



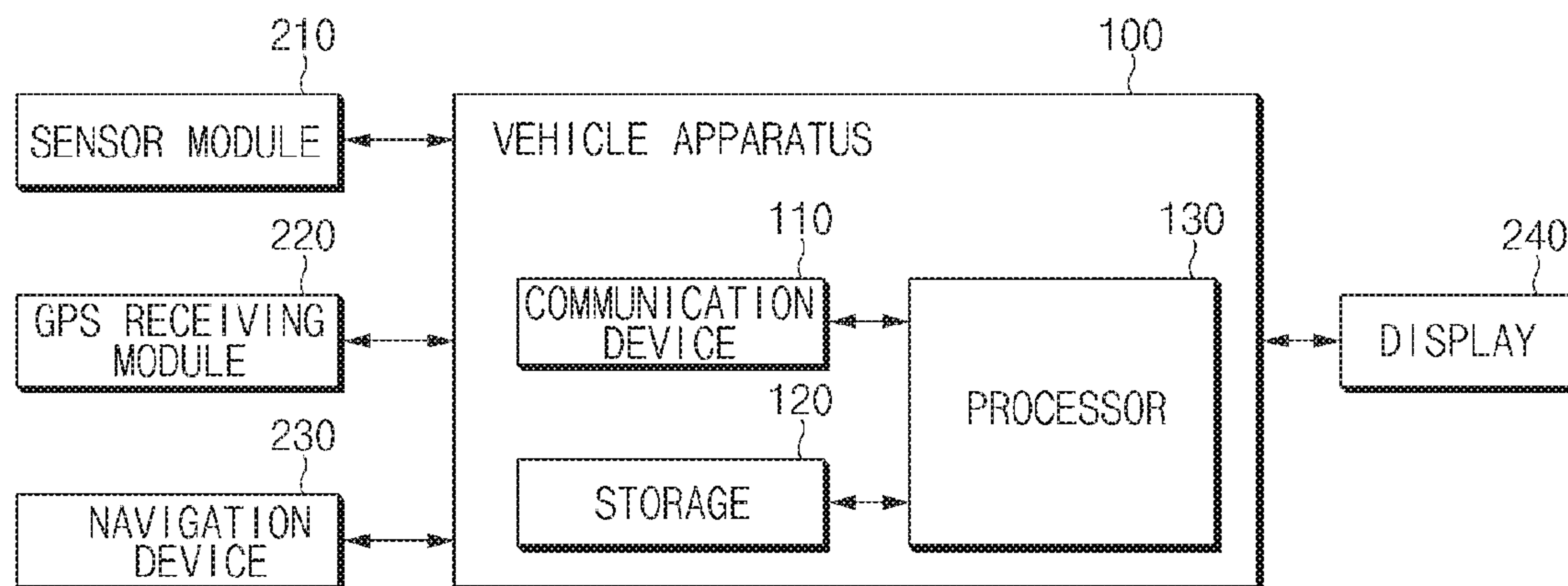
US 20190317522A1

(19) **United States**(12) **Patent Application Publication**
Yang et al.(10) **Pub. No.: US 2019/0317522 A1**(43) **Pub. Date: Oct. 17, 2019**(54) **VEHICLE APPARATUS, SYSTEM HAVING
THE SAME AND METHOD FOR
AUTOMATICALLY CHANGING OPERABLE
RANGE THEREOF**(71) Applicants: **Hyundai Motor Company**, Seoul
(KR); **Kia Motors Corporation**, Seoul
(KR)(72) Inventors: **Na Eun Yang**, Hwaseong (KR); **Jin Su
Jeong**, Suwon (KR); **Sung Min Park**,
Seoul (KR)(21) Appl. No.: **16/192,279**(22) Filed: **Nov. 15, 2018****Related U.S. Application Data**(60) Provisional application No. 62/655,831, filed on Apr.
11, 2018.(30) **Foreign Application Priority Data**

Aug. 10, 2018 (KR) 10-2018-0093914

Publication Classification(51) **Int. Cl.****G05D 1/02** (2006.01)**B60W 30/18** (2006.01)(52) **U.S. Cl.**CPC **G05D 1/0278** (2013.01); **B60W 10/18**
(2013.01); **B60W 30/18163** (2013.01)(57) **ABSTRACT**

A vehicle apparatus enters into traveling may include: a processor configured to determine an operable range of a driving assistance function or an autonomous driving function to be performed by a vehicle in a country when the vehicle enters into the country while traveling, and to control operation of the vehicle so as to perform the driving assistance function or the autonomous driving function according to the determined operable range; and a storage configured to store the determined operable range.



