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(54) **CONTROL DEVICE OF VEHICLE AND SYSTEM FOR REDUCING INPUT DURING RUNNING ON WAVY ROAD**

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CPC B60W 50/12; B60W 2554/4041; B60W 2552/20; B60W 2555/20; B60W 2520/28; B60W 2520/30
See application file for complete search history.

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(57) **ABSTRACT**

A control device of a vehicle includes a power transmission device transmitting a power of a power source to drive wheels, the control device comprises: a drive force limiting portion limiting a drive force of the vehicle by an upper limit value when the vehicle is running on a wavy road and a value representing a variation in a predetermined rotation speed of a drive system component disposed between the power source to the drive wheels is equal to or greater than a resonance determination value; an upper limit value setting portion setting the upper limit value to a value corresponding to the wavy road on which the vehicle is currently running, based on current position information indicative of a current position of the vehicle.

13 Claims, 10 Drawing Sheets

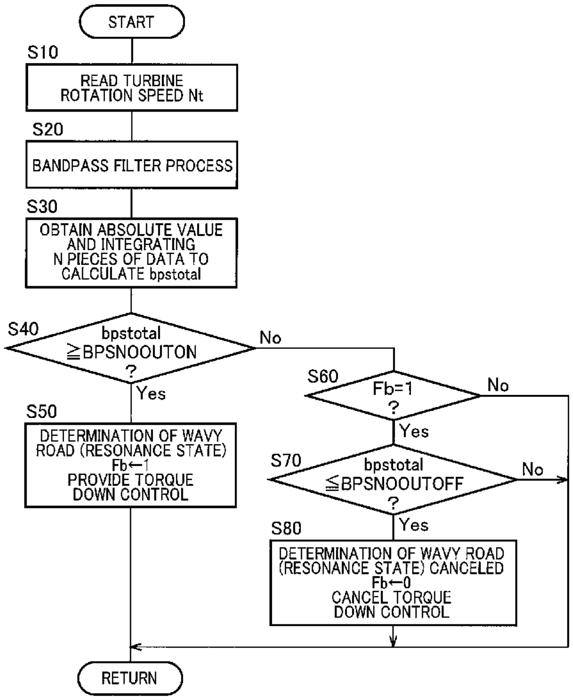


FIG.1

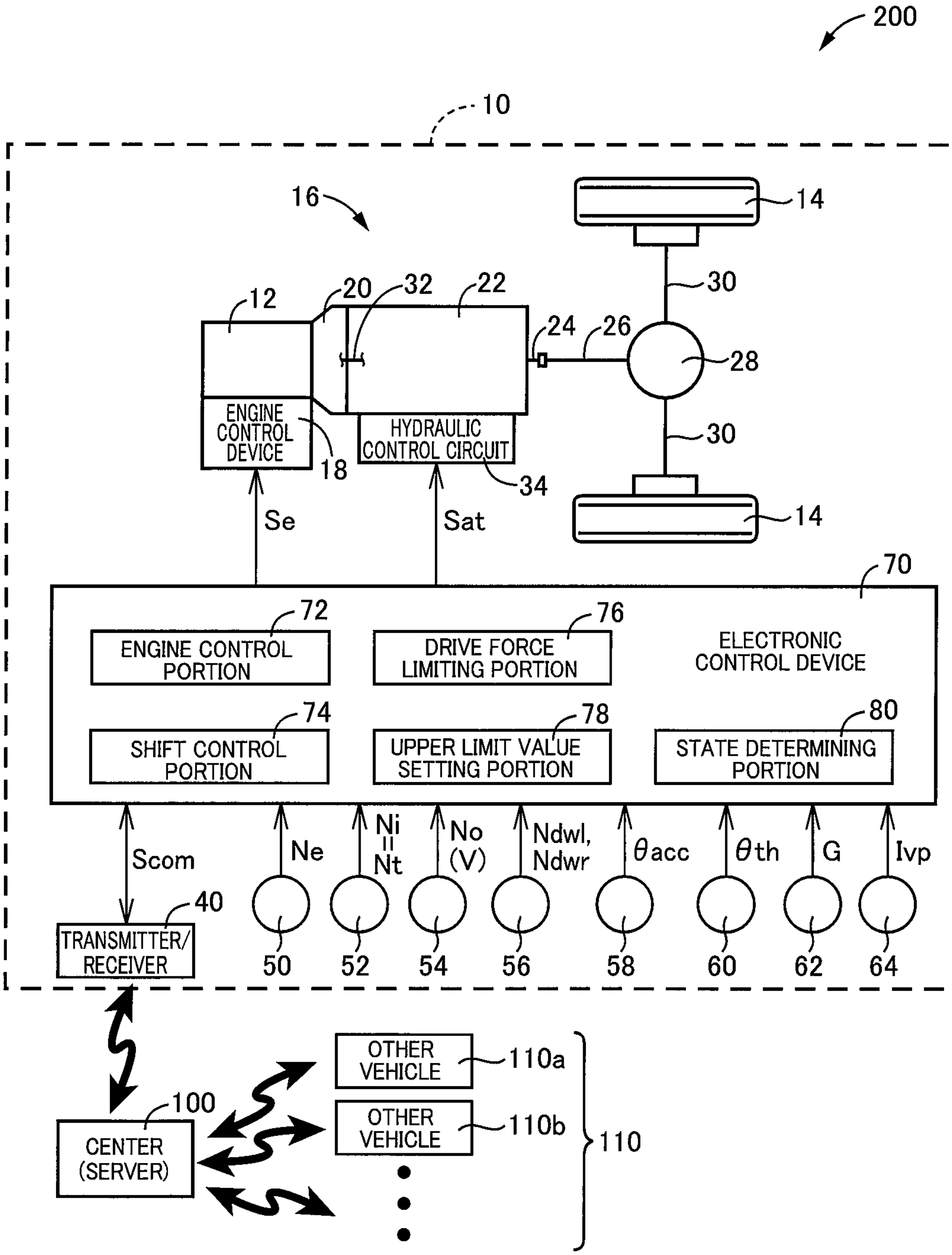

200
10
16
12
20
32
22
24
26
28
30
14
14
30
ENGINE CONTROL DEVICE
18
HYDRAULIC CONTROL CIRCUIT
34
Se
Sat
70
ENGINE CONTROL PORTION
72
DRIVE FORCE LIMITING PORTION
76
ELECTRONIC CONTROL DEVICE
SHIFT CONTROL PORTION
74
UPPER LIMIT VALUE SETTING PORTION
78
STATE DETERMINING PORTION
80
Scom
Ne
Ni = Nt
No (V)
Ndwl, Ndwr
θacc
θth
G
Ivp
TRANSMITTER/ RECEIVER
40
50
52
54
56
58
60
62
64
CENTER (SERVER)
100
OTHER VEHICLE
110a
OTHER VEHICLE
110b
110

