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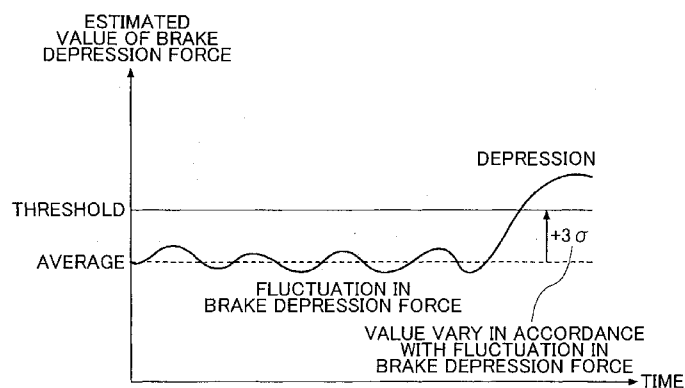
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(54) Title: VEHICLE AND CONTROL DEVICE FOR VEHICLE

FIG. 2



(57) Abstract: A control device for a vehicle includes a controller. The controller is configured to execute automatic stop control of an engine and automatic start control of the engine on the basis of an estimated value of a brake depression force. The estimated value of the brake depression force is calculated by using a brake fluid pressure and a brake booster pressure. The controller is configured to calculate a threshold on the basis of an average value of the estimated values of the brake depression force and a standard deviation that is calculated from the estimated values of the brake depression force. The controller is configured to determine depression of a brake pedal by comparing the estimated value of the brake depression force with the threshold.



VEHICLE AND CONTROL DEVICE FOR VEHICLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a vehicle and a control device for a vehicle.

2. Description of Related Art

[0002] As many have paid attention to environmental concerns, as one of methods for reducing fuel consumption of a vehicle, attention has been focused on control for automatically stopping an engine during idling in which a vehicle is stopped. This control is so-called idling stop control.

[0003] In such idling stop control, the engine automatically stops when a specified stop condition is met, and the engine automatically starts when a specified restart condition is met.

[0004] In recent years, control for automatically starting an engine on the basis of a change in brake fluid pressure that occurs in accordance with a brake pedal depression amount by a driver has been known (see Japanese Patent No. 3613970, for example). This further improves startability of the engine and realizes smooth automatic stop and smooth automatic start of the engine.

[0005] In a technique disclosed in Japanese Patent No. 3613970, whether an engine restart condition is met is determined on the basis of the change in brake fluid pressure that corresponds to a depression force by the driver on the brake pedal (hereinafter referred to as a "brake depression force") after a vehicle stops.

SUMMARY OF THE INVENTION

[0006] Since the brake fluid pressure varies by various factors, it cannot be said that the brake depression force is accurately obtained by the technique disclosed in Japanese Patent No. 3613970.

[0007] When this brake depression force cannot accurately be obtained, the brake pedal depression amount cannot precisely be grasped. As a result, the automatic start control of the engine cannot appropriately be executed.

[0008] In view of the above, the present invention provides a vehicle and a control device for a vehicle that can accurately execute control regarding automatic stop and automatic start of an engine.

[0009] According to a first aspect of the present invention, a control device for a vehicle includes a controller.. The controller is configured to execute automatic stop control of an engine and automatic start control of the engine on the basis of an estimated value of a brake depression force. The estimated value of the brake depression force is calculated by using a brake fluid pressure and a brake booster pressure. The controller is configured to calculate a threshold on the basis of an average value of the estimated values of the brake depression force and a standard deviation calculated from the estimated values of the brake depression force. The controller is configured to determine depression of a brake pedal by comparing the estimated value of the brake depression force with the threshold.

[0010] In the above aspect, the threshold may be calculated as a sum of the average value of the estimated values of the brake depression force and a value obtained by triplicating the standard deviation.

[0011] In the above aspect, the average value may be calculated on the basis of a moving average of the estimated values of the brake depression force.