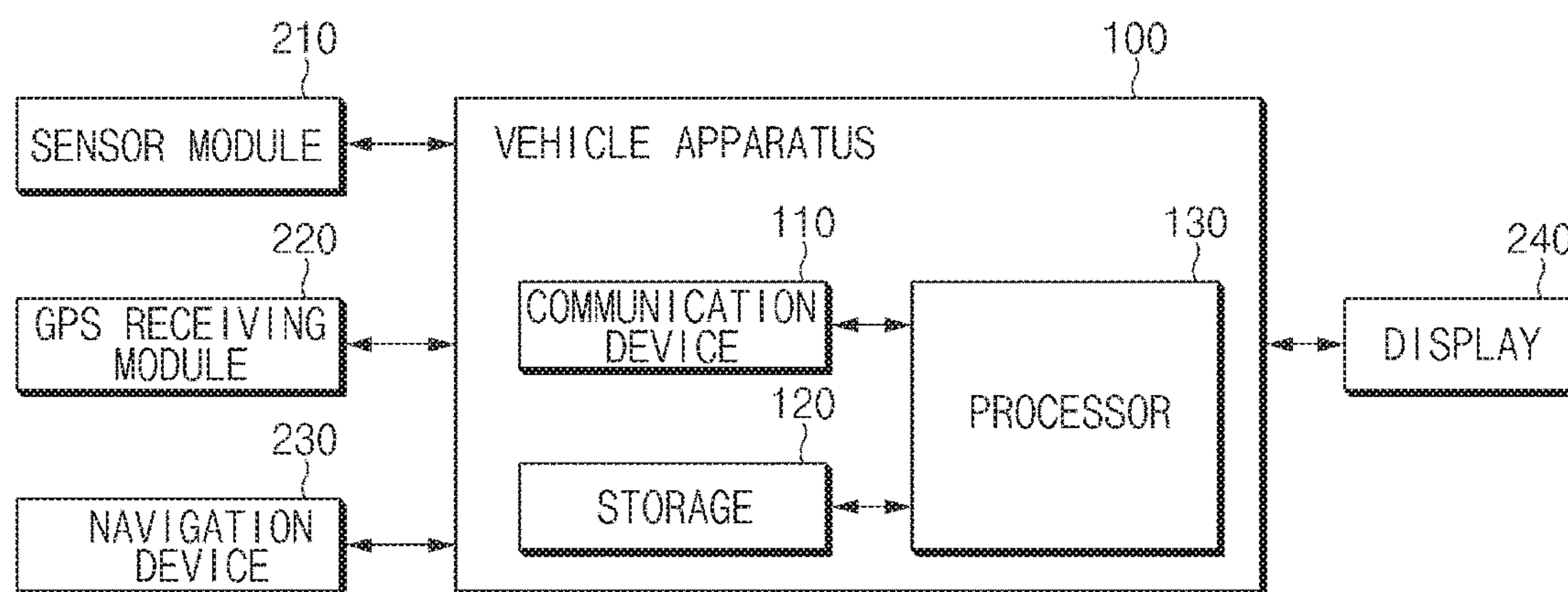


FIG. 1

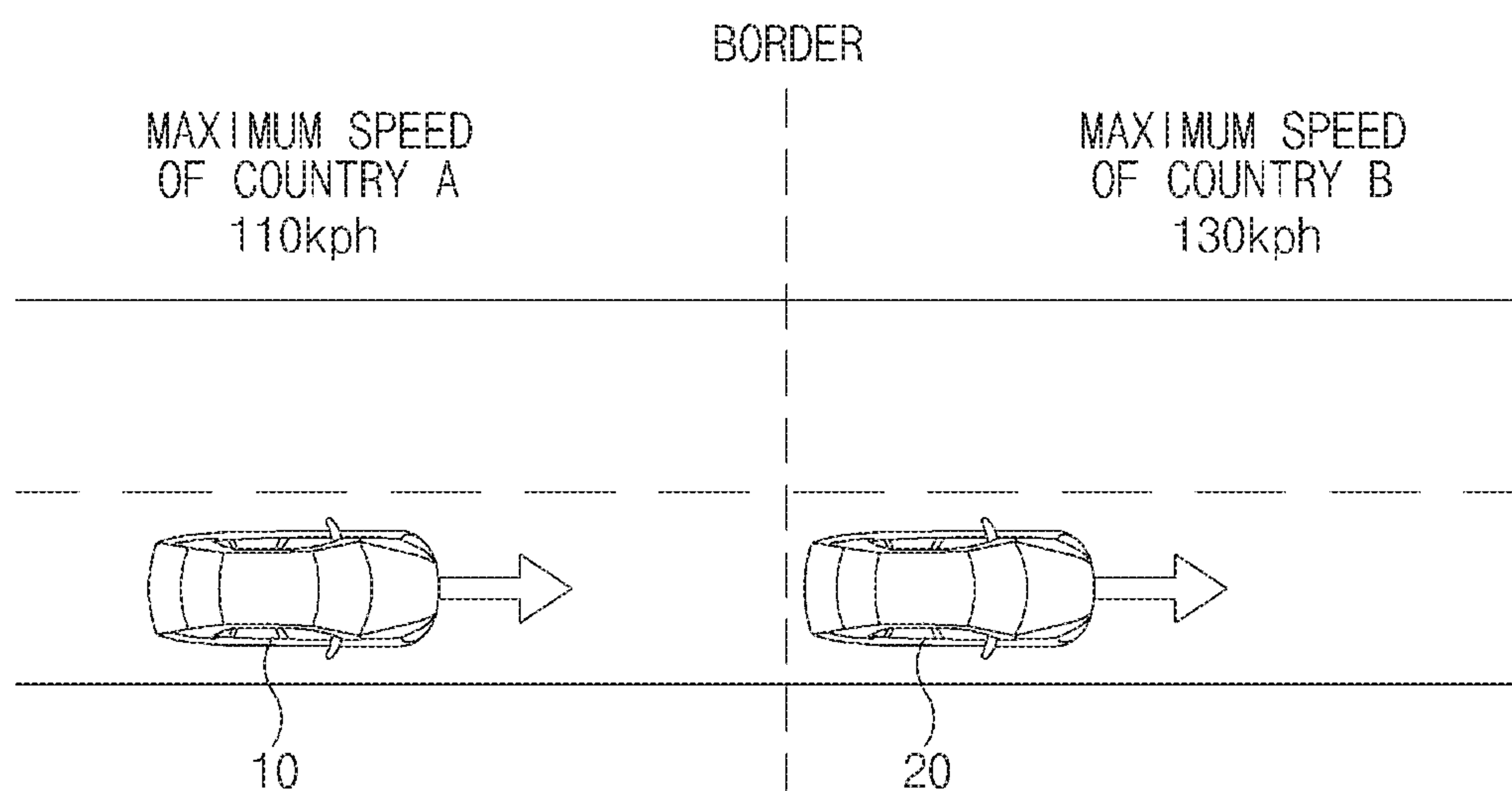


FIG. 2

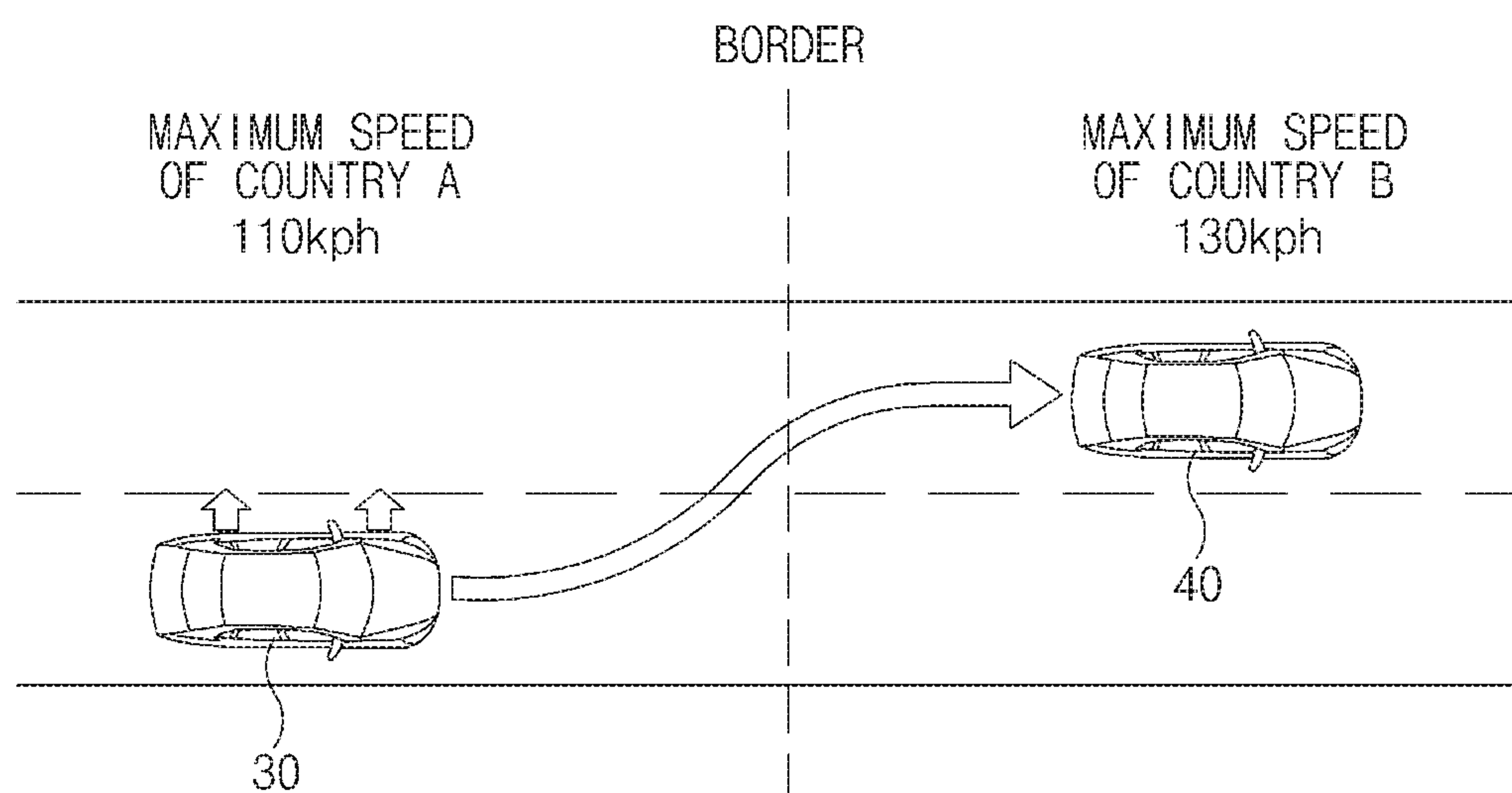


FIG. 3

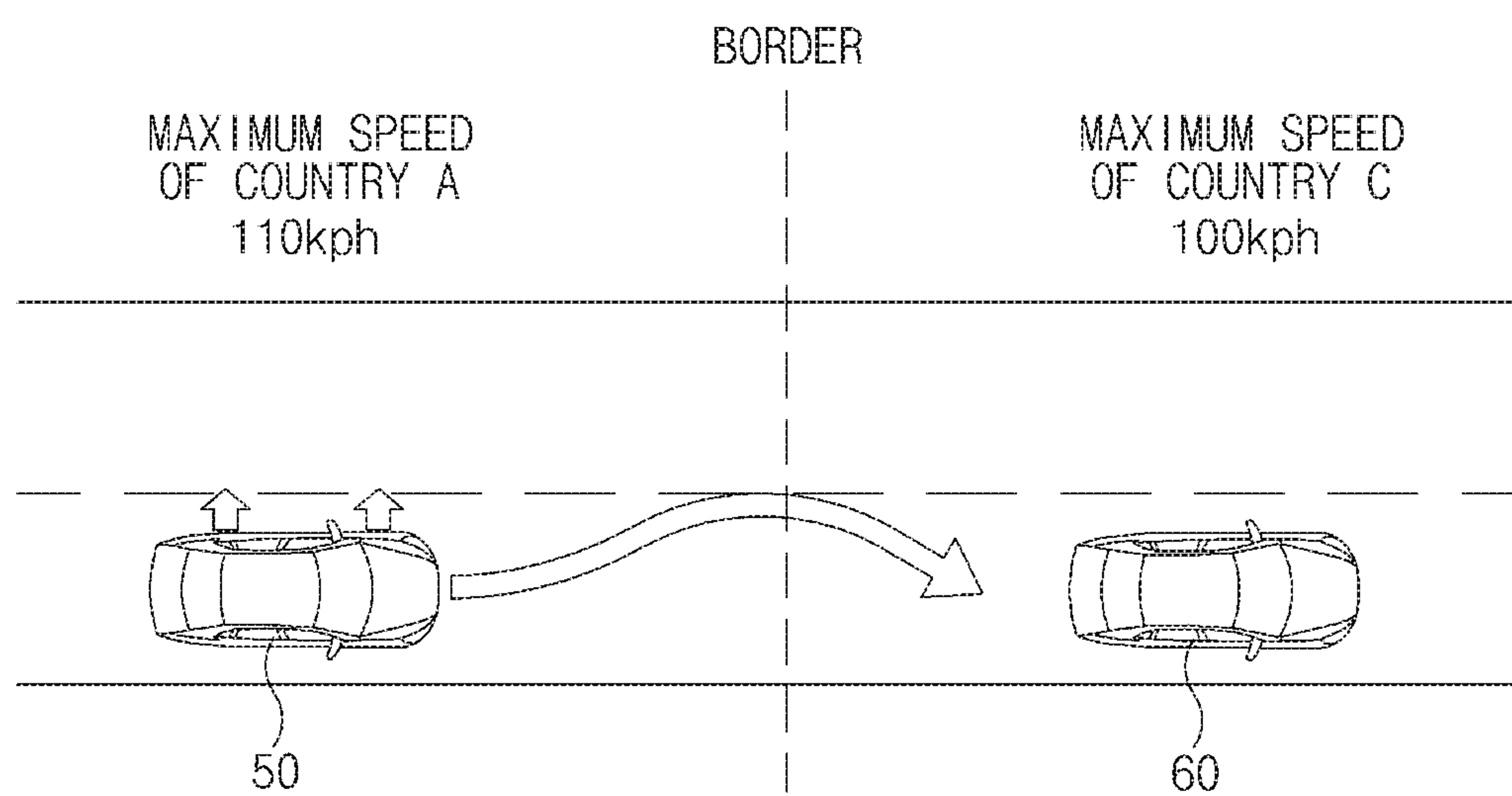


FIG. 4

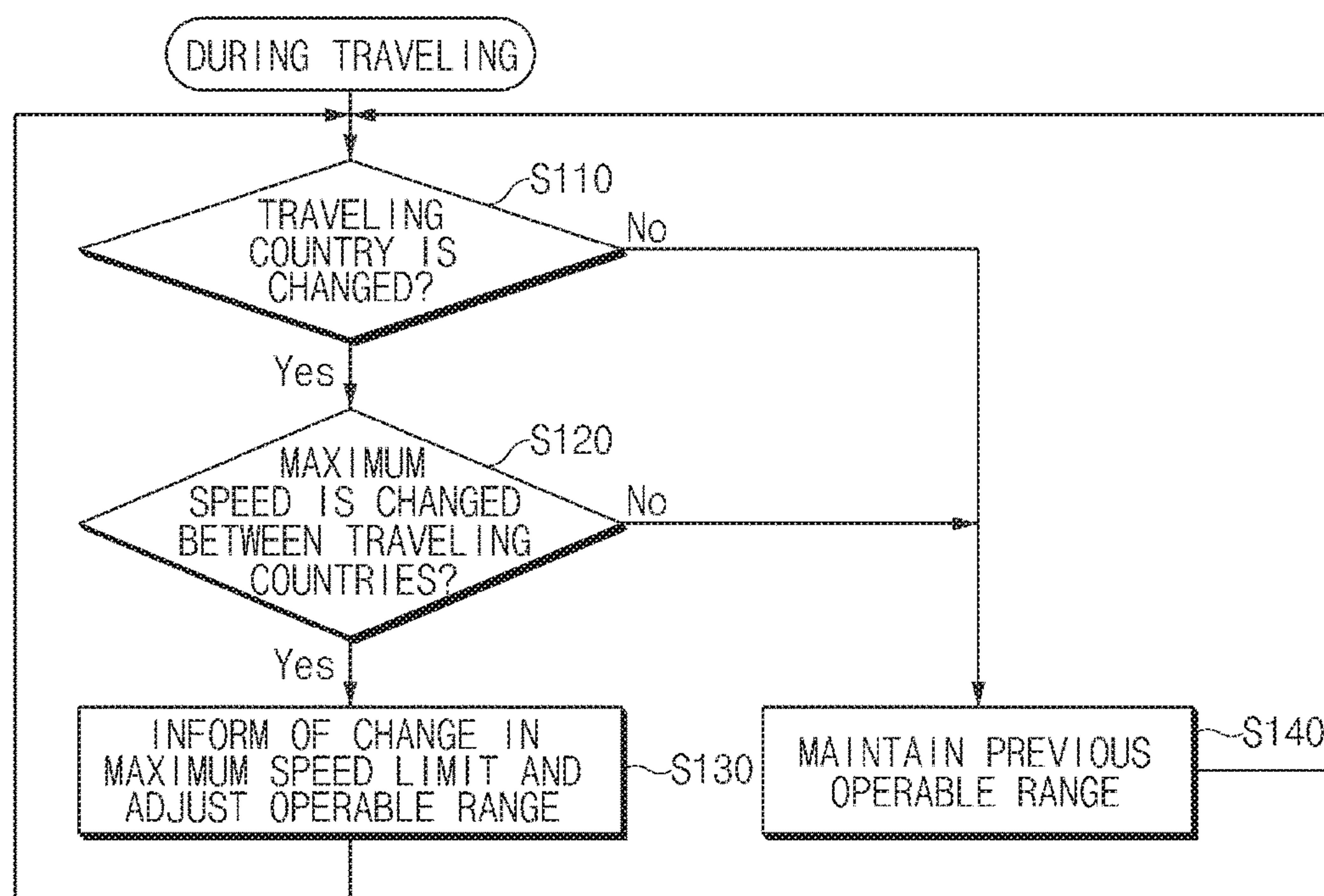


FIG. 5

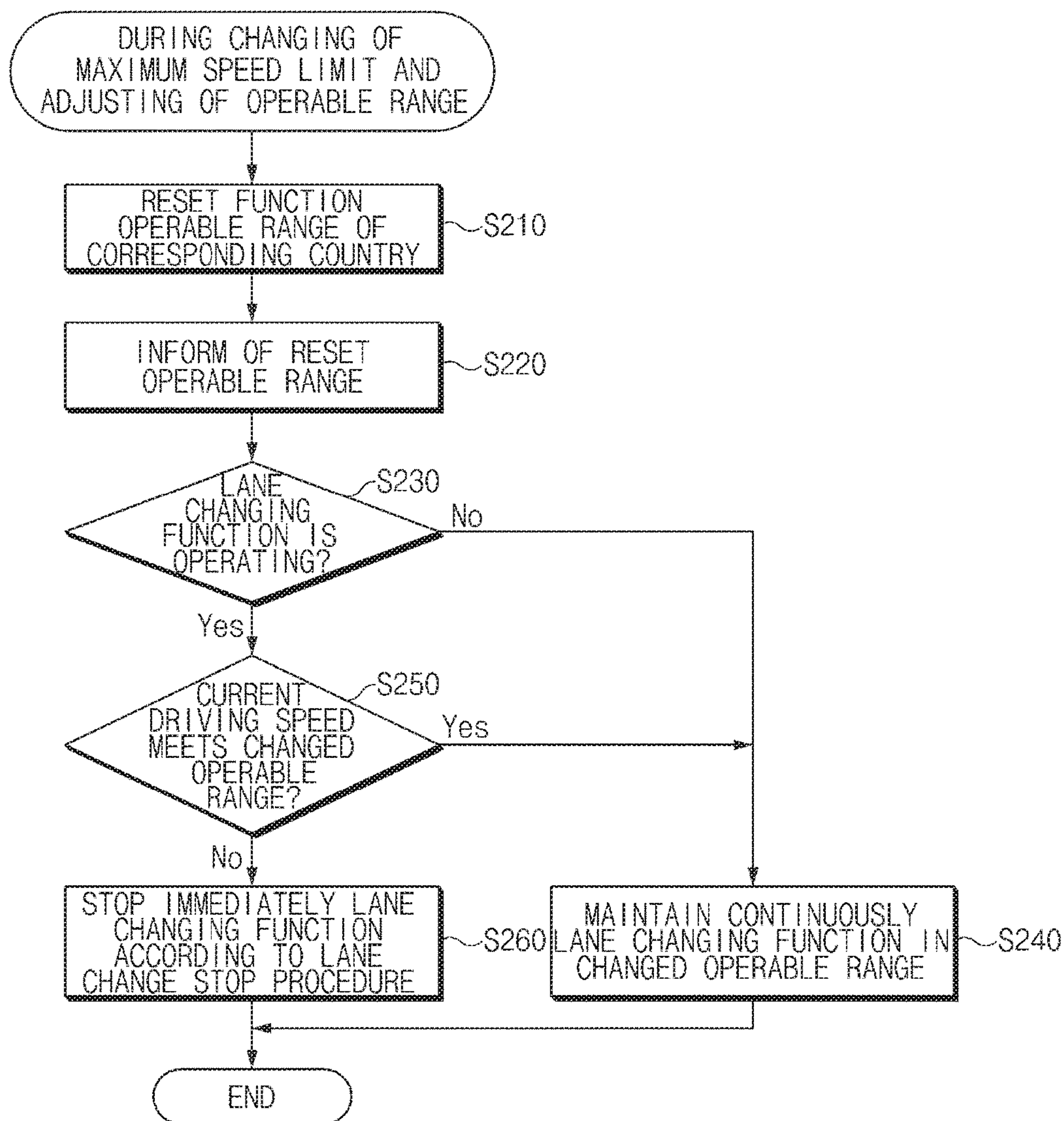


FIG. 6

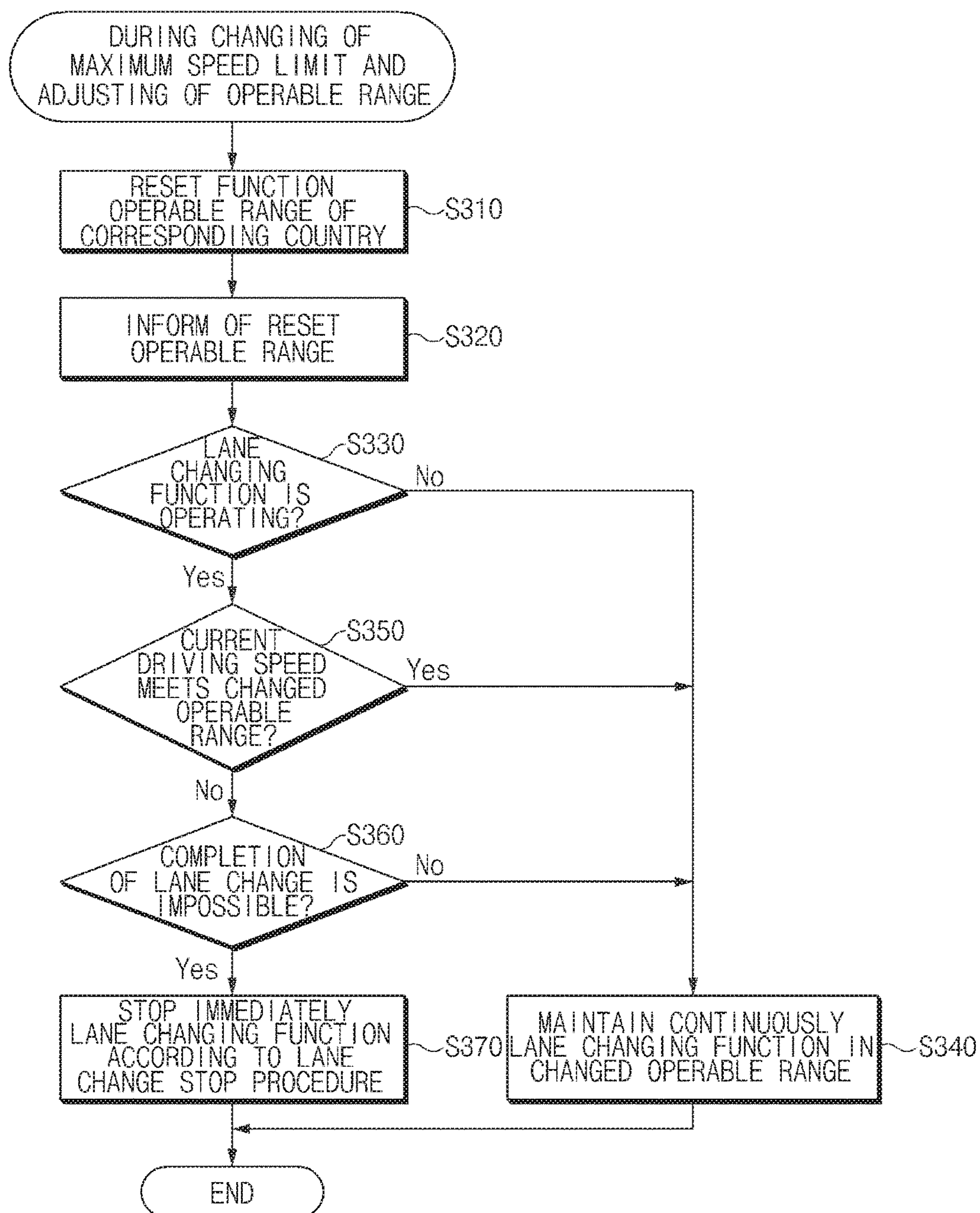


FIG. 7

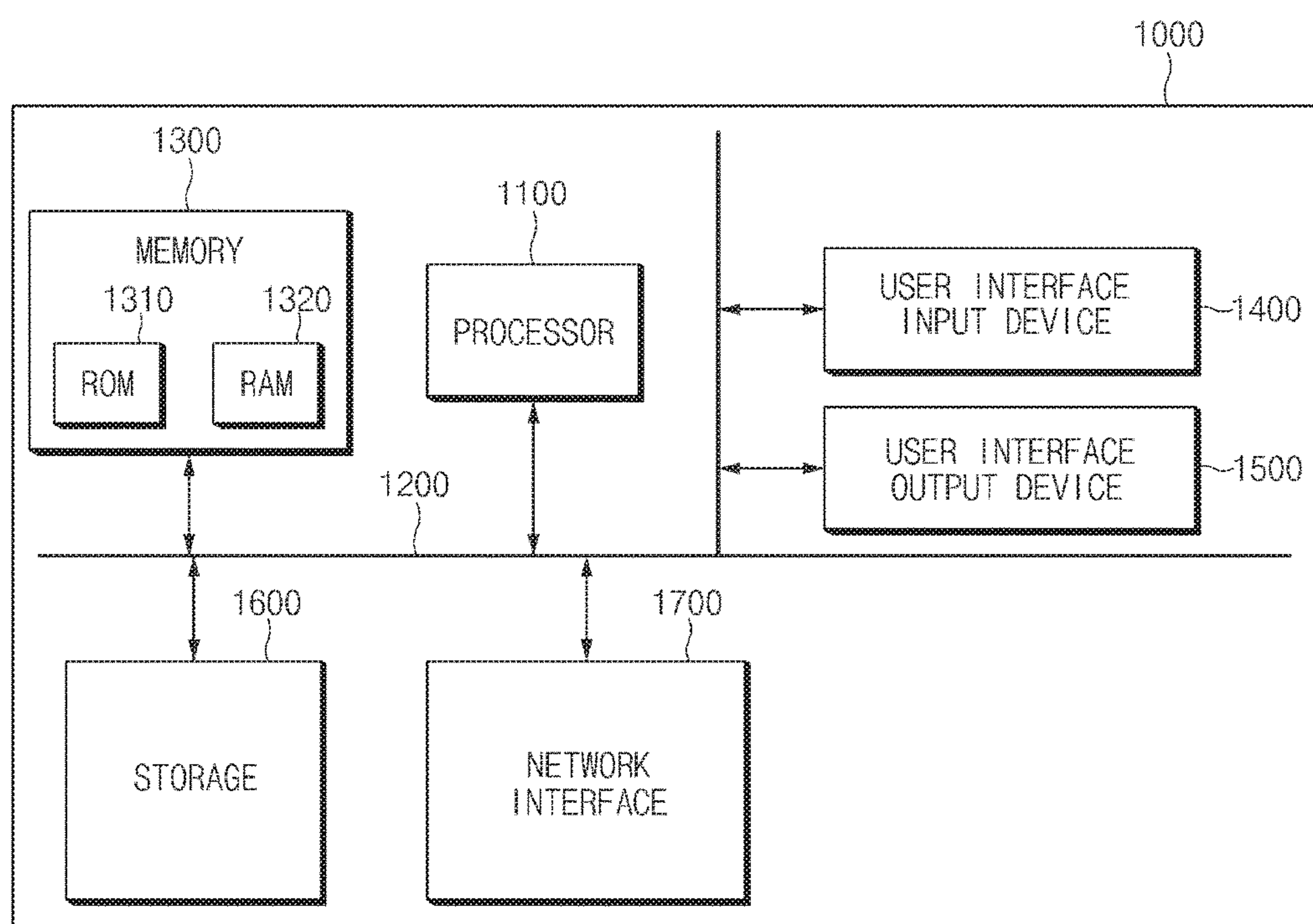


FIG. 8

**VEHICLE APPARATUS, SYSTEM HAVING
THE SAME AND METHOD FOR
AUTOMATICALLY CHANGING OPERABLE
RANGE THEREOF**

CROSS-REFERENCES TO RELATED
APPLICATIONS

[0001] This application claims the benefit of priority to Korean Patent Application No. 10-2018-0093914, filed on Aug. 10, 2018 in the Korean Intellectual Property Office, and U.S. Provisional Patent Application No. 62/655,831, filed on Apr. 11, 2018 in the United States Patent and Trademark Office, the entire contents of both of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to a vehicle apparatus, a system including the same, and a method for automatically changing an operable range thereof, and more particularly, to apparatuses, systems, and methods for performing a safe lane change by changing and applying an operable range of a given country.

BACKGROUND