FIG.2

FIG.3

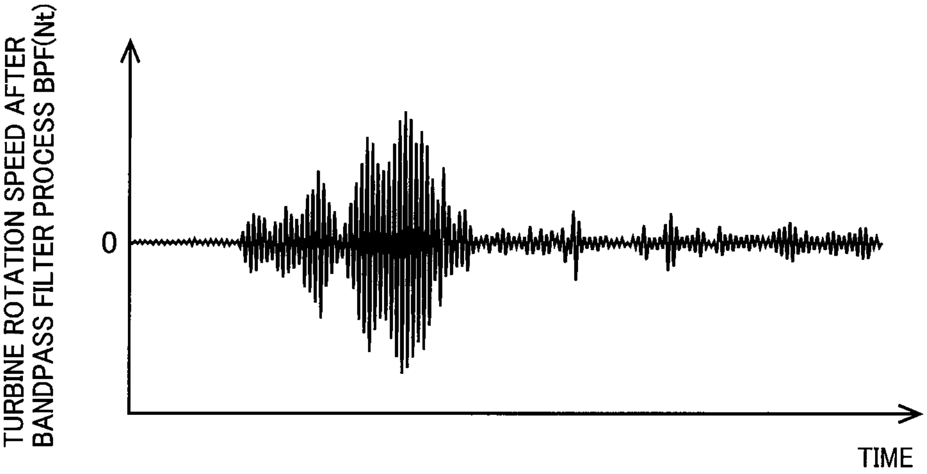

TURBINE ROTATION SPEED AFTER
BANDPASS FILTER PROCESS BPF(Nt)
0
TIME

FIG.4

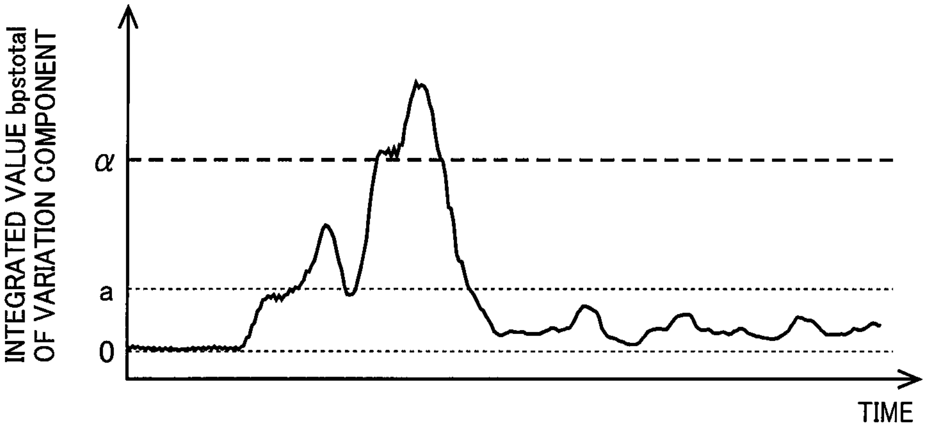

INTEGRATED VALUE bpstotal OF VARIATION COMPONENT
α
a
0
TIME

FIG.5

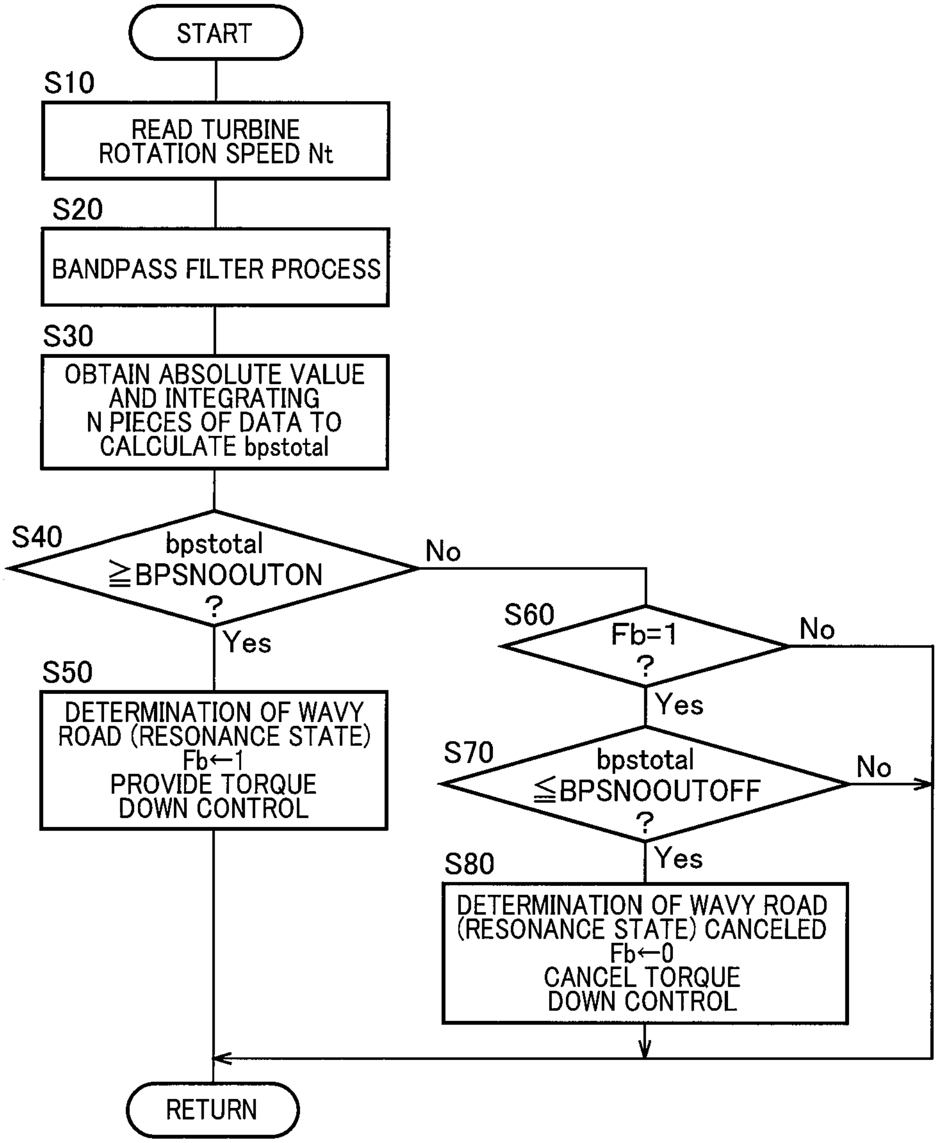

START
S10
READ TURBINE ROTATION SPEED Nt
S20
BANDPASS FILTER PROCESS
S30
OBTAIN ABSOLUTE VALUE AND INTEGRATING N PIECES OF DATA TO CALCULATE bpstotal
S40
bpstotal ≧BPSNOOUTON ?
Yes
No
S50
DETERMINATION OF WAVY ROAD (RESONANCE STATE) Fb←1 PROVIDE TORQUE DOWN CONTROL
S60
Fb=1 ?
Yes
No
S70
bpstotal ≦BPSNOOUTOFF ?
Yes
No
S80
DETERMINATION OF WAVY ROAD (RESONANCE STATE) CANCELED Fb←0 CANCEL TORQUE DOWN CONTROL
RETURN

FIG.6

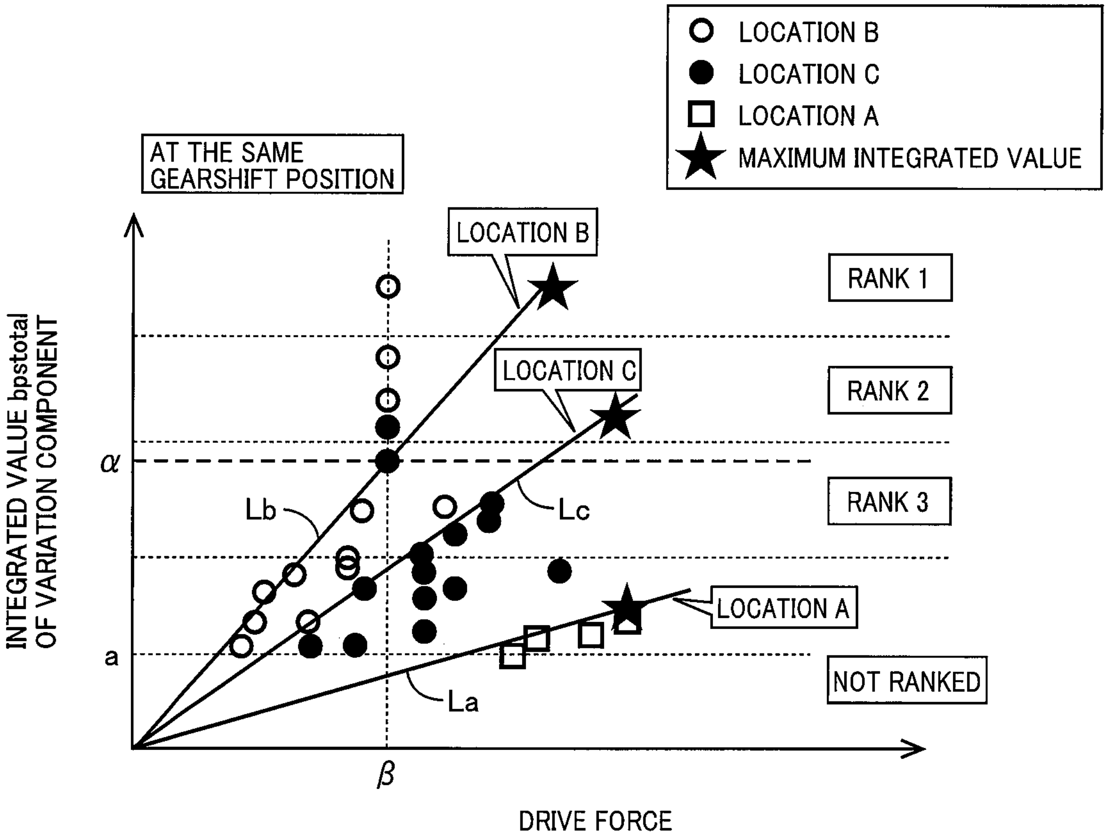

○ LOCATION B
● LOCATION C
□ LOCATION A
★ MAXIMUM INTEGRATED VALUE
AT THE SAME GEARSHIFT POSITION
LOCATION B
LOCATION C
LOCATION A
RANK 1
RANK 2
RANK 3
NOT RANKED
α
a
β
Lb
Lc
La
INTEGRATED VALUE bpstotal OF VARIATION COMPONENT
DRIVE FORCE

FIG.7

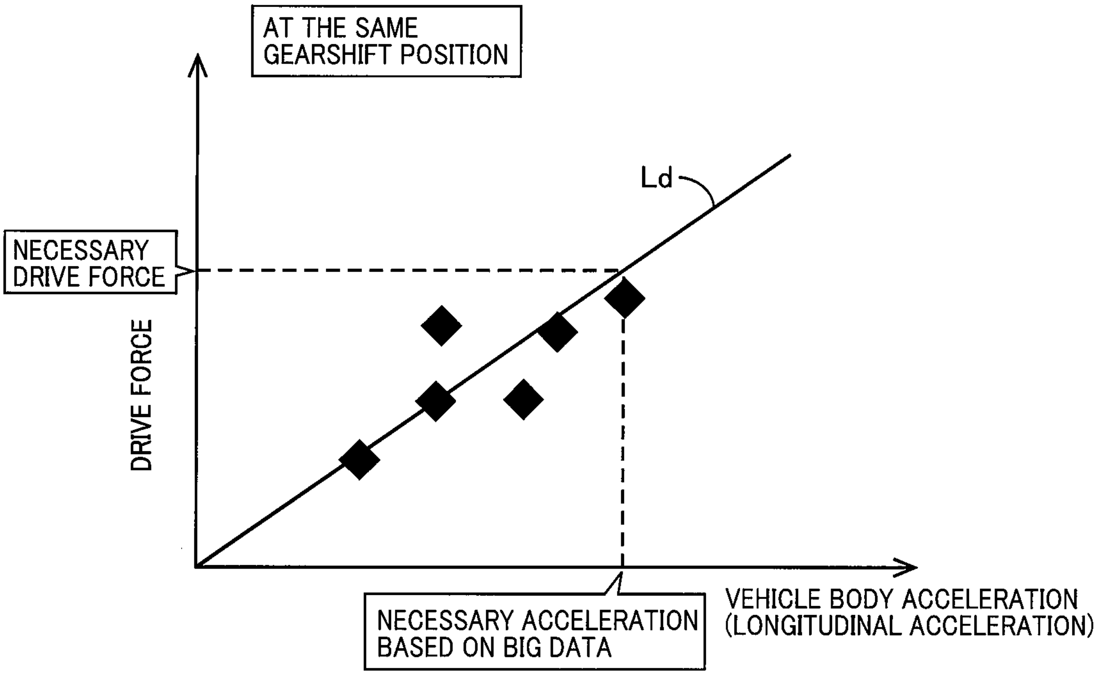

AT THE SAME
GEARSHIFT POSITION
Ld
NECESSARY
DRIVE FORCE
DRIVE FORCE
NECESSARY ACCELERATION
BASED ON BIG DATA
VEHICLE BODY ACCELERATION
(LONGITUDINAL ACCELERATION)

