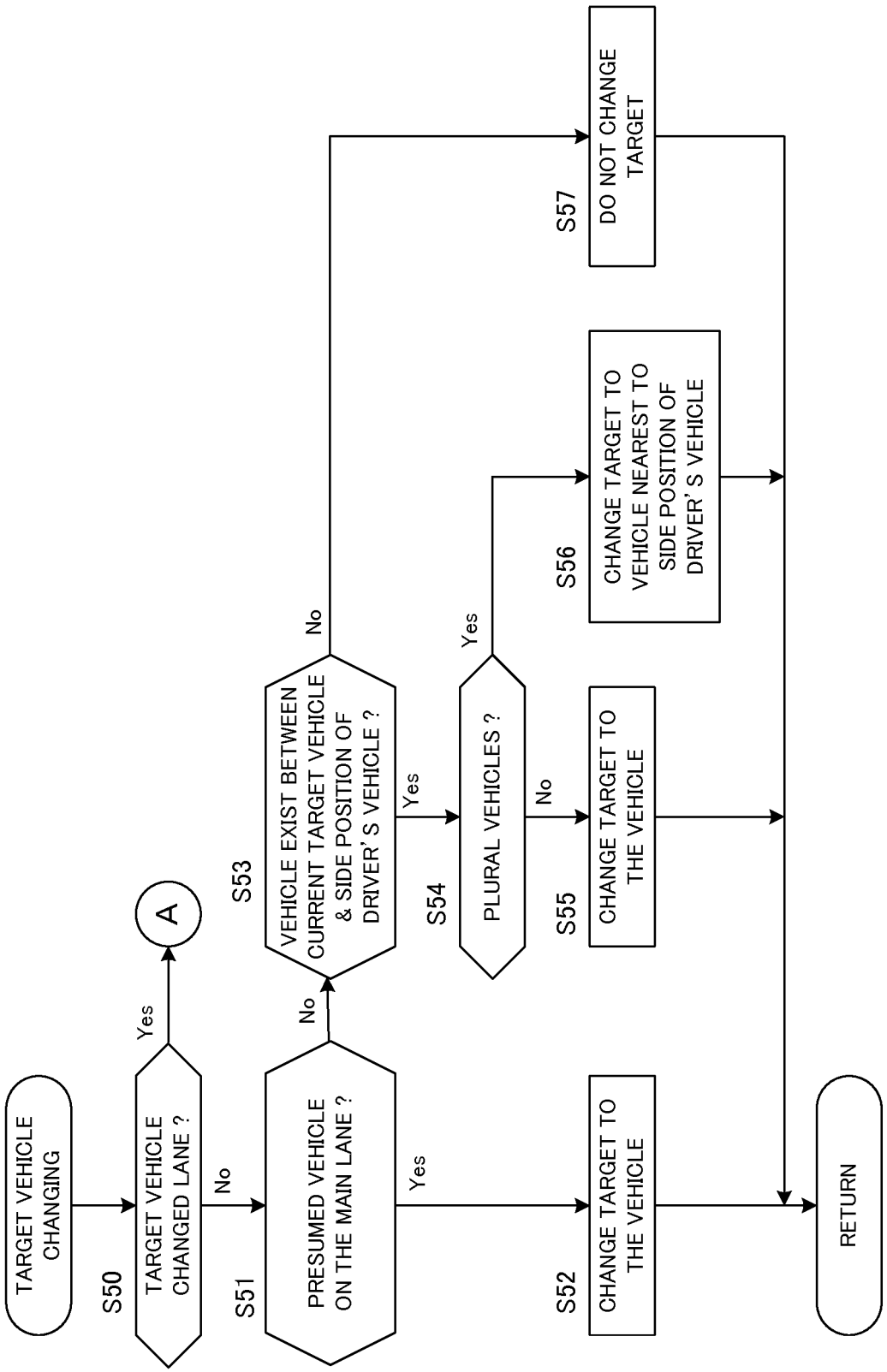

TARGET VEHICLE CHANGING
S50
TARGET VEHICLE CHANGED LANE ?
Yes
A
No
S51
PRESUMED VEHICLE ON THE MAIN LANE ?
Yes
S52
CHANGE TARGET TO THE VEHICLE
No
S53
VEHICLE EXIST BETWEEN CURRENT TARGET VEHICLE & SIDE POSITION OF DRIVER'S VEHICLE ?
Yes
S54
PLURAL VEHICLES ?
No
S55
CHANGE TARGET TO THE VEHICLE
Yes
S56
CHANGE TARGET TO VEHICLE NEAREST TO SIDE POSITION OF DRIVER'S VEHICLE
No
S57
DO NOT CHANGE TARGET
RETURN