[0012] According to another aspect of the present invention, a vehicle includes a brake pedal, a master cylinder, a brake booster, and a controller. The master cylinder is configured to generate a brake fluid pressure. The brake booster is configured to generate a force based on a brake booster pressure and transmit the force to the master cylinder. The controller is configured to control the engine such that the engine is kept

in a stop state when a brake pedal operation is canceled from a state that the brake pedal is operated by the larger brake depression force than the threshold during a stop of the vehicle and a stop of the engine. The controller is configured to control the engine such that the engine is started when the brake pedal operation is canceled from a state that the brake pedal is operated by the brake depression force that is equal to or lower than the threshold during the stop of the vehicle and the stop of the engine. The brake depression force is calculated on the basis of the brake fluid pressure and the brake booster pressure. The threshold is calculated on the basis of an average value of the brake depression force and a standard deviation that is calculated from the brake depression force.

[0013] According to the aspects of the present invention, the vehicle and the controller for the vehicle that can accurately execute control regarding the automatic stop and the automatic start of the engine can be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Features, advantages, and technical and industrial significance of exemplary embodiments of the invention will be described below with reference to the accompanying drawings, in which like numerals denote like elements, and wherein:

FIG. 1 illustrates a vehicle that includes a controller according to one embodiment; and

FIG. 2 illustrates a determination on depression of a brake pedal by the controller according to the one embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

[0015] A detailed description will hereinafter be made on an embodiment with reference to accompanying drawings.

[0016] A description will be made on a schematic configuration of a controller 100 for a vehicle 1 according to this embodiment with reference to the drawings. FIG. 1 illustrates the vehicle 1 that includes the controller 100 according to the one embodiment.

[0017] The vehicle 1 includes an engine E, a brake booster 12, a master cylinder 14, and the controller 100. In addition to the above, the vehicle 1 includes brake wheel cylinders 19a to 19d, a brake actuator 16, and the like. The brake actuator 16 adjusts a fluid pressure that is applied to each of the brake wheel cylinders 19a to 19d. The controller 100 controls these components, so as to execute control regarding automatic stop and automatic start of the engine E.

[0018] When a driver depresses a brake pedal 11, the controller 100 applies a braking force that corresponds to a brake depression force to the vehicle 1.

[0019] The brake pedal 11 is a device that receives a brake operation by the driver.

[0020] The brake booster 12 is a boosting mechanism that generates a force based on a brake booster pressure and transmits the force to the master cylinder 14. The brake booster 12 is separated by a diaphragm (not shown) into a constant pressure chamber on the master cylinder 14 side and a variable pressure chamber on the brake pedal 11 side. When the brake pedal 11 is not depressed, pressures in the constant pressure chamber and the variable pressure chamber are each maintained at the atmospheric pressure or lower. Then, when the brake pedal 11 is depressed by the driver in this state, the atmospheric air is introduced into the variable pressure chamber side. Accordingly, a difference in pressure occurs before and behind the diaphragm, and the force based on the brake booster pressure is thereby generated. Just as described, the brake booster 12 assists in the operation of the brake pedal 11 by the driver.

[0021] The master cylinder 14 is a device for generating a brake fluid pressure that corresponds to the brake depression force. The master cylinder 14 receives the brake depression force and the force based on the brake booster pressure that is generated by the brake booster 12, so as to generate the brake fluid pressure.

[0022] With this configuration, the master cylinder 14 can increase the brake fluid pressure in brakes that correspond to right and left wheels 15a to 15d to the brake fluid pressure that corresponds to the brake depression force.

[0023] The controller 100 includes a central processing unit (CPU), a read only memory (ROM), and a random access memory (RAM). The CPU executes various computation processes on the control regarding the automatic stop and the automatic start of the engine. The ROM stores an engine control program, various sets of data, and the like. The RAM temporarily stores results of the computation processes by the CPU, detection results of various sensors, and the like.