FIG.8

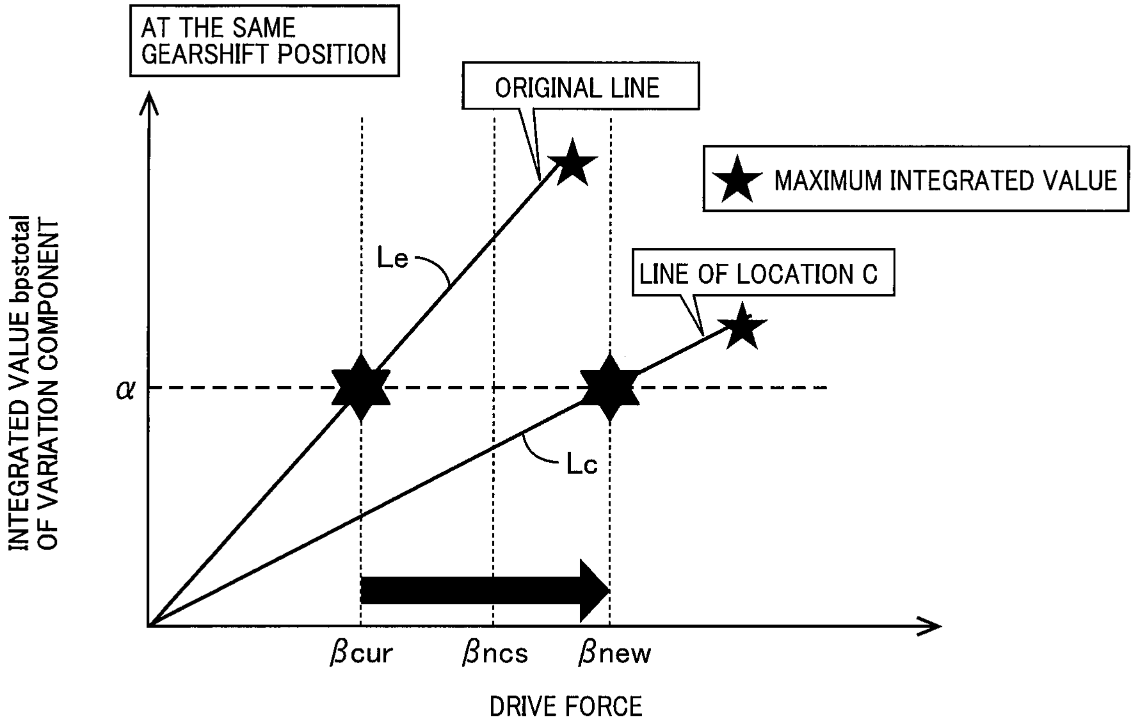

AT THE SAME GEARSHIFT POSITION
ORIGINAL LINE
★ MAXIMUM INTEGRATED VALUE
LINE OF LOCATION C
Le
Lc
α
INTEGRATED VALUE bpstotal OF VARIATION COMPONENT
βcur
βncs
βnew
DRIVE FORCE

FIG.9

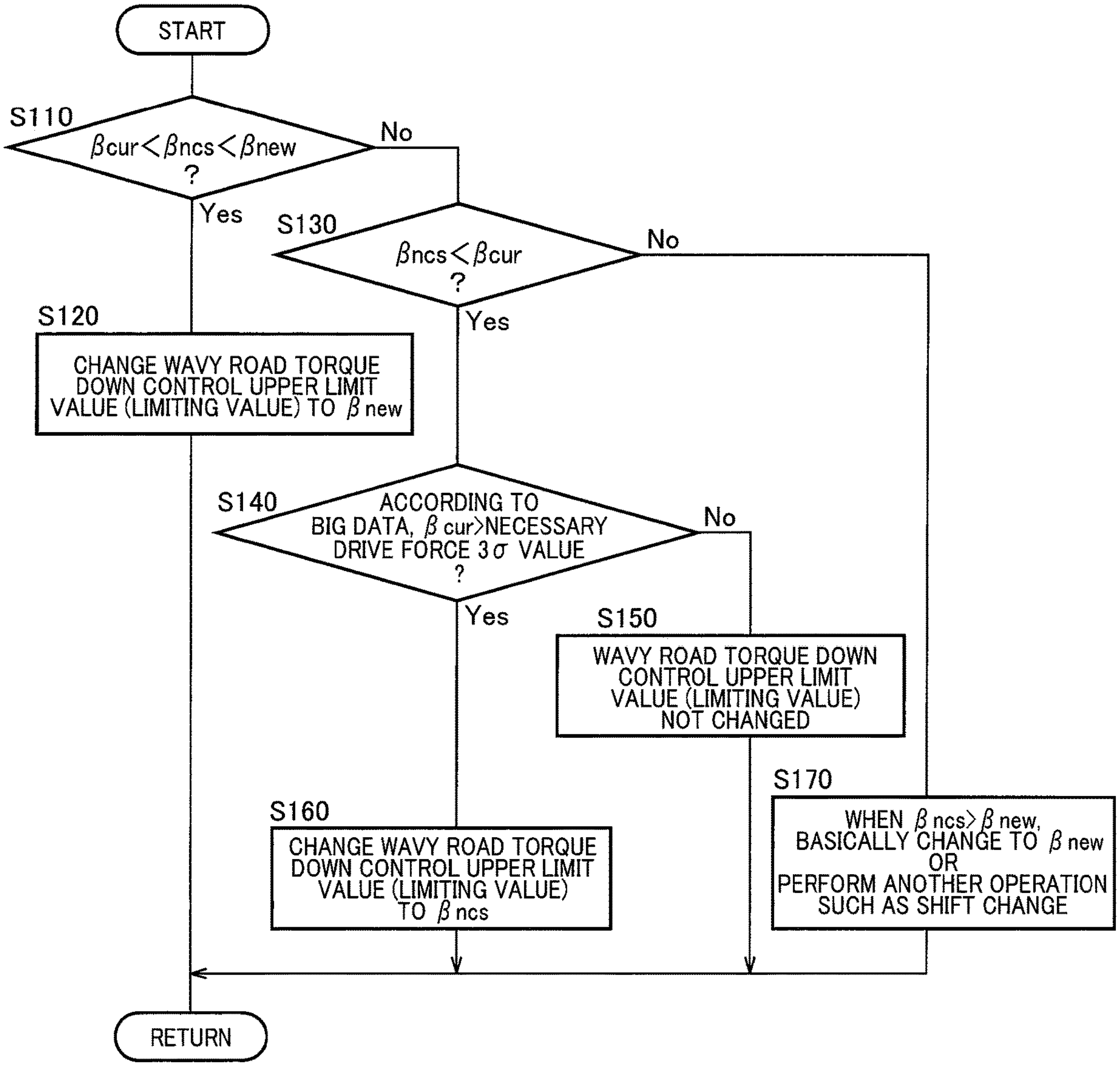
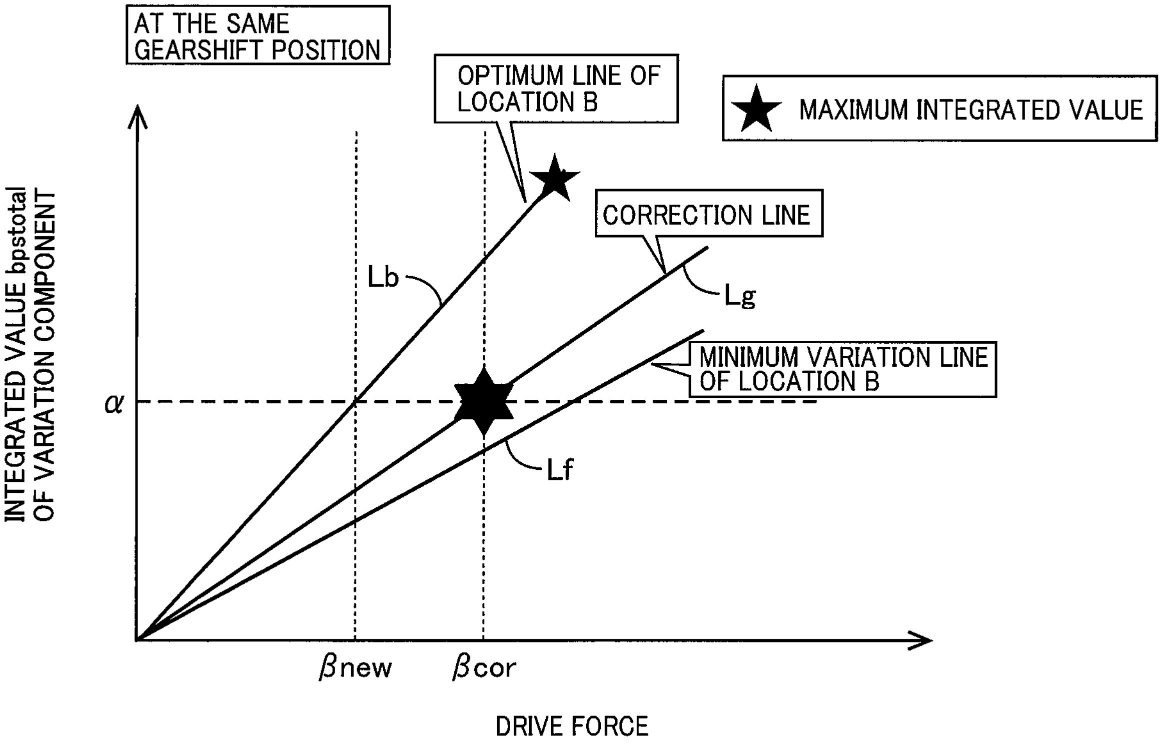

START
S110
βcur<βncs<βnew ?
Yes
No
S120
CHANGE WAVY ROAD TORQUE DOWN CONTROL UPPER LIMIT VALUE (LIMITING VALUE) TO β new
S130
βncs<βcur ?
Yes
No
S140
ACCORDING TO BIG DATA, β cur>NECESSARY DRIVE FORCE 3σ VALUE ?
Yes
No
S150
WAVY ROAD TORQUE DOWN CONTROL UPPER LIMIT VALUE (LIMITING VALUE) NOT CHANGED
S160
CHANGE WAVY ROAD TORQUE DOWN CONTROL UPPER LIMIT VALUE (LIMITING VALUE) TO β ncs
S170
WHEN β ncs>β new, BASICALLY CHANGE TO β new OR PERFORM ANOTHER OPERATION SUCH AS SHIFT CHANGE
RETURN

FIG.10


AT THE SAME GEARSHIFT POSITION
OPTIMUM LINE OF LOCATION B
★ MAXIMUM INTEGRATED VALUE
CORRECTION LINE
MINIMUM VARIATION LINE OF LOCATION B
INTEGRATED VALUE bpstotal OF VARIATION COMPONENT
α
Lb
Lg
Lf
βnew
βcor
DRIVE FORCE

CONTROL DEVICE OF VEHICLE AND SYSTEM FOR REDUCING INPUT DURING RUNNING ON WAVY ROAD

This application claims priority from Japanese Patent Application No. 2020-003161 filed on Jan. 10, 2020, the disclosure of which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

The present invention relates to a control device of a vehicle including a power transmission device transmitting a power of a power source to drive wheels, and a system for reducing input during running on a wavy road used in the vehicle.