[0003] In recent years, vehicles have been provided with an autonomous drive control system that automatically recognizes a road environment and determines a driving situation to control the driving of the vehicle. The vehicle can be automatically driven to a destination according to a planned route.

[0004] Meanwhile, vehicle driving assistance systems can perform various assistive operations, such as cruise control, lane keeping, lane changing, inter-vehicle distance control, and the like.

[0005] Conventional vehicle driving assistance systems and autonomous driving systems typically set and use an operable range which in view of a vehicle speed, a road condition, and the like. Problematically, such operable range may vary from country to country. Thus, when a vehicle moves beyond a border to another country while operations are being carried out by a vehicle driving assistance system or autonomous driving system, the operable range must be adapted to the appropriate country.

SUMMARY

[0006] The present disclosure has been made to solve the above-mentioned problems occurring in the related art, while advantages achieved by the related art are maintained intact.

[0007] An aspect of the present disclosure provides a vehicle apparatus, a system including the same, and a method for automatically changing an operable range thereof that can automatically change the operable range based on a given country and apply the changed operable range when inter-country movement occurs during driving assistance or autonomous driving. As a result, driving requirements of each country can be satisfied automatically, and operations such as lane changing functions can be safely performed.

[0008] The technical problems to be solved by the present inventive concept are not limited to the aforementioned problems, and any other technical problems not mentioned

herein will be clearly understood from the following description by those skilled in the art to which the present disclosure pertains.

[0009] According to embodiments of the present disclosure, a vehicle apparatus may include: a processor configured to determine an operable range of a driving assistance function or an autonomous driving function to be performed by a vehicle in a country when the vehicle enters into the country while traveling, and to control operation of the vehicle so as to perform the driving assistance function or the autonomous driving function according to the determined operable range; and a storage configured to store the determined operable range enters into traveling.

[0010] The operable range of the driving assistance function or the autonomous driving function may correspond to a range from a minimum operable speed to a maximum operable speed, the maximum operable speed being greater than or equal to a maximum speed limit of the country.