[0024] A brake fluid pressure sensor Sp and a brake booster pressure sensor Sb are connected to the controller 100. The brake fluid pressure sensor Sp detects the brake fluid pressure (the brake fluid pressure of the master cylinder 14). The brake booster pressure sensor Sb detects the pressure in the brake booster 12 (hereinafter referred to as the "brake booster pressure"). In addition to the above, a vehicle speed sensor, an engine speed sensor, and the like are connected to the controller 100, for example.

[0025] Next, a description will be made on a schematic configuration of the controller 100 for the vehicle 1 according to this embodiment with reference to the drawings.

[0026] The controller 100 automatically stops the engine E when a specified stop condition is met, and automatically starts the engine E when a specified restart condition is met. Such control is referred to as stop and start control.

[0027] More specifically, as shown in FIG. 1, detection signals are input to the controller 100, the detection signals being produced as a result of detection by various sensors in accordance with a driving status of the driver. Based on the input detection signals, the CPU computes the brake depression force. The computed brake depression force is output to the engine E. More specifically, a number of actuators, such as a starter motor (not shown) for driving the engine E, are connected to an output port of the controller 100. Then, the control regarding the automatic stop and the automatic start of the engine is executed by driving each of the actuators on the basis of the computed brake depression force.

[0028] In detail, in the stop and start control of this embodiment, when the driver depresses the brake pedal 11 and the vehicle 1 is thus brought to a stop, the engine

E is stopped. When the operation of the brake pedal 11 is canceled thereafter, the engine E is restarted. By the way, it can be a great burden for the driver to keep depressing the brake pedal 11 when the vehicle 1 is stopped due to a traffic jam or the like.

[0029] In view of the above, the controller 100 controls the engine E such that, when the brake pedal 11 is once depressed hard during the stop of the vehicle 1, an idling stop state (an engine stop state) is kept even when the operation of the brake pedal 11 is canceled thereafter. Thus, the burden of driving on the driver can be alleviated.

[0030] In such control, the controller 100 needs to determine a brake pedal depression status by the driver. A determination on the depression of the brake pedal 11 is made on the basis of the brake depression force.

[0031] More specifically, a determination on a degree of the depression of the brake pedal 11 by the driver (whether gentle depression or hard depression) is made by using the brake depression force of the driver. Thus, in order to make the determination on the depression of the brake pedal 11, it is important to further accurately compute and estimate the brake depression force.

[0032] Accordingly, the controller 100 can accurately execute the control regarding the automatic stop and the automatic start of the engine E.

[0033] The brake fluid pressure that is detected by the brake fluid pressure sensor Sp and the brake booster pressure that is detected by the brake booster pressure sensor Sb are used to estimate the brake depression force. As described above, the brake booster 12 is the boosting mechanism that generates the force based on the brake booster pressure. Accordingly, the brake fluid pressure also varies by the brake booster pressure. Thus, the brake fluid pressure and the brake booster pressure are used to estimate the brake depression force.

[0034] A brake force (a force to push the master cylinder 14) is calculated on the basis of the following equation (1).

[0035] (The brake force) = (the brake depression force) + (the force based on the brake booster pressure)...(1)

Accordingly, the brake depression force is calculated on the basis of the following equation (2).

[0036] (The brake depression force) = (the brake force) – (the force based on the brake booster pressure)...(2)

In this case, the brake force is calculated on the basis of the following equation (3).

[0037] (The brake force) = (the brake fluid pressure) × (an area of the master cylinder)...(3)

The force based on the brake booster pressure is calculated on the basis of the following equation (4).

[0038] (The force based on the brake booster pressure) = (the brake booster pressure) × (an area of the diaphragm of the brake booster 12)...(4)

Accordingly, the brake depression force is computed on the basis of the equations (2) to (4), and this computation result is used as an estimated value of the brake depression force. This computation is executed by the controller 100.