DESCRIPTION OF THE RELATED ART

A vehicle including a power transmission device transmitting a power of a power source to drive wheels is well known. For example, this corresponds to the vehicle described in Japanese Laid-Open Patent Publication No. 2019-108867. Japanese Laid-Open Patent Publication No. 2019-108867 discloses that when a vehicle enters a wavy road, an input to the vehicle is amplified by resonance between the input to the vehicle due to unevenness of a road surface and the natural frequency of the vehicle, a suspension, etc., which applies an overload to a drive system component included in the vehicle, and that when it is determined that the vehicle is running on a wavy road, an output of an engine or a motor is controlled.

SUMMARY OF THE INVENTION

Technical Problem

To suppress an input of excessive torque from drive wheels to drive system components from a power source to drive wheels, and to mounts supporting and fixing the power source, the power transmission device, etc. to a vehicle body, it is conceivable that when the vehicle is running on a wavy road and a value representing a variation in predetermined rotation speed of a drive system component becomes equal to or greater than a resonance determination value, the drive force of the vehicle is limited by an upper limit value. However, since a road surface condition and a running state differ depending on a location of the wavy road, if the upper limit value of the drive force is set uniformly regardless of the location of the wavy road, the upper limit value may deviate from an appropriate value depending on the location of the wavy road, which may make it unable to suppress an excessive input to the drive system components, the mounts, etc., or may deteriorate power performance.

The present invention was conceived in view of the situations and it is therefore an object of the present invention to provide a control device of a vehicle and a system for reducing input during running on a wavy road capable of ensuring power performance while suppressing an excessive input to a drive system component, a mount, etc. regardless of a location of a wavy road.

Solution to Problem

The object indicated above is achieved according to the following aspects of the present invention.

To achieve the above object, a first aspect of the present invention provides a control device of a vehicle including (a) a power transmission device transmitting a power of a power source to drive wheels, the control device comprising: (b) a drive force limiting portion limiting a drive force of the vehicle by an upper limit value when the vehicle is running on a wavy road and a value representing a variation in a predetermined rotation speed of a drive system component disposed between the power source to the drive wheels is equal to or greater than a resonance determination value; (c) an upper limit value setting portion setting the upper limit value to a value corresponding to the wavy road on which the vehicle is currently running, based on current position information indicative of a current position of the vehicle.

A second aspect of the present invention provides the control device of the vehicle recited in the first aspect of the invention, wherein the upper limit value setting portion sets, as the upper limit value, a value of the drive force at which the value representing a variation in the predetermined rotation speed is the resonance determination value in a predetermined characteristic corresponding to a location where the vehicle is currently running, among predetermined characteristics predefined for respective locations where the wavy road exists and indicative of a relationship between the value representing a variation in the predetermined rotation speed and the drive force.

A third aspect of the present invention provides the control device of the vehicle recited in the second aspect of the invention, wherein the predetermined characteristics are predefined based on the values representing variations in the predetermined rotation speed of drive system components of multiple vehicles including the vehicle and a vehicle other than the vehicle, the drive forces of the multiple vehicles, and the current position information, acquired through respective communications from the multiple vehicles in an external device separated from the vehicle.

A fourth aspect of the present invention provides the control device of the vehicle recited in the third aspect of the invention, wherein the upper limit value setting portion sets the upper limit value in consideration of a necessary drive force predefined based on the drive forces of the multiple vehicles and longitudinal accelerations of the multiple vehicles acquired through respective communications from the multiple vehicles in the external device.

A fifth aspect of the present invention provides the vehicle control device recited in any one of the first to fourth aspects of the invention, wherein the upper limit value setting portion sets the upper limit value in consideration of weather information of a location where the vehicle is currently running.

A sixth aspect of the present invention provides the vehicle control device recited in any one of the first to fifth aspects of the invention, wherein the value representing a variation in the predetermined rotation speed is a value obtained by integrating an absolute value of a variation component of the predetermined rotation speed in a resonance frequency band extracted from the predetermined rotation speed for a predetermined period.

A seventh aspect of the present invention provides (a) a system for reducing input during running on a wavy road used for multiple vehicles each including a power transmission device transmitting a power of a power source to drive wheels, the system comprising: (b) an external device separated from the vehicles and setting predetermined characteristics for respective locations where the wavy road exists, based on a value representing a variation in a predetermined rotation speed of a drive system component disposed between the power source to the drive wheels, a drive force of the vehicle, and current position information indicative of a current position of the vehicle acquired through respective communications from the vehicles, the predetermined characteristics indicating a relationship between the value representing a variation in the predetermined rotation speed and the drive force; and (c) a control device mounted on the vehicle and limiting the drive force by an upper limit value when the vehicle is running on the wavy road and the value representing a variation in the predetermined rotation speed is equal to or greater than a resonance determination value, the control device setting as the upper limit value a value of the drive force at which the value representing a variation in the predetermined rotation speed is the resonance determination value in the predetermined characteristic corresponding to a location where the vehicle is currently running, among the predetermined characteristics for the respective locations.

Advantageous Effects of Invention

According to the first aspect of the invention, when the vehicle is running on the wavy road and the value representing the variation in a predetermined rotation speed of the drive system component is equal to or greater than the resonance determination value, the drive force of the vehicle is limited by the upper limit value, and therefore, the input of excessive torque from the drive wheels is suppressed. Additionally, since the upper limit value of the drive force is set to a value corresponding to the wavy road where the vehicle is currently running based on the current position information of the vehicle, an inappropriate reduction or excessive reduction in the drive force is suppressed when the drive force is limited. Therefore, the power performance can be ensured while the excessive input to the drive system components, the mounts, etc. is suppressed regardless of the location of the wavy road.

According to the second aspect of the invention, the upper limit value is set to the value of the drive force at which the value representing the variation in the predetermined rotation speed is the resonance determination value in the predetermined characteristic corresponding to a location where the vehicle is currently running, among the predetermined characteristics predefined for respective locations where the wavy road exists, and therefore, the upper limit value is appropriately set to a value corresponding to the wavy road where the vehicle is currently running.

According to the third aspect of the invention, the predetermined characteristics are predefined based on the values representing variations in the predetermined rotation speed, the drive force, and the current position information acquired through respective communications from each of multiple vehicles in the external device, and therefore, the upper limit value corresponding to the wavy road is appropriately set by using the predetermined characteristics.

According to the fourth aspect of the invention, since the upper limit value is set in consideration of the necessary drive force predefined based on the drive forces and longitudinal accelerations acquired through respective communications from the multiple vehicles in the external device, an inappropriate reduction or excessive reduction in the drive force is suppressed when the drive force is limited.

According to the fifth aspect of the invention, since the upper limit value is set in consideration of the weather information in the location where the vehicle is currently running, the corrected upper limit value reflecting a change in the friction coefficient of the wavy road due to the weather is appropriately set.

According to the sixth aspect of the invention, the value representing a variation in the predetermined rotation speed is a value obtained by integrating the absolute value of the variation component in the resonance frequency band extracted from the predetermined rotation speed for the predetermined period, and therefore, an appropriate determination can be made on a state in which the drive force of the vehicle needs to be limited by the upper limit value, for example, a state in which resonance is occurring.

According to the seventh aspect of the invention, when the vehicle is running on a wavy road and a value representing a variation in predetermined rotation speed of the drive system component is equal to or greater than a resonance determination value, the drive force of the vehicle is limited by the upper limit value, so that the input of excessive torque from the drive wheels is suppressed. Additionally, the external device sets predetermined characteristics indicative of a relationship between the value representing a variation in a predetermined rotation speed and the drive force for respective locations where the wavy road exists, based on the value representing a variation in the predetermined rotation speed, a drive force, and current position information acquired through respective communications from multiple vehicles, and sets as the upper limit value a value of the drive force at which the value representing a variation in the predetermined rotation speed is the resonance determination value in the predetermined characteristic corresponding to a location where the vehicle is currently running, among the predetermined characteristics set for the respective locations, and therefore, the upper limit value of the drive force is appropriately set by using this predetermined characteristic to a value corresponding to the wavy road where the vehicle is currently running, so that an inappropriate reduction or excessive reduction in the drive force is suppressed when the drive force is limited. Therefore, the power performance can be ensured while the excessive input to the drive system components, the mounts, etc. is suppressed regardless of the location of the wavy road.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a diagram for explaining a general configuration of a vehicle to which the present invention is applied and is a diagram for explaining main portions of a control function and a control system for various controls in the vehicle.

FIG. **2** is a time chart showing an example of a change in the turbine rotation speed.

FIG. **3** is a time chart showing an example of a variation component of the turbine rotation speed shown in FIG. **2**.

FIG. **4** is a time chart showing an example of an integrated value of the variation component of the turbine rotation speed shown in FIG. **3**.

FIG. **5** is a flowchart for explaining a main portion of the control operation of the electronic control device, i.e., a flow chart for explaining the control operation for determining a resonance state in the wavy road running and limiting the drive force.

FIG. **6** is a diagram showing an example of predetermined characteristics for each location, indicative of a relationship between the NT variation component integrated value and the drive force.

FIG. **7** is a diagram showing an example of a relationship between the drive force and the longitudinal acceleration.