FIG. 8

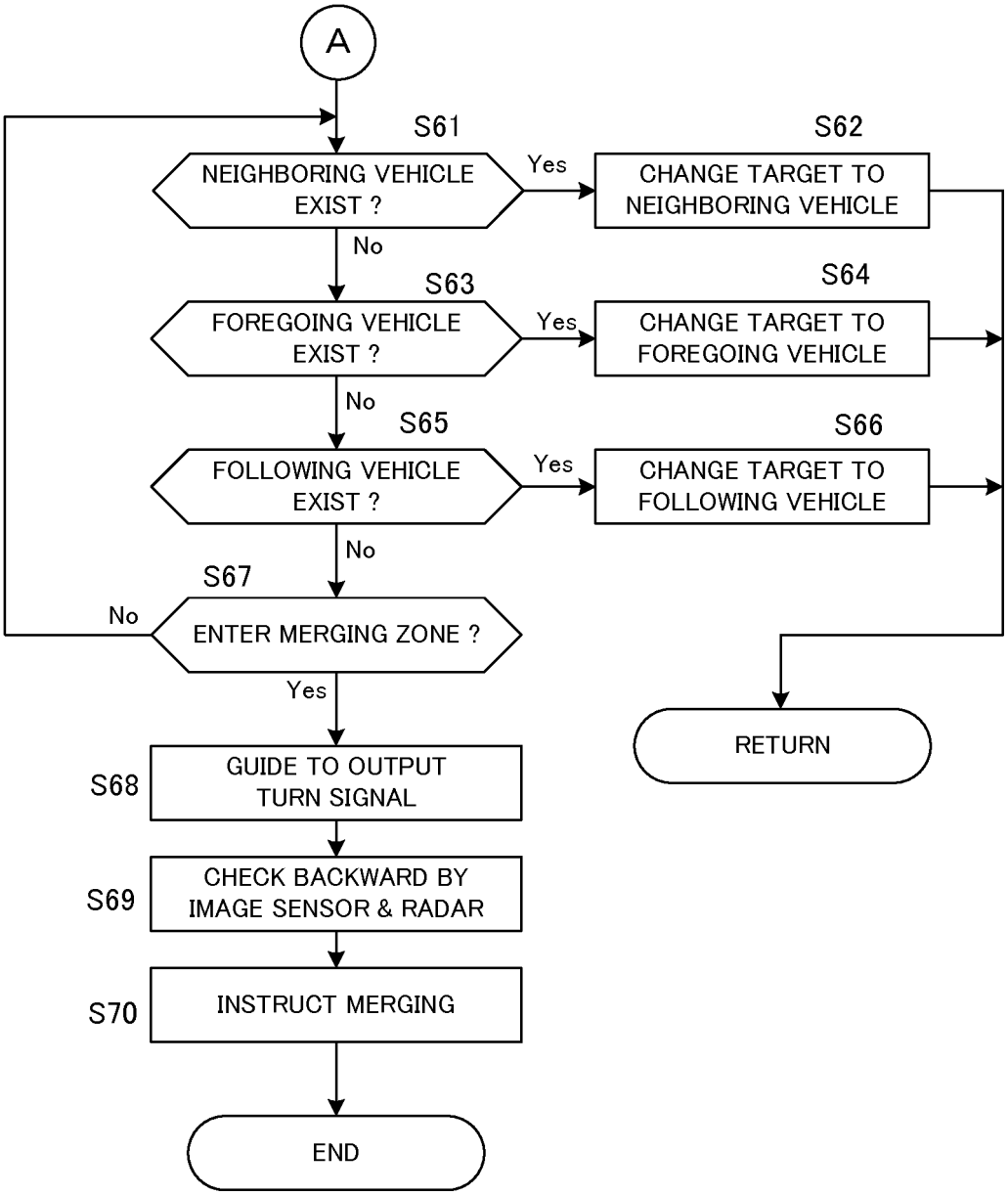

A
S61
NEIGHBORING VEHICLE EXIST ?
Yes
S62
CHANGE TARGET TO NEIGHBORING VEHICLE
No
S63
FOREGOING VEHICLE EXIST ?
Yes
S64
CHANGE TARGET TO FOREGOING VEHICLE
No
S65
FOLLOWING VEHICLE EXIST ?
Yes
S66
CHANGE TARGET TO FOLLOWING VEHICLE
No
S67
ENTER MERGING ZONE ?
No
Yes
RETURN
S68
GUIDE TO OUTPUT TURN SIGNAL
S69
CHECK BACKWARD BY IMAGE SENSOR & RADAR
S70
INSTRUCT MERGING
END