[0039] More specifically, the area of the master cylinder and the area of the diaphragm are stored in the ROM of the controller 100 in advance. Based on each of the areas stored in advance and the input of the detection signal from each of the sensors Sp, Sb, the CPU of the controller 100 computes the estimated value of the brake depression force. The area of the master cylinder and the area of the diaphragm are respectively computed from a diameter of the master cylinder and a diameter of the diaphragm of the brake booster 12.

[0040] As described above, the controller 100 according to this embodiment can calculate the estimated value of the brake depression force by using the brake booster pressure as one parameter. Therefore, it is possible to accurately calculate the estimated value of the brake depression force while reflecting an influence of the change in brake booster pressure.

[0041] In addition, the force based on the brake booster pressure is used to compute the estimated value of the brake depression force. Thus, it is possible to increase the accuracy in the determination on the depression. As shown in FIG. 2, this

determination on the depression is made by comparing the estimated value of the brake depression force with a threshold.

[0042] Next, calculation of the threshold will be described.

[0043] The threshold is calculated as a sum of an average value of the estimated values of the brake depression force and a standard deviation. The average value of the estimated values of the brake depression force is obtained by calculating a moving average of the computation results of the estimated values of the brake depression force. The standard deviation is calculated from the estimated values of the brake depression force. More specifically, the threshold is calculated on the basis of the following equation (5). In the equation (5), F_{AVE} is the average value of the estimated values of the brake depression force. Meanwhile, σ represents the standard deviation of the estimated values of the brake depression force. In this embodiment, a third standard deviation 3σ is used as the threshold.

$$(\text{The threshold}) = F_{AVE} + 3\sigma \dots (5)$$

Here, the standard deviation σ is calculated on the basis of the following equation (6). In the equation (6), x_i represents the estimated value of the brake depression force that is computed by the controller 100 at specified intervals.

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - F_{AVE})^2} \dots (6)$$

[0044] Next, the computation of the moving average will be described. The moving average is computed by calculating a simple average of the plural estimated values of the brake depression force. For example, when the last 10 of the estimated values of the brake depression force are sampled, the average value (the moving average) of the estimated values of the brake depression force is calculated on the basis of the following equation (7). The estimated value of the brake depression force is computed when the brake fluid pressure and the brake booster pressure, which correspond to the

depression amount of the brake pedal 11, are continuously input to the controller 100 at the specified intervals. Here, when the newest estimated value of the brake depression force is computed by the controller 100, the oldest estimated value of the brake depression force is updated successively by the newest estimated value of the brake depression force. Thus, this moving average varies in conjunction with the estimated value of the brake depression force.

$$F_{AVE} = \frac{x_1 + x_2 + \dots + x_{10}}{10} \quad \dots (7)$$

[0045] The standard deviation is calculated by using the simple average of the plural estimated values of the brake depression force. Thus, the standard deviation varies in conjunction with the estimated value of the brake depression force and the moving average. For example, when the last 10 of the estimated values of the brake depression force are sampled, the standard deviation is calculated on the basis of the following equation (8).

$$\sigma = \sqrt{\frac{1}{10} \{ (x_1 - F_{AVE})^2 + (x_2 - F_{AVE})^2 + \dots + (x_{10} - F_{AVE})^2 \}} \quad \dots (8)$$

[0046] In reality, the brake depression force varies by individuals. In addition, when the vehicle is stopped while inclined on a slope or the like, a heavier vehicle body is more likely to slide down than a lighter vehicle body. In order to prevent this, the driver may have to increase the brake depression force.

[0047] Due to such a factor, the actual brake depression force varies or fluctuates. Variability in the brake depression force refers to a variation in the brake depression force that is generated in accordance with an individual difference by the each

driver, a degree of inclination of the vehicle body, a difference in a weight of the vehicle body, or the like. A fluctuation in the brake depression force refers to a variation in the brake depression force that is generated inevitably when it is intended to maintain the brake depression force. Similarly, the variability and the fluctuation are also present in the estimated value of the brake depression force.