FIG. **8** is a diagram for explaining an example of setting the upper limit value according to the wavy road.

FIG. **9** is a flowchart for explaining a main portion of the control operation of the electronic control device, i.e., a flow chart for explaining the control operation for ensuring the power performance while suppressing an excessive input to the drive system components, the mounts, etc. regardless of the location of the wavy road.

FIG. **10** is a diagram for explaining an example of correcting the upper limit value depending on the weather.

MODES FOR CARRYING OUT THE INVENTION

In an embodiment of the present invention, for example, the power source is an engine such as a gasoline engine or a diesel engine generating power from combustion of fuel. The vehicle may include an electric motor etc. as the power source in addition to or instead of the engine.

The power transmission device includes a transmission, for example. This transmission is, for example, a known planetary gear type automatic transmission, a known synchronous meshing type parallel two-axis automatic transmission, a known DCT (dual clutch transmission) that is the synchronous meshing type parallel two-shaft automatic transmission including two systems of input shafts, a known belt type continuously variable transmission, a known electric continuously variable transmission, a known automatic transmission having multiple power transmission paths, which are a first power transmission path via a gear transmission mechanism and a second power transmission path via a continuously variable transmission, disposed in parallel on a power transmission path between an input rotating member and an output rotating member, a known synchronous meshing type parallel two-axis manual transmission, etc. Alternatively, in a vehicle in which only the electric motor is mechanically coupled to the drive wheels in a power transmittable manner, the power transmission device may not include the transmission, for example.

The predetermined rotation speed of the drive system component from the power source to the drive wheels is, for example, a wheel speed that is the rotation speed of the drive wheels, a rotation speed of a drive shaft, etc. Alternatively, in a vehicle including the transmission, for example, the predetermined rotation speed is an output rotation speed of the transmission corresponding to a vehicle speed, or an input rotation speed of the transmission. Alternatively, in a vehicle including the electric motor, for example, the predetermined rotation speed is a rotation speed of the electric motor. Alternatively, in a vehicle including a fluid transmission device such as a torque converter, for example, the predetermined rotation speed is an output rotation speed of the fluid transmission device, i.e., a turbine rotation speed.

The location is, for example, an area such as a country used as a unit, an area such as Asia, Europe, or the United States used as a unit, or an area such as an urban area, a suburb, or a mountainous area used as a unit. The location is synonymous with a region.

Examples of the present invention will now be described in detail with reference to the drawings.

Example 1

FIG. **1** is a diagram for explaining a general configuration of a vehicle **10** to which the present invention is applied and is a diagram for explaining main portions of a control function and a control system for various controls in the vehicle **10**. In FIG. **1**, the vehicle **10** includes an engine **12**, drive wheels **14**, and a power transmission device **16** transmitting the power of the engine **12** to the drive wheels **14**.

The engine **12** is a power source for running of the vehicle **10** and is a known internal combustion engine, for example. The engine **12** has an engine torque Te, which is an output torque of the engine **12**, controlled by an electronic control device **70** described later controlling an engine control device **18** such as a throttle actuator, a fuel injection device, and an ignition device included in the vehicle **10**.

The power transmission device **16** includes a torque converter **20** coupled to the engine **12**, an automatic transmission **22** coupled to the torque converter **20**, a propeller shaft **26** coupled to an AT output shaft **24** that is an output rotating member of the automatic transmission **22**, a differential gear **28** coupled to the propeller shaft **26**, a pair of drive shafts **30** coupled to the differential gear **28**, etc. In the power transmission device **16**, the power output from the engine **12** is transmitted to the drive wheels **14** sequentially via the torque converter **20**, the automatic transmission **22**, the propeller shaft **26**, the differential gear **28**, the drive shaft **30**, etc. The power is synonymous with torque and force if not particularly distinguished.

The torque converter **20** is a fluid transmission device transmitting the power of the engine **12**. A pump impeller is an input rotating member of the torque converter **20** and is coupled to the engine **12**. A turbine impeller is an output rotating member of the torque converter **20** and is coupled to an AT input shaft **32** that is an input rotating member of the automatic transmission **22**. The AT input shaft **32** is also a turbine shaft.

The automatic transmission **22** is a transmission constituting a portion of a power transmission path between the engine **12** and the drive wheels **14**. The automatic transmission **22** is a known planetary gear type automatic transmission including one set or multiple sets of planetary gear devices and multiple engaging devices, for example. The automatic transmission **22** has an operation state such as an engaged state and a released state of the engaging devices switched by a hydraulic pressure supplied from a hydraulic control circuit **34** included in the vehicle **10** and controlled by the electronic control device **70** described later. As a result, the automatic transmission **22** has multiple gearshift positions different in speed change ratio γ (=AT input rotation speed Ni/AT output rotation speed No) selectively formed. The AT input rotation speed Ni is the rotation speed of the AT input shaft **32**, i.e., the input rotation speed of the automatic transmission **22**, and has the same meaning as a turbine rotation speed Nt. The AT output rotation speed No is the rotation speed of the AT output shaft **24**, i.e., the output rotation speed of the automatic transmission **22**.

The vehicle **10** includes a transmitter/receiver **40**. The transmitter/receiver **40** is a device existing separately from the vehicle **10** and communicating with a center **100** serving as an external device separated from the vehicle **10**. The electronic control device **70** described later transmits/receives various types of information to/from the center **100** via the transmitter/receiver **40**. The center **100** is a server receiving, processing, analyzing, storing, and providing various types of information. The center **100** transmits/receives various types of information to/from vehicles **110***a*, **110***b*, . . . (referred to as the other vehicles **110** if not particularly distinguished) other than the vehicle **10** as in the case of the vehicle **10**. Therefore, the center **100** transmits/receives various types of information to/from a plurality of vehicles including the vehicle **10** and the other vehicles **110**. In this example, the plurality of vehicles is referred to as the multiple vehicles. The other vehicles **110** basically has the same function as the vehicle **10**. The transmitter/receiver **40** may have a function of directly performing vehicle-to-vehicle communication with the other vehicles **110** in the vicinity of the vehicle **10** without via the center **100**.

The vehicle **10** further includes the electronic control device **70** as a controller including a control device of the vehicle **10**. The electronic control device **70** includes a so-called microcomputer including a CPU, a RAM, a ROM, and an I/O interface, for example, and the CPU executes signal processes in accordance with a program stored in advance in the ROM, while utilizing a temporary storage function of the RAM, to provide various controls of the vehicle **10**. The electronic control device **70** includes respective computers for engine control, transmission control, etc., as needed.

The electronic control device **70** is supplied with various signals (e.g., an engine rotation speed Ne that is the rotation speed of the engine **12**, the turbine rotation speed Nt (=AT input rotation speed Ni), the AT output rotation speed No corresponding to a vehicle speed V, wheel speeds Ndwl, Ndwr that are respective rotation speeds Ndw of the left and right drive wheels **14**, an accelerator opening degree θacc defined as a driver's accelerating operation amount representing a magnitude of an accelerating operation of the driver, a throttle valve opening degree θth that is an opening degree of an electronic throttle valve driven by a throttle actuator, a longitudinal acceleration G of the vehicle **10**, position information Ivp, and a communication signal Scorn) based on detection values and acquired information from various sensors and various devices included in the vehicle **10** (e.g., an engine rotation speed sensor **50**, a turbine rotation speed sensor **52**, an output rotation speed sensor **54**, each of wheel speed sensors **56**, an accelerator opening degree sensor **58**, a throttle valve opening degree sensor **60**, a G sensor **62**, a position sensor **64**, and the transmitter/receiver **40**). The electronic control device **70** outputs to the devices included in the vehicle **10** (e.g., the engine control device **18**, the hydraulic control circuit **34**, the transmitter/receiver **40**) various command signals (e.g., an engine control command signal Se for controlling the engine **12**, a transmission control command signal Sat for controlling the automatic transmission **22**, and a communication signal Scorn).

The position sensor **64** includes a GPS antenna etc. The position information Ivp includes current position information indicative of the current position of the vehicle **10** on the surface of the earth or a map based on GPS signals (orbit signals) transmitted by GPS (Global Positioning System) satellites.

The communication signal Scorn includes running information of the vehicle **10** transmitted to/received from the center **100**, for example. Additionally or alternatively, the communication signal Scorn includes the vehicle-to-vehicle communication information directly transmitted to/received from the other vehicles **110** in the vicinity of the vehicle **10** without via the center **100**, for example. The running information includes information such as the vehicle speed V, the wheel speeds Ndwl, Ndwr, the accelerator opening degree θacc, the longitudinal acceleration G, the position information Ivp, the speed change ratio γ or the gearshift position of the automatic transmission **22**, a drive force Fd, and the engine torque Te, for example. For example, the drive force Fd is a target drive force Fdtgt or an estimated drive force Fdest. For example, the engine torque Te is a target engine torque Tetgt or an estimated engine torque Teest. The estimated drive force Fdest and the estimated engine torque Teest are values respectively corresponding to actual values.

To implement the various controls in the vehicle **10**, the electronic control device **70** includes an engine control means, i.e., an engine control portion **72**, a shift control means, i.e., a shift control portion **74**, and a drive force limiting means, i.e., a drive force limiting portion **76**.

The engine control portion **72** applies the accelerator opening degree θacc and the vehicle speed V to, for example, a drive force map that is a relationship obtained empirically or through design and stored in advance, i.e., a predefined relationship, and thereby calculates an amount of drive request from the driver to the vehicle **10**. This amount of drive request is, for example, a required drive force Fddem demanded from the driver to the vehicle **10**. A required drive torque etc. may be used instead of the required drive force Fddem. From a different point of view, this required drive torque is a required drive power at the current vehicle speed V. Alternatively, the AT output rotation speed No etc. may be used instead of the vehicle speed V. The engine control portion **72** sets the target drive force Fdtgt for achieving the required drive force Fddem and calculates the target engine torque Tetgt of the engine **12** for obtaining the target drive force Fdtgt based on a transmission loss, a load of auxiliary machines, the reduction ratio of the differential gear **28**, the speed change ratio γ of the automatic transmission **22**, etc. The engine control portion **72** outputs to the engine control device **18** the engine control command signal Se for controlling the engine **12** so that the target engine torque Tetgt is obtained.