FIG. 9A

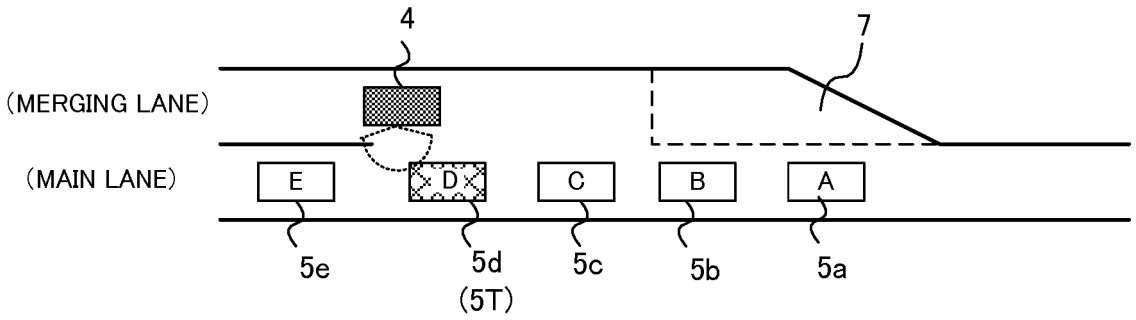


FIG. 9B

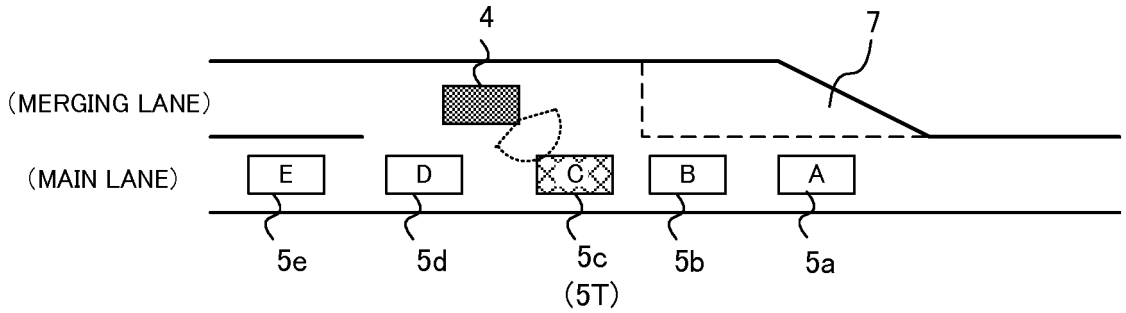


FIG. 9C

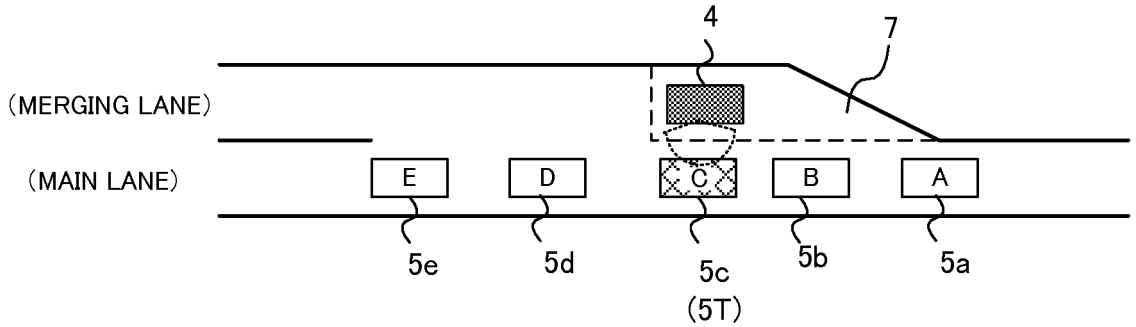


FIG. 10A

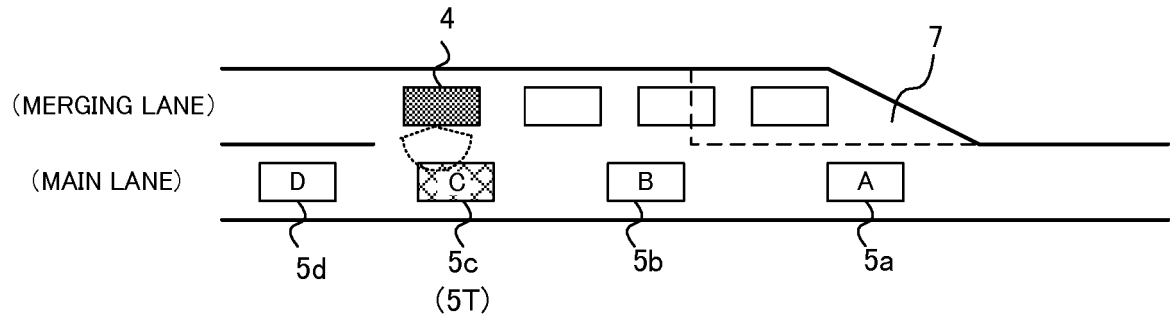


FIG. 10B

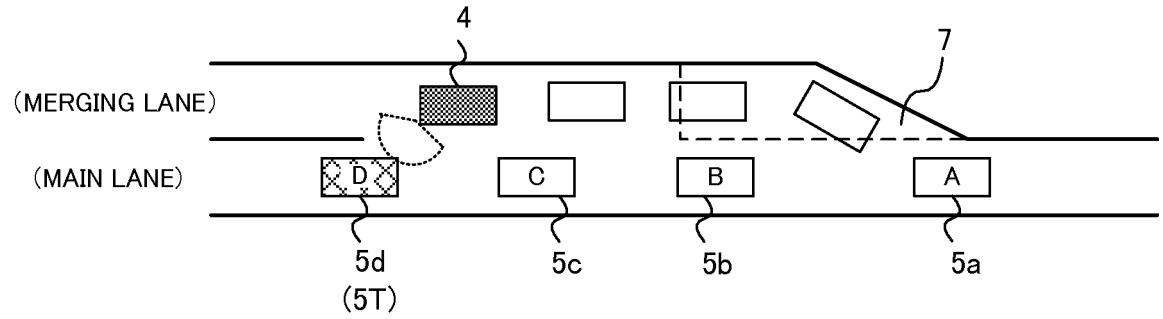
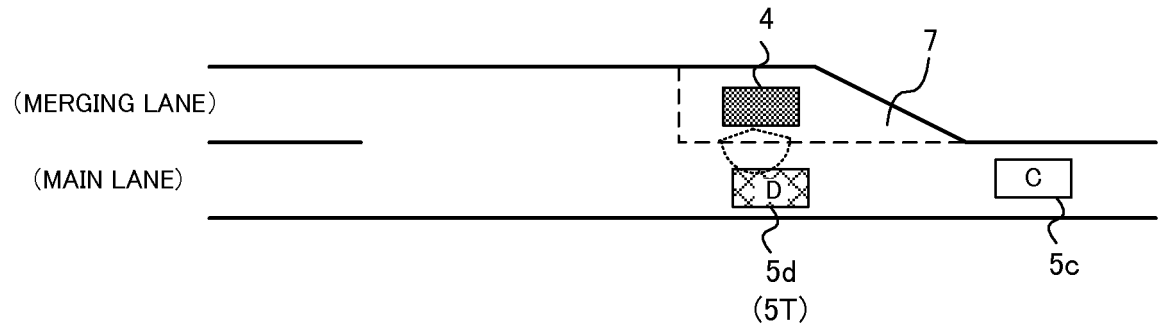


FIG. 10C



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/055069

A. CLASSIFICATION OF SUBJECT MATTER
G08G1/16(2006.01)i, *G01C21/26*(2006.01)i, *G08G1/09*(2006.01)i

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, G01C21/26, G08G1/09

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014
Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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.
Y	JP 2008-151507 A (Aisin AW Co., Ltd.), 03 July 2008 (03.07.2008), paragraphs [0029] to [0048] (Family: none)	1-8
Y	JP 2011-28630 A (Nissan Motor Co., Ltd.), 10 February 2011 (10.02.2011), paragraphs [0018] to [0021] (Family: none)	1-8
Y	JP 2007-296978 A (Toyota Motor Corp.), 15 November 2007 (15.11.2007), paragraph [0064] (Family: none)	4

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

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 April, 2014 (22.04.14)	13 May, 2014 (13.05.14)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/055069

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2005-38325 A (Nissan Motor Co., Ltd.), 10 February 2005 (10.02.2005), paragraph [0029] & US 2005/0015203 A1 & DE 102004034445 A	5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2012118870 A **[0003]**