[0048] However, as described above, since the threshold is set on the basis of the average value of the estimated values of the brake depression force, it is possible to calculate the threshold, to which the variability in the estimated value of the brake depression force is reflected.

[0049] In addition, the threshold is set on the basis of the standard deviation of the estimated values of the brake depression force. Thus, the threshold can correspond to a fluctuated status of the brake depression force and a depression status (whether the hard depression or the gentle depression). Accordingly, the threshold can be calculated while the fluctuation in the estimated value of the brake depression force is not erroneously recognized as a result of the hard depression. In addition, it is possible to accurately calculate the threshold by reflecting an influence of the individual difference by the each driver, the degree of inclination of the vehicle body, the weight of the vehicle body, or the like.

[0050] Then, based on the above equations (2) to (6), the determination on the depression of the brake pedal 11 is made.

[0051] More specifically, the estimated value of the brake depression force that is computed on the basis of the above equation (2) at the specified intervals is continuously and temporarily stored in the RAM of the controller 100. In addition, in correspondence with the estimated value of the brake depression force, the threshold is also computed by the CPU of the controller 100 at the specified intervals.

[0052] Next, the estimated value of the brake depression force and the threshold that are computed as described above are compared by the controller 100 at specified intervals. Then, when the estimated value of the brake depression force exceeds the

threshold, the controller 100 makes a determination that the brake pedal 11 is depressed hard.

[0053] During the stop of the vehicle 1 and the stop of the engine, even if the controller 100 determines that the brake pedal 11 is depressed by a powerful force that exceeds the threshold, and the operation of the brake pedal 11 is canceled thereafter, the controller 100 keeps the idling stop state (the engine stop state) and thus does not automatically start the engine E.

[0054] More specifically, a command signal for the automatic start of the engine is not transmitted from the controller 100 to the starter motor, and the engine stop state is kept as is.

[0055] On the other hand, when the controller 100 determines that the brake pedal 11 is depressed by a gentle force that is equal to or lower than the threshold, and the operation of the brake pedal 11 is canceled during the stop of the vehicle 1, the controller 100 starts the engine E.

[0056] In this embodiment, the controller 100 determines the depression of the brake pedal after the vehicle 1 is brought to a stop and the engine is automatically stopped. Thus, the controller 100 samples the estimated value of the brake depression force during the stop of the vehicle at the specified intervals, so as to compute the average value of the estimated values of the brake depression force and the threshold. Therefore, it is possible to accurately make the determination on the depression of the brake pedal 11 during the stop of the vehicle.

[0057] The preferred embodiment of the present invention has been described so far. However, the present invention is not limited to the above-described embodiment. The present invention can be used for various types of the vehicle 1 that controls the automatic stop and the automatic start of the engine. In this case, the configuration of the above-described embodiment can be changed, for example, by combining another element with the configuration of the above embodiment without departing from the gist of the present invention. It is possible to make the accurate determination on the

depression of the brake pedal 11 in accordance with a practical embodiment of the present invention.

[0058] For example, the estimated value of the brake depression force may be calculated on the basis of the brake fluid pressure, and the determination on the depression of the brake pedal 11 may be made on the basis of the estimated value of the thus-calculated brake depression force.

[0059] However, the brake fluid pressure varies by the force based on the brake booster pressure. Thus, it is possible by using the brake booster pressure to further accurately calculate the estimated value of the brake depression force.

[0060] In addition, in this embodiment, the threshold is calculated as the sum of the average value of the estimated values of the brake depression force (the average value by the moving average) and the standard deviation. However, the threshold is not limited thereto. For example, the driver may actually drive the vehicle as a trial, and the threshold may be determined on the basis of a driving result. In this case, the threshold that can be obtained from the driving result is stored in the ROM of the controller 100. The controller 100 determines that the brake is depressed hard when the estimated value of the brake depression force exceeds this threshold.