[0011] The processor may calculate the minimum operable speed according to at least one of: a maximum sensing distance in a rear-side direction of the vehicle, a maximum deceleration of an approaching vehicle, a margin time before the approaching vehicle decelerates when a lane change operation is performed, and a time for the approaching vehicle to maintain a clearance distance between the vehicle and the approaching vehicle after deceleration of the approaching vehicle.

[0012] When the vehicle enters into a new country while traveling, the processor may determine whether a maximum speed limit of the country is different from a maximum speed limit of the new country traveling.

[0013] The processor may control the vehicle so as to output a notification of a change in the maximum speed limit through a display when the maximum speed limit of the country is different from the maximum speed limit of the new country.

[0014] The processor may change the operable range of the driving assistance function or the autonomous driving function based on the maximum speed limit of the new country when the maximum speed limit of the country is different from the maximum speed limit of the new country.

[0015] The processor may control the vehicle so as to output the changed operable range of the driving assistance function or the autonomous driving function through a display.

[0016] The processor may determine whether a lane changing function is in operation and to determine whether a current driving speed of the vehicle is within the changed operable range when the lane changing function is in operation.

[0017] The processor may allow operation of the lane changing function when the current driving speed of the vehicle is within the changed operable range.

[0018] The processor may prevent operation of the lane changing function when the current driving speed of the vehicle is not within the changed operable range.

[0019] The processor may determine whether the lane changing function can be completed at the current driving speed of the vehicle when the current driving speed of the vehicle is not within the changed operable range.

[0020] The processor may control operation of the vehicle so as to perform the lane changing function in the changed operable range when the lane changing function can be completed at the current driving speed of the vehicle, and

prevent operation of the lane changing function when the lane changing function cannot be completed at the current driving speed of the vehicle.

[0021] Furthermore, according to embodiments of the present disclosure, a vehicle system enters into traveling may include: a vehicle apparatus configured to determine an operable range of a driving assistance function or an autonomous driving function to be performed by a vehicle in a country when the vehicle enters into the country while traveling, and to control operation of the vehicle so as to perform the driving assistance function or the autonomous driving function according to the determined operable range; and a display configured to output a notification of the determined operable range.

[0022] Furthermore, according to embodiments of the present disclosure, a method enters into traveling may include: determining, by a processor, an operable range of a driving assistance function or an autonomous driving function to be performed by a vehicle in a country when the vehicle enters into the country while traveling; controlling, by the processor, operation of the vehicle so as to perform the driving assistance function or the autonomous driving function according to the determined operable range; and outputting, by a display, a notification of the determined operable range.

[0023] The method may further include calculating, by the processor, a minimum operable speed according to at least one of: a maximum sensing distance in a rear-side direction of the vehicle, a maximum deceleration of an approaching vehicle, a margin time before the approaching vehicle decelerates when a lane change operation is performed, and a time for the approaching vehicle to maintain a clearance distance between the vehicle and the approaching vehicle after deceleration of the approaching vehicle. The operable range of the driving assistance function or the autonomous driving function may correspond to a range from the calculated minimum operable speed to a maximum operable speed, the maximum operable speed being greater than or equal to a maximum speed limit of the country.

[0024] The traveling method may further include: determining, by the processor, whether a lane changing function is in operation; and determining, by the processor, whether a current driving speed of the vehicle is within the changed operable range when the lane changing function is in operation.

[0025] The method may further include: allowing, by the processor, operation of the lane changing function when the current driving speed of the vehicle is within the changed operable range; and preventing, by the processor, operation of the lane changing function when the current driving speed of the vehicle is not within the changed operable range.

[0026] The method may further include determining, by the processor, whether the lane changing function can be completed at the current driving speed of the vehicle when the current driving speed of the vehicle is not within the changed operable range.

[0027] The method may further include: when the vehicle enters into a new country while traveling, determining, by the processor, whether a maximum speed limit of the country is different from a maximum speed limit of the new country; and changing, by the processor, the operable range based on the maximum speed limit of the new country.

[0028] The method may further include: controlling, by the processor, operation of the vehicle so as to perform the

lane changing function in the changed operable range when the lane changing function can be completed at the current driving speed of the vehicle; and preventing, by the processor, operation of the lane changing function when the lane changing function cannot be completed at the current driving speed of the vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The above and other objects, features and advantages of the present disclosure will be more apparent from the following detailed description taken in conjunction with the accompanying drawings:

[0030] FIG. 1 is a block diagram illustrating a configuration of a vehicle apparatus according to embodiments of the present disclosure;

[0031] FIG. 2 is a view illustrating a method of controlling a vehicle when a country in which the vehicle is traveling is changed according to embodiments of the present disclosure;

[0032] FIG. 3 is a view illustrating a method of controlling a vehicle in the case of lane changing when a country in which the vehicle is traveling is changed while traveling according to embodiments of the present disclosure;

[0033] FIG. 4 is a view illustrating a method of controlling in the case of stopping a lane change when a traveling country is changed while traveling according to embodiments of the present disclosure;

[0034] FIG. 5 is a flowchart illustrating a method of automatically changing an operable range of a vehicle apparatus according to embodiments of the present disclosure;

[0035] FIG. 6 is a flowchart illustrating a method of controlling a vehicle when an operable range of a vehicle apparatus is automatically changed according to embodiments of the present disclosure;

[0036] FIG. 7 is another flowchart illustrating a method of controlling a vehicle when an operable range of a vehicle apparatus is automatically changed according to embodiments of the present disclosure; and

[0037] FIG. 8 is a view illustrating a computing system according to embodiments of the present disclosure.

[0038] It should be understood that the above-referenced drawings are not necessarily to scale, presenting a somewhat simplified representation of various preferred features illustrative of the basic principles of the disclosure. The specific design features of the present disclosure, including, for example, specific dimensions, orientations, locations, and shapes, will be determined in part by the particular intended application and use environment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0039] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. Throughout the specification, it is noted that the same or like reference numerals denote the same or like components even though they are provided in different drawings. Further, in the following description of the present disclosure, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the subject matter of the present disclosure rather unclear.

[0040] In addition, terms, such as first, second, A, B, (a), (b) or the like may be used herein when describing components of the present disclosure. The terms are provided only to distinguish the elements from other elements, and the essences, sequences, orders, and numbers of the elements are not limited by the terms. In addition, unless defined otherwise, all terms used herein, including technical or scientific terms, have the same meanings as those generally understood by those skilled in the art to which the present disclosure pertains. The terms defined in the generally used dictionaries should be construed as having the meanings that coincide with the meanings of the contexts of the related technologies, and should not be construed as ideal or excessively formal meanings unless clearly defined in the specification of the present disclosure.

[0041] As used herein, the singular forms “a,” “an,” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

[0042] It is understood that the term “vehicle” or “vehicular” or other similar term as used herein is inclusive of motor vehicles in general such as passenger automobiles including sports utility vehicles (SUV), buses, trucks, various commercial vehicles, watercraft including a variety of boats and ships, aircraft, and the like, and includes hybrid vehicles, electric vehicles, plug-in hybrid electric vehicles, hydrogen-powered vehicles and other alternative fuel vehicles (e.g., fuels derived from resources other than petroleum). As referred to herein, a hybrid vehicle is a vehicle that has two or more sources of power, for example both gasoline-powered and electric-powered vehicles.

[0043] Additionally, it is understood that one or more of the below methods, or aspects thereof, may be executed by at least one controller. The term “controller” may refer to a hardware device that includes a memory and a processor. The memory is configured to store program instructions, and the processor is specifically programmed to execute the program instructions to perform one or more processes which are described further below. The controller may control operation of units, modules, parts, devices, or the like, as described herein. Moreover, it is understood that the below methods may be executed by an apparatus comprising the controller in conjunction with one or more other components, as would be appreciated by a person of ordinary skill in the art.

[0044] Furthermore, the controller of the present disclosure may be embodied as non-transitory computer readable media containing executable program instructions executed by a processor. Examples of the computer readable mediums include, but are not limited to, ROM, RAM, compact disc (CD)-ROMs, magnetic tapes, floppy disks, flash drives, smart cards and optical data storage devices. The computer readable recording medium can also be distributed throughout a computer network so that the program instructions are stored and executed in a distributed fashion, e.g., by a telematics server or a Controller Area Network (CAN).

[0045] Hereinafter, embodiments will be described in detail with reference to FIGS. 1 to 8.

[0046] FIG. 1 is a block diagram illustrating a configuration of a vehicle apparatus according to embodiments of the present disclosure.

[0047] As shown in FIG. 1, a vehicle system for driving assistance or autonomous driving may include a sensor module 210, a GPS receiving module 220, a navigation device 230, a display 240, and a vehicle apparatus 100. The vehicle apparatus 100 of FIG. 1 may be mounted on a vehicle.

[0048] The sensor module 210 may include at least one sensor for sensing an object around the vehicle. The sensor module 210 may obtain information about the location, speed, moving direction, and/or kind of an external object (e.g., a vehicle, a pedestrian, a bicycle, a motorcycle, a road sign, or the like) and transfer the information to the vehicle apparatus 100.

[0049] The sensor module 210 may include a yaw rate sensor, a wheel speed sensor, a torque measurement sensor, an acceleration sensor, and the like for measuring dynamic information of the vehicle, and may include a laser, a radar, a camera, a lidar, and the like. In this case, one or more cameras may be provided on a front, a rear, a side, and the like.