The electronic control device **70** applies the actual throttle valve opening degree θth and the engine rotation speed Ne to a predefined engine torque map, for example, and thereby calculates an estimated engine torque Teest that is an estimated value of the engine torque Te. The electronic control device **70** calculates an estimated drive force Fdest that is an estimated value of the drive force Fd, based on the estimated engine torque Teest, the reduction ratio of the differential gear **28**, the speed change ratio γ of the automatic transmission **22**, etc.

The transmission control portion **74** determines a shift of the automatic transmission **22** by using a shift map that is a predefined relationship, for example, and outputs to the hydraulic control circuit **34** the transmission control command signal Sat for providing the shift control of the automatic transmission **22** as needed. The shift map is a predetermined relationship having a shift line for determining the shift of the automatic transmission **22** on two-dimensional coordinates having the vehicle speed V and the required drive force Fddem as variables, for example.

If the vehicle **10** runs on a wavy road etc. and thereby causes the drive wheels **14** to repeatedly slip and grip so that, for example, variations in the wheel speeds Ndwl and Ndwr, i.e., wheel speed variations, increase, a phenomenon called unspring resonance may occur in the power transmission path between the engine **12** and the drive wheels **14**, and torsional vibrations due to the wheel speed variations amplified by the resonance may be transmitted from the drive wheels **14** toward the engine **12** on the upstream side. Therefore, at the time of passing through the unspring resonance during running on a wavy road etc., a large torque variation may be input from the drive wheels **14** to drive system components from the engine **12** to the drive wheels **14**, and mounts etc. supporting and fixing the engine **12**, the power transmission device **16**, etc. to a vehicle body. When a large torque variation is input from the drive wheels **14**, a large reaction force is generated in the mounts, for example.

This may adversely affect the durability of the drive system components and the mounts. The drive system components are devices and components constituting the power transmission device **16**, for example, and may include the engine **12** etc.

The drive force limiting portion **76** limits the drive force Fd of the vehicle **10** by an upper limit value β so as to suppress the input of the torque variation due to the resonance as described above. For example, when the required drive force Fddem is larger than the upper limit value β, the engine control portion **72** sets the target drive force Fdtgt to the upper limit value β to provide a torque down control for reducing the engine torque Te.

Specifically, FIG. **2** is a time chart showing an example of a change in the turbine rotation speed Nt. FIG. **3** is a time chart showing an example of a variation component of the turbine rotation speed Nt shown in FIG. **2**. FIG. **4** is a time chart showing an example of an integrated value of the variation component of the turbine rotation speed Nt shown in FIG. **3**. In FIG. **2**, the change in the turbine rotation speed Nt used as a predetermined rotation speed of the drive system component shows a state of accelerated running, for example. In FIG. **3**, the variation component of the turbine rotation speed Nt indicates the variation component of the turbine rotation speed Nt after a bandpass filter process, i.e., an NT variation component BPF(Nt). This bandpass filter process is a process of extracting a variation amount of the turbine rotation speed Nt in the frequency band causing a resonance in the power transmission device **16**. Therefore, the NT variation component BPF(Nt) is a variation component of the turbine rotation speed Nt in the resonance frequency band extracted from the turbine rotation speed Nt that is a detection value of the turbine rotation speed sensor **52**. In FIG. **4**, an integrated value bpstotal of the NT variation component BPF(Nt), i.e., the NT variation component integrated value bpstotal, is a value obtained by integrating the absolute value of the NT variation component BPF(Nt) for a predetermined period. Therefore, the NT variation component integrated value bpstotal is a value obtained by integrating N (=predetermined period/sampling cycle) pieces of data of the absolute value of the NT variation component BPF(Nt) in the predetermined period. This predetermined period is, for example, a predefined period in which the NT variation component integrated value bpstotal becomes suitable for determining wavy road running. The NT variation component integrated value bpstotal is a value representing the variation in the turbine rotation speed Nt used for determination of the wavy road running. In FIG. **4**, "a" is a predefined wavy road determination value for determining that the vehicle **10** is running on a wavy road. In FIG. **4**, "a" is a predefined resonance determination value for determining that the vehicle **10** is in a resonance state during wavy road running. When the NT variation component integrated value bpstotal becomes equal to or greater than the resonance determination value α while the vehicle **10** is running on a wavy road, the drive force Fd is limited by the upper limit value β.

FIG. **5** is a flowchart for explaining a main portion of the control operation of the electronic control device **70**, i.e., a flow chart for explaining the control operation for determining a resonance state in the wavy road running and limiting the drive force Fd, and is repeatedly executed during running, for example. Steps of FIG. **5** correspond to functions of the drive force limiting portion **76**.

In FIG. **5**, first, at step (hereinafter, step is omitted) S**10**, the turbine rotation speed Nt is read (see FIG. **2**). At S**20**, the bandpass filter process is executed for the turbine rotation speed Nt to extract the NT variation component BPF(Nt) (see FIG. **3**). At S**30**, N pieces of data of the absolute value of the NT variation component BPF(Nt) are integrated to calculate the NT variation component integrated value bpstotal (see FIG. **4**). At S**40**, it is determined whether the NT variation component integrated value bpstotal is equal to or greater than a threshold value BPSNOOUTON. The threshold value BPSNOOUTON is the resonance determination value α. If the determination of S**40** is affirmative, it is determined at S**50** that the vehicle is in a resonance state on a wavy road, and a flag Fb is set to "1". Additionally, the drive force Fd is limited by the upper limit value β and, for example, the torque down control is provided. If the determination of S**40** is negative, it is determined at S**60** whether the flag Fb is "1". If the determination of S**60** is negative, this routine is terminated. If the determination of S**60** is affirmative, it is determined at S**70** that the NT variation component integrated value bpstotal is equal to or less than a threshold value BPSNOOUTOFF. The threshold value BPSNOOUTOFF is a value reduced from the resonance determination value α by an amount for preventing a hunting in determination of the resonance state. If the determination of S**70** is negative, this routine is terminated. If the determination of S**70** is affirmative, the determination of the resonance state on the wavy road is canceled at S**80**, and the flag Fb is set to "0". Additionally, the limitation of the drive force Fd by the upper limit value β is canceled and, for example, the torque down control is canceled. As described above, when the vehicle **10** is running on the wavy road and the NT variation component integrated value bpstotal is equal to or greater than the resonance determination value α, the drive force limiting portion **76** limits the drive force Fd of the vehicle **10** by the upper limit value β.

When the wavy road is different, the road surface condition of the wavy road may be different, and the running state may be different in a location where the wavy road exists. Therefore, if the upper limit value β of the drive force Fd is set to a uniform value, the upper limit value β may be set to a value too large to suppress an excessive input to the drive system components, the mounts, etc., or to a value too small for an excessive input, depending on the location of the wavy road, which may deteriorate a power performance.

To implement a control function of ensuring a power performance while suppressing an excessive input to the drive system components, the mounts, etc. regardless of the location of the wavy road, the electronic control device **70** further includes an upper limit value setting means, i.e., an upper limit value setting portion **78**, and a state determining means, i.e., a state determining portion **80**.

The upper limit value setting portion **78** sets the upper limit value β to a value corresponding to the wavy road on which the vehicle **10** is currently running, based on the position information Ivp. The upper limit value setting portion **78** sets the upper limit value β to a value corresponding to an increase rate of the NT variation component integrated value bpstotal on the wavy road where the vehicle **10** is currently running. When the increase rate of the NT variation component integrated value bpstotal is small, the upper limit value setting portion **78** sets the upper limit value β to a larger value as compared to when the increase rate is large. The increase rate of the NT variation component integrated value bpstotal is a rate of change when the NT variation component integrated value bpstotal increases toward the resonance determination value α.

Specifically, FIG. **6** is a diagram showing an example of predetermined characteristics for each location, indicative of a relationship between the NT variation component integrated value bpstotal and the drive force Fd at the same gearshift position of the automatic transmission **22**. The predetermined characteristics are wavy road lines LW predefined for respective locations where the wavy road exists, based on the NT variation component integrated value bpstotal, the drive force Fd, and the position information Ivp acquired through respective communications from multiple vehicles including the vehicle **10** and the other vehicles **110** in the center **100**. In FIG. **6**, a solid line La is a wavy road line LWa in a location A, a solid line Lb is a wavy road line LWb in a location B, and a solid line Lc is a wavy road line LWc in a location C. Additionally, "□", "◯", and "•" are plotted (entered) on the diagram as positions of points indicated by the NT variation component integrated value bpstotal and the drive force Fd. The wavy road line LWa is an approximate line based on the points "□" in the location A, the wavy road line LWb is an approximate line based on the points "○" in the location B, and the wavy road line LWc is an approximate line based on the points "•" in the location C. The NT variation component integrated value bpstotal at each of the points "□", "○", and "•" is the maximum value of the NT variation component integrated value bpstotal when the NT variation component integrated value bpstotal becomes equal to or greater than the wavy road determination value α for a certain period of time or longer. The drive force Fd at each of the points "□", "○", and "•" is, for example, a peak value of the estimated drive force Fdest in a period of several seconds before and after the time of occurrence of the maximum value of the NT variation component integrated value bpstotal. The center **100** collects the NT variation component integrated value bpstotal and the running information in a period of several seconds before and after the time of occurrence of the maximum value of the NT variation component integrated value bpstotal. Since the estimated drive force Fdest does not always reach the peak value at the time of the maximum value of the NT variation component integrated value bpstotal, the running information in a period of several seconds before and after the time of occurrence of the maximum value is collected. For each of the locations, "★" indicates a predicted value of the maximum value of the NT variation component integrated value bpstotal. Although the "★" of each location may deviate from each of the wavy road lines LW since the drive force Fd is limited by the upper limit value β when the NT variation component integrated value bpstotal becomes equal to or greater than the resonance determination value α, the center **100** predicts the "★" of each location by an extrapolation method.