[0061] The threshold is preferably calculated as described above. It is because the threshold can accurately be calculated while the influence of the individual difference by the each driver, the degree of the inclination of the vehicle, the weight of the vehicle body, or the like is reflected thereto.

[0062] In this embodiment, the third standard deviation 3σ is used to calculate the threshold. However, the present invention is not limited thereto. The standard deviation can appropriately be changed in accordance with the individual difference by the each driver, a difference in the weight of the vehicle body, or the like. For example, a first standard deviation 1σ , a second standard deviation 2σ , or the like may be used.

[0063] In this embodiment, the average value of the estimated values of the brake depression force is calculated as the simple moving average by sampling the plural sets of data. However, the present invention is not limited thereto. A moving average

obtained by another computation may be adopted. In addition, the average value of the estimated values of the brake depression force may be calculated by computation other than the moving average.

[0064] In this embodiment, the description has been made particularly on the determination on whether the brake pedal is depressed hard. However, the present invention is not limited thereto. The present invention may be applied to a determination on whether the operation of the brake pedal is canceled. In other words, when control for restarting the engine when the operation of the brake pedal is canceled is executed from the stop state of the vehicle 1 without depressing the brake pedal hard, the present invention can also be applied to determine whether the brake pedal is canceled. In this case, it is determined whether the automatic start of the engine will be performed on the basis of whether the brake pedal is depressed hard enough to exceed an upper threshold and whether the estimated value of the brake depression force is reduced to be equal to or lower than a lower threshold.

[0065] In this embodiment, the description has been made by exemplifying a case where the control regarding the brake and the stop-and-start control are realized by the one controller 100. However, the present invention is not limited thereto. For example, the controller 100 may be configured by including a brake ECU and an economic running ECU, and the control regarding the brake and the stop and start control may be executed by different electronic control units. In other words, the brake ECU may execute the control regarding the brake, and the economic running ECU may execute the control regarding the automatic stop and the automatic start of the engine.

CLAIMS

1. A control device for a vehicle, the control device comprising:
a controller configured to
 - (a) execute automatic stop control of an engine and automatic start control of the engine on the basis of an estimated value of a brake depression force, the estimated value of the brake depression force being calculated by using a brake fluid pressure and a brake booster pressure,
 - (b) calculate a threshold on the basis of an average value of the estimated values of the brake depression force and a standard deviation that is calculated from the estimated values of the brake depression force, and
 - (c) determine depression of a brake pedal by comparing the estimated value of the brake depression force and the threshold.
2. The control device according to claim 1 wherein
the threshold is calculated as a sum of the average value of the estimated values of the brake depression force and a value obtained by triplicating the standard deviation.
3. The control device according to claim 1 or 2 wherein
the average value is calculated on the basis of a moving average of the estimated values of the brake depression force.
4. A vehicle comprising:
an engine;
a brake pedal;
a master cylinder configured to generate a brake fluid pressure;
a brake booster configured to generate a force based on a brake booster pressure and transmit the force to the master cylinder; and
a controller configured to

(a) control the engine such that the engine is kept in a stop state when a brake pedal operation is canceled from a state that the brake pedal is operated by a larger brake depression force than a threshold during a stop of the vehicle and a stop of the engine, and

(b) control the engine such that the engine is started when the brake pedal operation is canceled from a state that the brake pedal is operated by the brake depression force that is equal to or lower than the threshold during the stop of the vehicle and the stop of the engine,

the brake depression force being calculated on the basis of the brake fluid pressure and the brake booster pressure, and the threshold being calculated on the basis of an average value of the brake depression force and a standard deviation calculated from the brake depression force.