[0050] The GPS receiving module 220 may receive location information through GPS to estimate the location of the vehicle and transmit the location information to the vehicle apparatus 100.

[0051] The navigation device 230 may provide information about a travel route and a travel location to a processor 130 by using the location information of the vehicle received by the GPS receiving module 220, map information stored therein, and the like.

[0052] The display 240 may display an operable range of a current traveling country, a changed operable range, a maximum speed limit of a changed traveling country, and the like. The display 240 may visually display information to be recognized by a driver in accordance with a driving environment and a control state. For example, the display 240 may display graphics, icons, texts, and the like, and may provide audio guidance.

[0053] When the vehicle enters into a country while traveling, the vehicle apparatus 100 may change and apply the operable range of the vehicle driving assistance function or the autonomous driving function for each country. That is, the vehicle apparatus 100 may control operation of the vehicle so as to perform the vehicle driving assistance function or the autonomous driving function according to the changed operable range.

[0054] The vehicle apparatus 100 may be electrically connected to the sensor module 210, the GPS receiving module 220, and the navigation device 230. The vehicle apparatus 100 may include a communication device 110, a storage 120, and the processor 130.

[0055] The communication device 110 may communicate with the sensor module 210, the GPS receiving module 220, the navigation device 230, the display 240, and the like in the vehicle.

[0056] The storage 120 (e.g., memory) may store information transmitted and received through the communication device 110, and may store in advance a table of the maxi-

imum speed limits for each country and a table of operational ranges for each country calculated in advance (e.g., by experiment).

[0057] The processor **130** may be an electrical circuit that executes software instructions, and may process and calculate various data as described below.

[0058] The processor **130** may obtain dynamic information and the surrounding environment information of the vehicle by interworking with the sensor module **210** and obtain information about a location and a path of the vehicle itself by interworking with the GPS receiving module **220** and the navigation device **230**.

[0059] The processor **130** may set the operable range such that the vehicle driving assistance function or the autonomous driving function is safely operated in each country according to the maximum speed limit of the current traveling country, and may change the operable range when the traveling country is changed.

[0060] When the vehicle enters into a country while traveling, the processor **130** may change the operable range of the function by country when performing the vehicle driving assistance function or the autonomous driving function, and apply the changed operable range.

[0061] When the vehicle enters into a country while traveling, the processor **130** may change and apply the operable range of the vehicle driving assistance function or the autonomous driving function by country. In this case, the operable range may correspond to a range from the minimum operable speed to the maximum operable speed, and the maximum operable speed may be set according to the maximum speed limit of the country such that the maximum operable speed is greater than or equal to the maximum speed limit of the country.

[0062] The processor **130** may calculate the minimum operable speed by using at least one of the maximum sensing distance in a rear-side direction, the maximum deceleration of an approaching vehicle, a margin time until the approaching vehicle decelerates after a lane changing operation starts, and a time for the approaching vehicle to maintain a clearance distance between the vehicles after deceleration of the approaching vehicle.

[0063] The processor **130** may define the maximum operable speed in consideration of a risk of collision with a nearby vehicle in a lane change, and may determine the maximum operable speed by using the maximum speed limit or higher of each country. In this case, the maximum operable speed may be set to the maximum speed limit or higher of each country for convenience of explanation, but the embodiment is not limited thereto and the maximum operable speed may be changed within a range allowed by a sensor of a vehicle, a processor, a controller, and the like.

[0064] In addition, the processor **130** may calculate the minimum operable speed through Equation 1 as follows.

$$V_{Smin} = \frac{a*(t_B - t_G) + v_{app}}{\sqrt{a^2*(t_B - t_G)^2 - 2*a*(v_{app}*t_G - S_{rear})}} \quad [\text{Equation 1}]$$

[0065] Here, 'V_{Smin}' is the minimum operable speed, 'a' is the maximum deceleration of an approaching vehicle, 't_B' is a margin time until an approaching vehicle decelerates after the start of a lane changing operation, and 't_G' is a time for an approaching vehicle to maintain a clearance distance between vehicles after deceleration. In addition, 'V_{app}' represents the maximum speed limit of each country, and 'S_{rear}' represents the maximum sensing distance of a sensor

in a rear-side direction. 'V_{app}' is the speed of the approaching vehicle at the rear of the target lane for lane change and can be the maximum speed limit for each country, taking into account the most critical situation in a typical situation.

[0066] In Equation 1, the maximum deceleration 'a' of an approaching vehicle, the margin time 't_B' until an approaching vehicle decelerates after the start of a lane changing operation, and the time 't_G' for an approaching vehicle to maintain a clearance distance between vehicles after deceleration may be fixed to 3 m/s², 0.4 seconds, and 1 s, respectively, such that a driver does not feel a great threat when decelerating. In addition, the maximum sensing distance 'S_{rear}' of a sensor in a rear-side direction may be predetermined according to the performance of the sensor and may be assumed to be 55 m for convenience.

[0067] When the above-described assumption values are applied to Equation 1 to calculate the minimum operable speed 'V_{Smin}', the minimum operable speed 'V_{Smin}' of country 'A' is 60 kph and the minimum operable speed 'V_{Smin}' of country 'B' is 85 kph, so that not only the maximum speed limit of the traveling country but also the minimum operable speed may be changed, thereby changing the operable range.

TABLE 1

S _{rear} = 55 m	Country A	Country B
Maximum operable speed	110 kph	130 kph
Minimum operable speed	60 lph (V _{SminA})	85 kph (V _{SminB})

[0068] Although processor **130** may calculate the minimum speed limit of the corresponding country each time through Equation 1, the minimum speed limit may be calculated in advance and stored in the storage **120** as an operable range table for each country, and the processor **130** may change the operable range by using the operable range table when the vehicle moves from one country to another country.

[0069] When the country in which the vehicle is traveling is changed, the processor **130** may determine whether the maximum speed limit of the previous traveling country is different from the maximum speed limit of the current traveling country. Further, the processor **130** may control the display **240** to output a notification of the change in the maximum speed limit when the maximum speed limit of the previous traveling country is different from the maximum speed limit of the current traveling country. The processor **130** may change the operable range of a function according to the maximum speed limit of the present traveling country when the maximum speed limit of the previous traveling country is different from the maximum speed limit of the current traveling country.

[0070] The processor **130** may control such that the changed operable range of the function is output through the display **240**. In addition, the processor **130** may determine whether the lane changing function is currently in operation and whether the current driving speed of the vehicle meets the changed operable range when the lane changing function is in operation. In addition, the processor **130** may continue to perform the lane changing function in the changed operable range when the current driving speed of the vehicle meets the changed operable range.

[0071] The processor **130** may stop performing the lane changing function when the current driving speed of the vehicle does not meet the changed operable range, and may determine whether the lane change is able to be completed at the current driving speed of the vehicle when the current driving speed of the vehicle does not meet the changed operable range. In addition, the processor **130** may control operation of the vehicle so as to perform the lane changing function in the changed operable range when the lane change is able to be completed at the current driving speed of the vehicle, and may prevent operation of the lane changing function when the lane change is unable to be completed at the current driving speed of the vehicle.

[0072] In addition, the processor **130** may obtain route information through interlocking with the navigation device **230** or the like, so that the processor **130** detects the change of the country in which the vehicle is traveling in advance, thereby controlling the traveling speed to satisfy the operable range at the time of country change.

[0073] In addition, the processor **130** may guide the change of the operable range according to the change of the traveling country in advance before crossing the border.

[0074] In addition, the processor **130** may change not only the operable range for each country but also the operable range for each road when the running road is changed. That is, the processor **130** may change the operable range by calculating the minimum operable speed based on the maximum speed limit of each road.

[0075] The function of the processor **130** may be integrated into the navigation device **230** to be implemented as a single device.

[0076] As described above, according to embodiments of the present disclosure, even if the traveling country (i.e., the country in which the vehicle is traveling) is changed while traveling, by changing and applying the operable range of the vehicle system providing the lane changing function according to the traveling country, it is possible to comply with the traffic regulations of the corresponding country and prepare for a dangerous situation.

[0077] In addition, it is possible to increase the usability of the system function by automatically changing and applying only the operable range of each country without diversifying the system for each country.

[0078] In addition, it is possible to further increase the efficiency of the safe driving by outputting the change in the operable range of the system according to the inter-country movement to the display to allow the user to recognize the change in real time.

[0079] FIG. 2 is a view illustrating a method of controlling a vehicle when a country in which the vehicle is traveling is changed according to embodiments of the present disclosure.

[0080] FIG. 2 illustrates a case where a vehicle **10** travels on a road near the border of country 'A' and then crosses the border to enter a road of country 'B'. It is assumed that the maximum speed limit of the country 'A' is 110 kph and the maximum speed limit of country 'B' is 130 kph.

[0081] When the vehicle **10** travels on the one-way secondary road of the country 'A' and then travels across the border to the country 'B' so that the traveling country is changed, the operable range of the vehicle apparatus **100** may be changed and set in accordance with the general maximum speed limit of the changed traveling country, and then, the vehicle apparatus **100** of the vehicle **20** traveling on

the road of the country 'B' may output the operable range of the changed country 'B' through the display **240** to allow the user to recognize the operable range of the country 'B'.

[0082] In FIG. 2, since the lane changing operation is not performed when the traveling country is changed, the change of the operable range may be immediately performed and applied and displayed on the display **240**.