FIG. **7** is a diagram showing an example of a relationship between the drive force Fd and the longitudinal acceleration G at the same gearshift position of the automatic transmission **22**. In FIG. **7**, "◆" is plotted on the diagram as a position of a point indicated by the drive force Fd and the longitudinal acceleration G The drive force Fd at "◆" is, for example, a peak value of the estimated drive force Fdest in a period of several seconds before and after the time of occurrence of the maximum value of the NT variation component integrated value bpstotal. The longitudinal acceleration G at "◆" is the longitudinal acceleration G at the time of occurrence of the peak value of the estimated drive force Fdest. A solid line Ld is an approximate line based on the point "◆" determined in the center **100** for each location. The center **100** creates a frequency distribution of the longitudinal acceleration G as big data acquired through respective communications from the multiple vehicles including the vehicle **10** and the other vehicles **110**, and calculates a value that is two to three times the standard deviation a of the longitudinal acceleration G (=mean value of the longitudinal acceleration G+(2 to 3σ)) as a necessary acceleration. The center **100** sets the value of the drive force Fd at which the longitudinal acceleration G is the necessary acceleration on the solid line Ld, to a necessary drive force βncs for each location. In this way, the necessary drive force βncs is predefined based on the drive force Fd and the longitudinal acceleration G acquired through respective communications from the multiple vehicles including the vehicle **10** and the other vehicles **110** in the center **100**.

FIG. **8** is a diagram for explaining an example of setting the upper limit value β according to the wavy road at the same gearshift position of the automatic transmission **22**. In FIG. **8**, the solid line Lc is a wavy road line LWc in the location C similar to the solid line Lc of FIG. **6**. The upper limit value setting portion **78** acquires from the center **100** the wavy road line LWc in the location C where the vehicle **10** is currently running, among the wavy road lines LW predefined by the center **100** for each location where the wavy road exists, based on the position information Ivp. A solid line Le is an original wavy road line LWe predefined according to a road surface condition of a wavy road and a running state on a wavy road where the NT variation component integrated value bpstotal tends to increase. Therefore, the wavy road line LWe is the wavy road line LW based on the assumption that the NT variation component integrated value bpstotal hardly becomes higher than the wavy road line LWe in the market. "βcur" is a value of the drive force Fd at which the NT variation component integrated value bpstotal is the resonance determination value α on the original wavy road line LWe, and is the upper limit value β predefined by using the wavy road line LWe or, for example, the upper limit value β at the current time, i.e., a current upper limit value βcur. When the vehicle **10** is running in the location C, the new upper limit value β, i.e., a new upper limit value βnew, is set as the value of the drive force Fd at which the NT variation component integrated value bpstotal is the resonance determination value α on the wavy road line LWc. Therefore, when the vehicle **10** is running in the location C, the new upper limit value βnew is set by using the wavy road line LWc.

The state determining portion **80** compares the values of the current upper limit value βcur, the new upper limit value βnew, and the necessary drive force βncs. For example, the state determining portion **80** determines whether "the current upper limit value βcur<the necessary drive force βncs<the new upper limit value βnew" is satisfied. The state determining portion **80** also determines whether "the necessary drive force βncs<the current upper limit value βcur" is satisfied. The state determining portion **80** determines whether the current upper limit value βcur is larger than a value that is three times the standard deviation a of the necessary drive force βncs as big data calculated by the center **100** (=mean value of the necessary drive force βncs+3σ). The new upper limit value β is the upper limit value β calculated by the upper limit value setting portion **78** by using the wavy road line LW in the location where the vehicle **10** is currently running, which is acquired from the center **100**. The necessary drive force βncs is the necessary drive force βncs in the location where the vehicle **10** is currently running, which is obtained from the center **100**. Since the current upper limit value βcur is the upper limit value β obtained by using the original wavy road line LWe in this example, it is assumed that "the current upper limit value βcur<the new upper limit value βnew" is satisfied.

If the state determining portion **80** determines that "the current upper limit value βcur<the necessary drive force

βncs<the new upper limit value βnew" is satisfied, the upper limit value setting portion **78** changes the upper limit value β from the current upper limit value βcur to the new upper limit value βnew (see FIG. **8**). In this way, the upper limit value setting portion **78** sets, as the upper limit value β, the new upper limit value βnew that is the value at which the NT variation component integrated value bpstotal is the resonance determination value α on the wavy road line LW in the location where the vehicle **10** is currently running, among the wavy road lines LW predefined by the center **100** for respective locations where the wavy road exists. In this case, the upper limit value setting portion **78** sets the upper limit value β in consideration of the necessary drive force βncs predefined by the center **100** for each of the locations where the wavy road exists.

If the state determining portion **80** determines that "the current upper limit value βcur<the necessary drive force βncs<the new upper limit value βnew" is not satisfied and determines that "the necessary drive force βncs<the current upper limit value βcur" is satisfied, the upper limit value setting portion **78** does not change the upper limit value β and keeps the current upper limit value βcur. However, in this case, if the state determining portion **80** further determines that the current upper limit value βcur is larger than a value three times the standard deviation a of the necessary drive force βncs, the upper limit value setting portion **78** may change the upper limit value β from the current upper limit value βcur to the necessary drive force βncs.

If "the current upper limit value βcur<the necessary drive force βncs<the new upper limit value βnew" is not satisfied and "the necessary drive force βncs<the current upper limit value βcur" is not satisfied, this means that "the new upper limit value βnew<the necessary drive force βncs" is satisfied. However, since the torque down control is provided so that the drive force Fd does not exceed the upper limit value β, "the new upper limit value βnew<the necessary drive force βncs" is not achieved. However, if the driver performs an operation of increasing acceleration after the upper limit value β has been changed to the new upper limit value βnew so that the drive force Fd equal to or higher than the new upper limit value βnew is required in many situations, "the new upper limit value βnew<the necessary drive force βncs" may be satisfied. Therefore, if the state determining portion **80** determines that "the current upper limit value βcur<the necessary drive force βncs<the new upper limit value βnew" is not satisfied and determines that "the necessary drive force βncs<the current upper limit value βcur" is not satisfied, the upper limit value setting portion **78** may forcibly change the gearshift position of the automatic transmission **22** although the upper limit value β is basically changed from the current upper limit value βcur to the new upper limit value βnew.

FIG. **9** is a flowchart for explaining a main portion of the control operation of the electronic control device **70**, i.e., a flow chart for explaining the control operation for ensuring the power performance while suppressing an excessive input to the drive system components, the mounts, etc. regardless of the location of the wavy road, and is repeatedly executed, for example.

In FIG. **9**, first, at S**110** corresponding to the function of the state determining portion **80**, it is determined whether "the current upper limit value βcur<the necessary drive force βncs<the new upper limit value βnew" is satisfied. If the determination of S**110** is affirmative, the upper limit value β during limitation of the drive force Fd on the wavy road is changed from the current upper limit value βcur to the new upper limit value βnew at S**120** corresponding to the function of the upper limit value setting portion **78**. If the determination of S**110** is negative, it is determined at S**130** corresponding to the function of the state determining portion **80** whether "the necessary drive force βncs<the current upper limit value βcur" is satisfied. If the determination of S**130** is affirmative, it is determined at S**140** corresponding to the function of the state determining portion **80** whether "the current upper limit value βcur>the value three times the standard deviation σ of the necessary drive force βncs" is satisfied. If the determination of S**140** is negative, the upper limit value β is not changed from the current upper limit value βcur at S**150** corresponding to the function of the upper limit value setting portion **78**. If the determination of S**140** is affirmative, the upper limit value β is changed from the current upper limit value βcur to the necessary drive force βncs at S**160** corresponding to the function of the upper limit value setting portion **78**. If the determination of S**130** is negative, the upper limit value β is basically changed from the current upper limit value βcur to the new upper limit value βnew at S**170** corresponding to the function of the upper limit value setting portion **78**. Alternatively, another operation such as the shift control of changing the gearshift position of the automatic transmission **22** (=shift change) may be performed.

In this example, the same electronic control devices as the electronic control device **70** mounted on the vehicle **10** and the electronic control devices **70** mounted on the other vehicles **110** and the center **100** can each be considered as a device constituting a system **200** for reducing input during running on a wavy road (see FIG. **1**) used for the multiple vehicles including the vehicle **10** and the other vehicles **110**.

As described above, according to this example, when the vehicle **10** is running on a wavy road and the NT variation component integrated value bpstotal is equal to or greater than the resonance determination value α, the drive force Fd of the vehicle **10** is limited by the upper limit value β, and therefore, the input of excessive torque from the drive wheels **14** is suppressed. Additionally, since the upper limit value β is set to a value corresponding to the wavy road where the vehicle is currently running based on the position information Ivp, an inappropriate reduction or excessive reduction in the drive force Fd is suppressed when the drive force Fd is limited. Therefore, the power performance can be ensured while the excessive input to the drive system components, the mounts, etc. is suppressed regardless of the location of the wavy road.

According to this example, the upper limit value β is set to the value of the drive force Fd at which the NT variation component integrated value bpstotal is the resonance determination value α on the wavy road line LW in the location where the vehicle **10** is currently running, among the wavy road lines LW predefined for respective locations where the wavy road exists, and therefore, the upper limit value β is appropriately set to a value corresponding to the wavy road where the vehicle is currently running.

According to this example, the wavy road lines LW are predefined based on the NT variation component integrated value bpstotal, the drive force Fd, and the position information Ivp acquired through respective communications from each of multiple vehicles including the vehicle **10** and the other vehicles **110** in the center **100**, and therefore, the upper limit value β corresponding to the wavy road is appropriately set by using the wavy road lines LW.

According to this example, since the upper limit value β is set in consideration of the necessary drive force βncs predefined by the center **100** for each of the locations where the wavy road exists, an inappropriate reduction or excessive reduction in the drive force Fd is suppressed when the drive force Fd is limited.

According to this example, the NT variation component integrated value bpstotal is a value obtained by integrating the absolute value of the NT variation component BPF(Nt), which is the variation component in the resonance frequency band extracted from the turbine rotation speed Nt, for a predetermined period, and therefore, an appropriate determination can be made on a state in which the drive force Fd of the vehicle **10** needs to be limited by the upper limit value β, for example, a state in which resonance is occurring.

According to this example, the same effect as described above can be obtained in the system **200** for reducing input during running on a wavy road including the electronic control device **70**, the electronic control devices mounted on the other vehicles **110**, and the center **100**.