FIG. 1

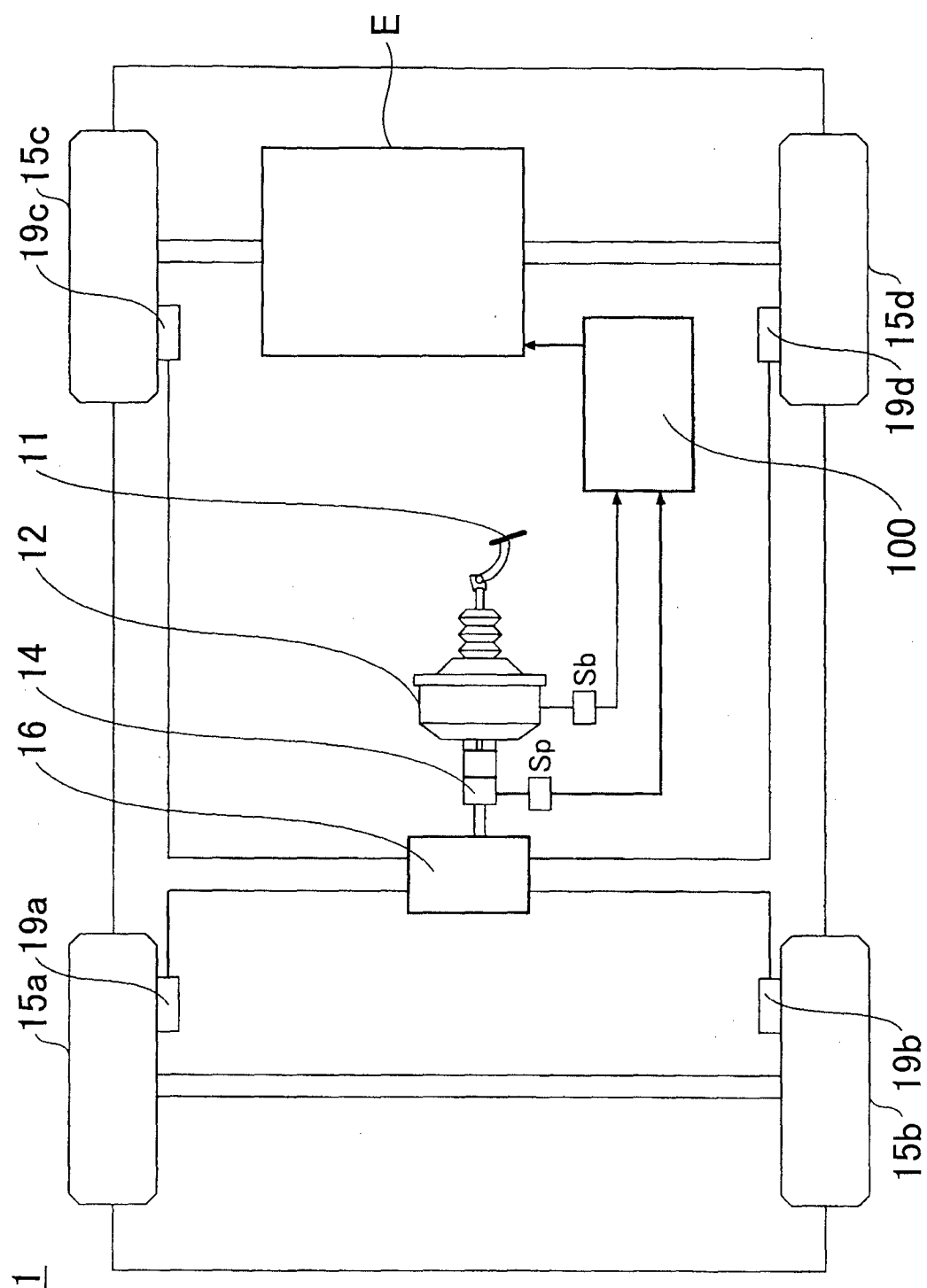
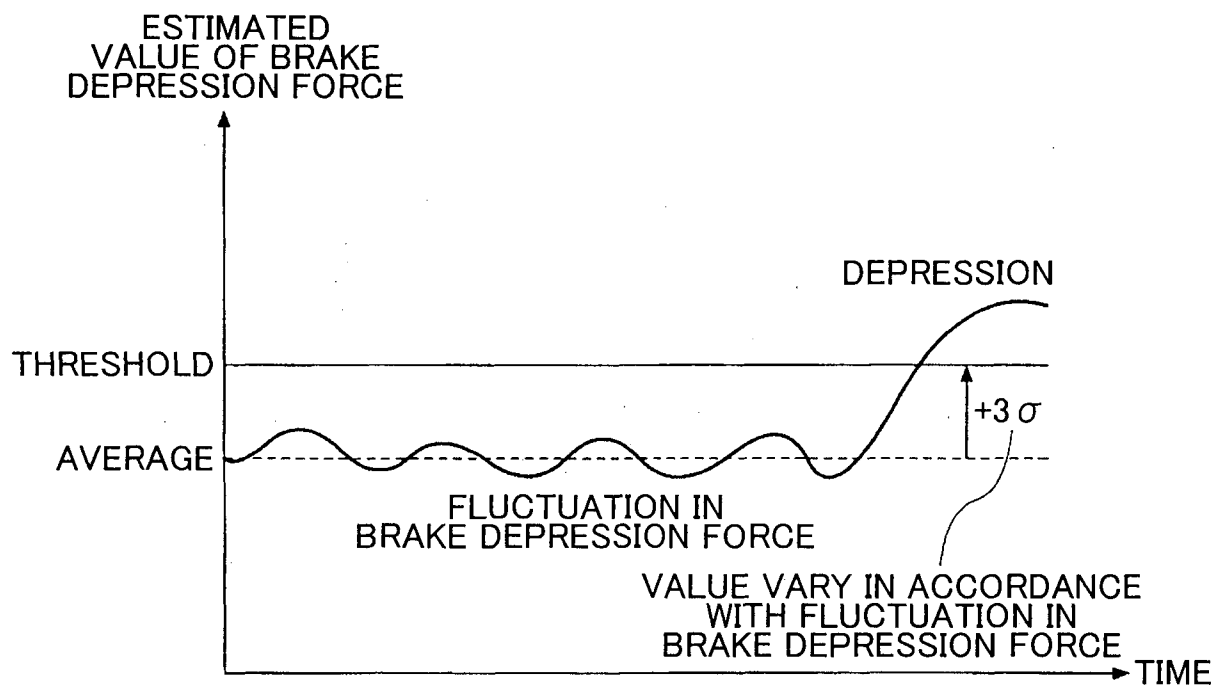


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2014/002441

A. CLASSIFICATION OF SUBJECT MATTER
INV. F02N11/08 B60W30/18
ADD.

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)
F02N B60W

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 016 779 A2 (NISSAN MOTOR [JP]) 5 July 2000 (2000-07-05)	1-3
Y	abstract; figures 1a,1b,2,3 paragraphs [0007] - [0010], [0014] - [0039], [0042] -----	4
Y	US 2011/112740 A1 (HASHIMOTO IKURO [JP]) 12 May 2011 (2011-05-12) paragraphs [0036], [0040], [0137] - [0138], [0142]; figures 10,13 paragraphs [0143], [0145], [0158] - [0161] paragraphs [0173] - [0179], [0196] -----	4
Y	WO 2013/125327 A1 (NISSAN MOTOR [JP]) 29 August 2013 (2013-08-29) abstract; figures 1,2 ----- -/-	4



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2007/073466 A1 (TAMAI GORO [US] ET AL) 29 March 2007 (2007-03-29) paragraphs [0004], [0006], [0018], [0019], [0027], [0034] - [0038]; figures 1,2 -----	1-4
A	JP 2010 174711 A (MAZDA MOTOR) 12 August 2010 (2010-08-12) abstract -----	1-4

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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