[0083] FIG. 3 is a view illustrating a method of controlling a vehicle in the case of lane changing when a country in which the vehicle is traveling is changed while traveling according to embodiments of the present disclosure. FIG. 4 is a view illustrating a method of controlling in the case of preventing a lane change when a country in which the vehicle is traveling is changed while traveling according to embodiments of the present disclosure.

[0084] An example of changing a lane while a vehicle **30** travels along the road around the border of country 'A' and then travels across the border to the road of country 'B' will be described with reference to FIG. 3.

[0085] That is, when the lane changing function operation is started just before the vehicle **30** reaches the border between the country 'A' and the country 'B', the turn signal lamp starts to operate, and the lane change is normally completed without considering the border, the vehicle **30** travels to the position of a vehicle **40**.

[0086] In this case, when the traveling country (i.e., the country in which the vehicle is traveling) is changed while the vehicle travels at the current driving speed, the vehicle apparatus **100** may determine whether to continue or stop the lane changing function in consideration of the current driving speed, the operable range of the changed country, and the remaining time until completion of the lane change. That is, when the operable range of the country 'A' overlaps with the operable range of the country 'B', and the lane changing function is impossible in the country 'A' and possible in the country 'B', the vehicle apparatus **100** may perform the lane changing function.

[0087] Referring to FIG. 4, when a vehicle **50** moves from country 'A' to country 'C' and the lane change is impossible due to the change in the operable minimum speed 'V_{min}' and the operable maximum speed limit 'V_{max}' of the country 'C', the vehicle apparatus **100** may stop the lane changing function and output the changed operable range through the display **240**, thereby allowing a user to recognize the fact.

[0088] Hereinafter, a method of automatically changing an operable range of a vehicle apparatus according to an embodiment will be described with reference to FIG. 5. FIG. 5 is a flowchart illustrating a method of automatically changing an operable range of a vehicle apparatus according to embodiments of the present disclosure.

[0089] Hereinafter, it is assumed that the vehicle apparatus **100** of FIG. 1 carries out the process of FIG. 5. In addition, it may be understood that in the description of FIG. 5, the operations described as being performed by devices are controlled by the processor **130** of the vehicle apparatus **100**.

[0090] As shown in FIG. 5, in operation S110, the vehicle apparatus **100** may determine whether the country in which the vehicle is currently traveling is changed. In this case, the vehicle apparatus **100** may recognize its own location from the location information received from the GPS receiving module **220** or the map information of the navigation device **230** to determine whether the traveling country is changed.

[0091] In operation S140, when the traveling country is not changed at the current position of the vehicle, the vehicle apparatus 100 maintains the previous operable range. When the traveling country is changed at the current position of the vehicle is changed, in operation S120, the vehicle apparatus 100 compares the maximum speed limit of the previous traveling country with the maximum speed limit of the current (or new) traveling country.

[0092] When the maximum speed limit of the current (or new) traveling country is different from the maximum speed limit of the current traveling country, that is, when the maximum speed limit of the traveling country is changed, the vehicle apparatus 100 outputs the change in the maximum speed limit through the display 240 to inform the user of the fact and adjusts the operable range based on the maximum speed limit of the current (or new) traveling country (S130).

[0093] Meanwhile, in operation S140, when the maximum speed limit of the previous traveling country is equal to that of the current traveling country, that is, when the maximum speed limit of the traveling country is not changed, the vehicle apparatus 100 maintains the previous operable range. Thereafter, the operation S110 is continued to monitor whether the traveling country is changed, and the subsequent operations S120 to S140 are repeated until the driving of the vehicle is stopped. In this case, the vehicle apparatus 100 may determine whether the traveling country is changed in a specified period of time, or may predict in advance whether the traveling country is changed based on the route and map information of the navigation device 230.

[0094] Hereinafter, a method of controlling a vehicle when an operable range of a vehicle apparatus is automatically changed according to embodiments of the present disclosure will be described in detail with reference to FIG. 6. FIG. 6 is a flowchart illustrating a method of controlling a vehicle when an operable range of a vehicle apparatus is automatically changed according to embodiments of the present disclosure. In following description, it is assumed that the process of FIG. 6 is performed by the vehicle apparatus 100 of FIG. 1. In addition, it may be understood that in the description of FIG. 6, the operations described as being performed by devices are controlled by the processor 130 of the vehicle apparatus 100.

[0095] As shown in FIG. 6, in operation S210, when the traveling country is changed and the maximum speed limit is changed in FIG. 5, the operable range for the lane changing function of the changed country is changed. In this case, as described above, the operable range may include a range between the minimum operable speed and the maximum operable speed, and the maximum operable speed may include the maximum speed limit or higher of the traveling country in which the vehicle is currently traveling. In addition, the vehicle apparatus 100 may calculate the minimum operable speed by using the maximum speed limit 'Vapp', the maximum deceleration 'a' of an approaching vehicle, the margin time 'tB' until an approaching vehicle decelerates after the start of a lane changing operation, the time 'tG' for an approaching vehicle to maintain a clearance distance between vehicles after deceleration, the maximum sensing distance 'Srear' of a sensor in a rear-side direction, and the like, which is calculated through Equation 1.

[0096] Thereafter, in operation S220, the vehicle apparatus 100 may inform the user of the changed operable range through the display 240 or the like, so that the user may

recognize the change in the operable range. Then, in operation S230, the vehicle apparatus 100 determines whether the lane changing function is currently in operation. In this case, the vehicle apparatus 100 may determine whether the lane changing function is currently in operation through the communication with a device in the vehicle that supports the lane changing function or based on the on/off information of the turn signal lamp, and the like.

[0097] In operation S240, when the lane changing function is not in operation, the vehicle apparatus 100 may continuously maintain the lane changing function in the changed operable range.

[0098] Meanwhile, in operation S250, when the lane changing function is in operation, the vehicle apparatus 100 determines whether the current driving speed meets the changed operable range.

[0099] In operation S240, when the current driving speed satisfies the changed operable range, the vehicle apparatus 100 continues to perform the lane changing function in the changed operable range.

[0100] To the contrary, when the current driving speed does not satisfy the changed operable range, in operation S260, the vehicle apparatus 100 stops the lane changing function according to a lane change stop procedure.

[0101] Hereinafter, a method of controlling a vehicle when an operable range of a vehicle apparatus is automatically changed according to embodiments of the present disclosure will be described in detail with reference to FIG. 7. FIG. 7 is another flowchart illustrating a method of controlling a vehicle when an operable range of a vehicle apparatus is automatically changed according to embodiments of the present disclosure.

[0102] In the following description, it is assumed that the process of FIG. 7 is performed by the vehicle apparatus 100 of FIG. 1. In addition, it may be understood that in the description of FIG. 7, the operations described as being performed by devices are controlled by the processor 130 of the vehicle apparatus 100.

[0103] As shown in FIG. 7, in operation S310, when the traveling country is changed and the maximum speed limit is changed in FIG. 5, the operable range for the lane changing function of the changed country is changed. In this case, as described above, the operable range may include a range between the minimum operable speed and the maximum operable speed, and the maximum operable speed may include the maximum speed limit or higher of the traveling country in which the vehicle is currently traveling. In addition, the vehicle apparatus 100 may calculate the minimum operable speed by using the maximum speed limit 'Vapp', the maximum deceleration 'a' of an approaching vehicle, the margin time 'tB' until an approaching vehicle decelerates after the start of a lane changing operation, the time 'tG' for an approaching vehicle to maintain a clearance distance between vehicles after deceleration, the maximum sensing distance 'Srear' of a sensor in a rear-side direction, and the like, which is calculated through Equation 1.

[0104] Thereafter, in operation S320, the vehicle apparatus 100 may inform the user of the changed operable range through the display 240 or the like, so that the user may recognize the change in the operable range. Then, in operation S330, the vehicle apparatus 100 determines whether the lane changing function is currently in operation. In this case, the vehicle apparatus 100 may determine whether the lane changing function is currently in operation through the

communication with a device in the vehicle that supports the lane changing function or based on the on/off information of the turn signal lamp, and the like.

[0105] In operation S340, when the lane changing function is not in operation, the vehicle apparatus 100 may continuously maintain the lane changing function in the changed operable range.

[0106] Meanwhile, when the lane changing function is in operation, in operation S350, the vehicle apparatus 100 determines whether the current driving speed meets the changed operable range.

[0107] In operation S340, when the current driving speed satisfies the changed operable range, the vehicle apparatus 100 continues to perform the lane changing function in the changed operable range.

[0108] To the contrary, when the current driving speed does not satisfy the changed operable range, in operation S360, the vehicle apparatus 100 determines whether it is possible to complete the lane change when the vehicle continues to run at the current driving speed.

[0109] In this case, when the surrounding environment condition perceived by the sensor module 210 is suitable for the lane change, the speed is adjustable within the changed operable range for the remaining time until completion of the lane change, the vehicle apparatus 100 may determine that it is possible to complete the lane change. That is, the case where the surrounding environment condition is suitable for the lane change may include a case where there is no risk of collision although a vehicle which exists at a rear-side on a target lane for the lane change is within the sensing distance 'Srear' of the sensor in a rear-side direction (e.g., a case where the speed of a vehicle at a rear-side is lower than that of the present vehicle). In order to determine that the speed is adjustable within the operable range changed for the remaining time until completion of the lane change, when the lane change operation is not completed after the start of the lane change operation and the time to automatically cancel the lane change operation is 'tC', the vehicle apparatus 100 determines whether it is possible to change the driving speed by accelerating or decelerating the driving speed within the operable range at the acceleration or deceleration 'a' at which the driver does not feel a great sense of heterogeneity while reaching 'tC' after the start of the lane changing operation. That is, when the driving speed is accelerated or decelerated within the operable range at the acceleration or deceleration 'a' at which the driver does not feel a great sense of heterogeneity while reaching 'tC' after the start of the lane changing operation, the vehicle apparatus 100 may determine that it is possible to complete the lane change.