Another example of the present invention will be described. In the following description, the portions common to the examples are denoted by the same reference numerals and will not be described.

Example 2

Even on the same wavy road, a friction coefficient μ between a tire and a road surface changes due to a difference in weather such as fine weather, rainy weather, and an amount of rainfall in rainy weather. Therefore, the upper limit value setting portion **78** sets the upper limit value β in consideration of weather information in the location where the vehicle **10** is currently running. For example, the weather information includes the current weather, the weather in the past several hours, etc. acquired from the center **100** or a center providing the weather information. Alternatively, for example, the weather information may be acquired based on an operating state of wipers of the vehicle **10** or the other vehicles **110** near the vehicle **10**.

Specifically, FIG. **10** is a diagram for explaining an example of correcting the upper limit value β depending on the weather. In FIG. **10**, the solid line Lb is the wavy road line LWb in the location B similar to the solid line Lb of FIG. **6**. A solid line Lf is a wavy road line LWf predefined in the center **100** so that the NT variation component integrated value bpstotal becomes equal to or greater than the NT variation component integrated value bpstotal of the wavy road line LWf at any points "○" (see FIG. **6**) in the location B, for example. When the vehicle **10** is running in the location B, the upper limit value setting portion **78** acquires the wavy road line LWf together with the wavy road line LWb from the center **100**. The upper limit value setting portion **78** sets a correction line LWg as shown as a solid line Lg located between the wavy road line LWb and the wavy road line LWf based on the weather information, and sets the upper limit value β corrected by using the correction line LWg, i.e., a corrected upper limit value βcor.

As described above, according to this example, the same effect as Example 1 described above can be obtained. Additionally, since the upper limit value β is set in consideration of the weather information in the location where the vehicle **10** is currently running, the corrected upper limit value βcor reflecting a change in the friction coefficient **11** of the wavy road due to the weather is appropriately set.

Although the examples of the present invention have been described in detail with reference to the drawings, the present invention is also applied in other forms.

For example, in the examples, the wavy road line LW as shown in FIG. **6** may be updated for each predetermined amount of data such as the running state acquired in the center **100** or in each fixed period of time. As a result, for example, when the wavy road has changed over time due to leveling or paving, the currently set wavy road line LW not reflecting the actual road surface condition of the wavy road can be changed to the appropriate wavy road line LW.

In the examples, the wavy road line LW is determined for each location where the wavy road exists, and therefore, for example, the severity of resonance variation at each location can be ranked based on the maximum integrated value, as indicated by "Rank 1", "Rank 2", "Rank 3", and "Not Ranked" in FIG. **6**, for example. As a result, the resonance determination value α can be changed, or an appropriate component can be selected in accordance with each location. For example, in the location A in FIG. **6**, the severity of resonance variation is Not Ranked, i.e., the lowest, and the NT variation component integrated value bpstotal does not reach the resonance determination value α, and therefore, mounted components of vehicles for the location A can be made smaller than those of vehicles for the location B or the location C.

In the examples, the current upper limit value βcur is the upper limit value β obtained by using the original wavy road line LWe, and therefore, it is assumed that "the current upper limit value βcur<the new upper limit value βnew" is satisfied; however, the present invention is not limited to this form. For example, in the case of running in the location B while the upper limit value β obtained by using the wavy road line LWc of the location C shown as the solid line Lc in FIG. **6** is set as the current upper limit value βcur, the upper limit value β obtained by using the wavy road line LWb of the location B shown as the solid line Lb in FIG. **6** is set as the new upper limit value βnew, so that "the new upper limit value βnew<the current upper limit value βcur" is satisfied. In such a case, for example, if the state determining portion **80** determines that "the new upper limit value βnew<the current upper limit value βcur" is satisfied, the upper limit value setting portion **78** changes the upper limit value β from the current upper limit value βcur to the new upper limit value βnew.

In the examples, the drive force Fd is exemplified as a value limited by using the upper limit value β; however, the present invention is not limited to this form. The present invention is applicable, for example, even if the drive force Fd is replaced with a drive torque, a torque on the propeller shaft **26**, a torque on the drive shaft **30**, the output torque of the automatic transmission **22**, etc. Alternatively, in an electric vehicle including an electric motor in addition to or instead of the engine **12**, the drive force Fd can be replaced with an output torque of the electric motor etc. When the torque on the propeller shaft **26**, the output torque of the electric motor, etc. are used, the value of the output torque of the electric motor etc. is acquired in the center **100** as a piece of the running information. Alternatively, for example, when the resonance state in wavy road running is determined in an electric vehicle by using an integrated value of a variation component of the rotation speed of the electric motor, the integrated value, the output torque of the electric motor, and the position information Ivp are acquired in the center **100** to set the wavy road line LW. Alternatively, in a vehicle without a fluid transmission device such as the torque converter **20**, for example, the resonance state in wavy road running is determined by using an integrated value of a variation component of the input rotation speed of the transmission etc., and the integrated value, the drive force Fd, and the position information Ivp are acquired in the center **100** to set the wavy road line LW. The value representing the variation of the predetermined rotation speed used for determining the resonance state in wavy road running may be a moving average obtained by dividing the integrated value of the variation component of the predetermined rotation speed such as the NT variation component integrated value bpstotal by the number of integrated samples. Alternatively, for example, the resonance state in wavy road running may be determined based on the magnitude of the variation component of the predetermined rotation speed.

The above description is merely an embodiment and the present invention can be implemented in variously modified and improved forms based on the knowledge of those skilled in the art.

REFERENCE SIGNS LIST

10: vehicle
12: engine (power source)
14: drive wheels
16: power transmission device
70: electronic control device (control device)
76: drive force limiting portion
78: upper limit value setting portion
100: center (external device)
110: other vehicles
200: system for reducing input during running on a wavy road

What is claimed is:

1. A control device of a vehicle including a power transmission device transmitting a power of a power source to drive wheels, the control device comprising:

a drive force limiting portion limiting a drive force of the vehicle by an upper limit value when the vehicle is running on a wavy road and a value representing a variation in a predetermined rotation speed of a drive system component disposed between the power source to the drive wheels is equal to or greater than a resonance determination value; and

an upper limit value setting portion setting the upper limit value to a value corresponding to the wavy road on which the vehicle is currently running, based on current position information indicative of a current position of the vehicle,

wherein the upper limit value setting portion sets, as the upper limit value, a value of the drive force at which the value representing a variation in the predetermined rotation speed is the resonance determination value in a predetermined characteristic corresponding to a location where the vehicle is currently running, among predetermined characteristics predefined for respective locations where the wavy road exists and indicative of a relationship between the value representing a variation in the predetermined rotation speed and the drive force.

2. The control device of a vehicle according to claim **1**, wherein the predetermined characteristics are predefined based on the values representing variations in the predetermined rotation speed of drive system components of multiple vehicles including the vehicle and a vehicle other than the vehicle, the drive forces of the multiple vehicles, and the current position information, acquired through respective communications from the multiple vehicles in an external device separated from the vehicle.

3. The control device of a vehicle according to claim **2**, wherein the upper limit value setting portion sets the upper limit value in consideration of a necessary drive force predefined based on the drive forces of the multiple vehicles and longitudinal accelerations of the multiple vehicles acquired through respective communications from the multiple vehicles in the external device.

4. The vehicle control device according to claim **1**, wherein the upper limit value setting portion sets the upper limit value in consideration of weather information of a location where the vehicle is currently running.

5. The vehicle control device according to claim **2**, wherein the upper limit value setting portion sets the upper limit value in consideration of weather information of a location where the vehicle is currently running.

6. The vehicle control device according to claim **3**, wherein the upper limit value setting portion sets the upper limit value in consideration of weather information of a location where the vehicle is currently running.

7. The vehicle control device according to claim **1**, wherein the value representing a variation in the predetermined rotation speed is a value obtained by integrating an absolute value of a variation component of the predetermined rotation speed in a resonance frequency band extracted from the predetermined rotation speed for a predetermined period.

8. The vehicle control device according to claim **2**, wherein the value representing a variation in the predetermined rotation speed is a value obtained by integrating an absolute value of a variation component of the predetermined rotation speed in a resonance frequency band extracted from the predetermined rotation speed for a predetermined period.

9. The vehicle control device according to claim **3**, wherein the value representing a variation in the predetermined rotation speed is a value obtained by integrating an absolute value of a variation component of the predetermined rotation speed in a resonance frequency band extracted from the predetermined rotation speed for a predetermined period.

10. The vehicle control device according to claim **4**, wherein the value representing a variation in the predetermined rotation speed is a value obtained by integrating an absolute value of a variation component of the predetermined rotation speed in a resonance frequency band extracted from the predetermined rotation speed for a predetermined period.

11. The vehicle control device according to claim **5**, wherein the value representing a variation in the predetermined rotation speed is a value obtained by integrating an absolute value of a variation component of the predetermined rotation speed in a resonance frequency band extracted from the predetermined rotation speed for a predetermined period.

12. The vehicle control device according to claim **6**, wherein the value representing a variation in the predetermined rotation speed is a value obtained by integrating an absolute value of a variation component of the predetermined rotation speed in a resonance frequency band extracted from the predetermined rotation speed for a predetermined period.

13. A system for reducing input during running on a wavy road used for multiple vehicles each including a power transmission device transmitting a power of a power source to drive wheels, the system comprising:

an external device separated from the vehicles and setting predetermined characteristics for respective locations where the wavy road exists, based on a value representing a variation in a predetermined rotation speed of a drive system component disposed between the power source to the drive wheels, a drive force of the vehicle, and current position information indicative of a current position of the vehicle acquired through respective communications from the vehicles, the predetermined characteristics indicating a relationship between the value representing a variation in the predetermined rotation speed and the drive force; and

a control device mounted on the vehicle and limiting the drive force by an upper limit value when the vehicle is running on the wavy road and the value representing a variation in the predetermined rotation speed is equal to or greater than a resonance determination value, the control device setting as the upper limit value a value of the drive force at which the value representing a variation in the predetermined rotation speed is the resonance determination value in the predetermined characteristic corresponding to a location where the vehicle is currently running, among the predetermined characteristics for the respective locations.

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