[0110] When it is determined in operation S360 that it is possible to complete the lane change, in operation S340, the vehicle apparatus 100 performs the lane changing function in the changed operable range.

[0111] To the contrary, when it is impossible to complete the lane change, in operation S370, the vehicle apparatus 100 stops the lane changing function according to a lane change stop procedure.

[0112] As described above, according to embodiments of the present disclosure, even if a vehicle moves across a border while traveling so that an inter-country movement occurs, the operable range may be safely changed in preparation for a rear-side dangerous situation corresponding to the maximum speed limit of the country, so that the usability

of the driving assistance or autonomous driving function is increased without the need to diversify the autonomous driving system.

[0113] In addition, when an inter-country movement occurs while traveling, the information about the changing and setting of the operable range may be provided to the user in real time, thereby allowing the user to safely drive the vehicle.

[0114] FIG. 8 is a view illustrating a computing system according to embodiments of the present disclosure.

[0115] As shown in FIG. 8, a computing system 1000 may include at least one processor 1100, a memory 1300, a user interface input device 1400, a user interface output device 1500, a storage 1600, and a network interface 1700, which are connected through a bus 1200.

[0116] The processor 1100 may be a central processing unit (CPU) or a semiconductor device that processes instructions stored in the memory 1300 and/or the storage 1600. The memory 1300 and the storage 1600 may include various volatile or nonvolatile storage media. For example, the memory 1300 may include a read only memory (ROM) and a random access memory (RAM).

[0117] Accordingly, the processes of the method or algorithm described in relation to the embodiments of the present disclosure may be implemented directly by hardware executed by the processor 1100, a software module, or a combination thereof. The software module may reside in a storage medium (i.e., the memory 1300 and/or the storage 1600), such as a RAM memory, a flash memory, a ROM memory, an EPROM memory, an EEPROM memory, a register, a hard disk, a detachable disk, or a CD-ROM.

[0118] The exemplary storage medium is coupled to the processor 1100, and the processor 1100 may read information from the storage medium and may write information in the storage medium. In another method, the storage medium may be integrated with the processor 1100. The processor and the storage medium may reside in an application specific integrated circuit (ASIC). The ASIC may reside in a user terminal. In another method, the processor and the storage medium may reside in the user terminal as an individual component.

[0119] According to embodiments of the present disclosure, it is possible to automatically change the operable range into the operable range of a corresponding country and apply the changed operable range when inter-country movement occurs during driving. Thus, driving assistance functions or autonomous driving functions can be performed in automatic accordance with the driving requirements of each country, such that functions such as a lane changing function may be safely performed.

[0120] In addition, according to embodiments of the present disclosure, in a case where the vehicle enters into a country while a lane changing function is in operation, the lane changing is allowed to operate when the current driving speed of the vehicle meets the changed operable range, but the vehicle is controlled to prevent operation of the lane changing when the current driving speed of the vehicle does not meet the changed operable range, so that the safe driving may be achieved.

[0121] Various effects that are directly or indirectly understood through the present disclosure may be provided.

[0122] The above description is a simple exemplification of the technical spirit of the present disclosure, and the present disclosure may be variously corrected and modified

by those skilled in the art to which the present disclosure pertains without departing from the essential features of the present disclosure.

[0123] Therefore, the disclosed embodiments of the present disclosure do not limit the technical spirit of the present disclosure but are illustrative, and the scope of the technical spirit of the present disclosure is not limited by the embodiments of the present disclosure. The scope of the present disclosure should be construed by the claims, and it will be understood that all the technical spirits within the equivalent range fall within the scope of the present disclosure.

What is claimed is:

1. A vehicle apparatus comprising:
 - a processor configured to determine an operable range of a driving assistance function or an autonomous driving function to be performed by a vehicle in a country when the vehicle enters into the country while traveling, and to control operation of the vehicle so as to perform the driving assistance function or the autonomous driving function according to the determined operable range; and
 - a storage configured to store the determined operable range.
2. The vehicle apparatus according to claim 1, wherein the operable range of the driving assistance function or the autonomous driving function corresponds to a range from a minimum operable speed to a maximum operable speed, the maximum operable speed being greater than or equal to a maximum speed limit of the country.
3. The vehicle apparatus according to claim 2, wherein the processor is configured to calculate the minimum operable speed according to at least one of: a maximum sensing distance in a rear-side direction of the vehicle, a maximum deceleration of an approaching vehicle, a margin time before the approaching vehicle decelerates when a lane change operation is performed, and a time for the approaching vehicle to maintain a clearance distance between the vehicle and the approaching vehicle after deceleration of the approaching vehicle.
4. The vehicle apparatus according to claim 1, wherein, when the vehicle enters into a new country while traveling, the processor is configured to determine whether a maximum speed limit of the country is different from a maximum speed limit of the new country.
5. The vehicle apparatus according to claim 4, wherein the processor is configured to control the vehicle so as to output a notification of a change in the maximum speed limit through a display when the maximum speed limit of the country is different from the maximum speed limit of the new country.
6. The vehicle apparatus according to claim 4, wherein the processor is configured to change the operable range of the driving assistance function or the autonomous driving function based on the maximum speed limit of the new country when the maximum speed limit of the country is different from the maximum speed limit of the new country.
7. The vehicle apparatus according to claim 6, wherein the processor is configured to control the vehicle so as to output the changed operable range of the driving assistance function or the autonomous driving function through a display.
8. The vehicle apparatus according to claim 7, wherein the processor is configured to determine whether a lane changing function is in operation and to determine whether a

current driving speed of the vehicle is within the changed operable range when the lane changing function is in operation.

9. The vehicle apparatus according to claim 8, wherein the processor is configured to allow operation of the lane changing function when the current driving speed of the vehicle is within the changed operable range.

10. The vehicle apparatus according to claim 8, wherein the processor is configured to prevent operation of the lane changing function when the current driving speed of the vehicle is not within the changed operable range.

11. The vehicle apparatus according to claim 8, wherein the processor is configured to determine whether the lane changing function can be completed at the current driving speed of the vehicle when the current driving speed of the vehicle is not within the changed operable range.

12. The vehicle apparatus according to claim 11, wherein the processor is configured to control operation of the vehicle so as to perform the lane changing function in the changed operable range when the lane changing function can be completed at the current driving speed of the vehicle, and to prevent operation of the lane changing function when the lane changing function cannot be completed at the current driving speed of the vehicle.

13. A vehicle system comprising:

- a vehicle apparatus configured to determine an operable range of a driving assistance function or an autonomous driving function to be performed by a vehicle in a country when the vehicle enters into the country while traveling, and to control operation of the vehicle so as to perform the driving assistance function or the autonomous driving function according to the determined operable range enters into traveling; and
- a display configured to output a notification of the determined operable range.

14. A method comprising:

- determining, by a processor, an operable range of a driving assistance function or an autonomous driving function to be performed by a vehicle in a country when the vehicle enters into the country while traveling enters into traveling;
- controlling, by the processor, operation of the vehicle so as to perform the driving assistance function or the autonomous driving function according to the determined operable range; and
- outputting, by a display, a notification of the determined operable range.

15. The method of claim 14, further comprising

- calculating, by the processor, a minimum operable speed according to at least one of: a maximum sensing distance in a rear-side direction of the vehicle, a maximum deceleration of an approaching vehicle, a margin time before the approaching vehicle decelerates when a lane change operation is performed, and a time for the approaching vehicle to maintain a clearance distance between the vehicle and the approaching vehicle after deceleration of the approaching vehicle,

wherein the operable range of the driving assistance function or the autonomous driving function corresponds to a range from the calculated minimum operable speed to a maximum operable speed, the maximum operable speed being greater than or equal to a maximum speed limit of the country.

16. The method of claim **14**, further comprising:
when the vehicle enters into a new country while traveling, determining, by the processor, whether a maximum speed limit of the country is different from a maximum speed limit of the new country; and
changing, by the processor, the operable range based on the maximum speed limit of the new country.

17. The method of claim **16**, further comprising:
determining, by the processor, whether a lane changing function is in operation; and
determining, by the processor, whether a current driving speed of the vehicle is within the changed operable range when the lane changing function is in operation.

18. The method of claim **17**, further comprising:
allowing, by the processor, operation of the lane changing function when the current driving speed of the vehicle is within the changed operable range; and

preventing, by the processor, operation of the lane changing function when the current driving speed of the vehicle is not within the changed operable range.

19. The method of claim **18**, further comprising:
determining, by the processor, whether the lane changing function can be completed at the current driving speed of the vehicle when the current driving speed of the vehicle is not within the changed operable range.

20. The method of claim **19**, further comprising:
controlling, by the processor, operation of the vehicle so as to perform the lane changing function in the changed operable range when the lane changing function can be completed at the current driving speed of the vehicle; and

preventing, by the processor, operation of the lane changing function when the lane changing function cannot be completed at the current driving speed of the vehicle.

* * * * *