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(54) Abstract Title
Vehicle drive force controller

(57) A vehicle drive force controller comprises a navigation device for determining whether or not the vehicle is travelling in a mountainous region. The navigation device comprises a global positioning system for determining vehicle position, combined with a memory in which is stored altitude data for an area surrounding the vehicle position. A microprocessor determines the slope of the road on which the vehicle is travelling from the altitude data, and then a vehicle drive force characteristic suitable for a mountainous region is selected if the slope is equal to or greater than a predetermined value. A different drive force characteristic is selected if the slope is less than a predetermined value. The drive force characteristic may be the throttle gain of an electronic throttle or the speed change pattern of an automatic transmission. The microprocessor can be programmed so that the throttle opening is larger when the vehicle is travelling in a mountainous region, or so that a lower gear is selected when the vehicle is in a mountainous region.

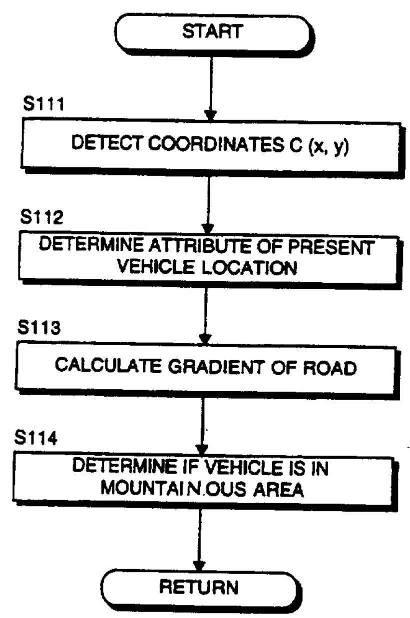

FIG. 24

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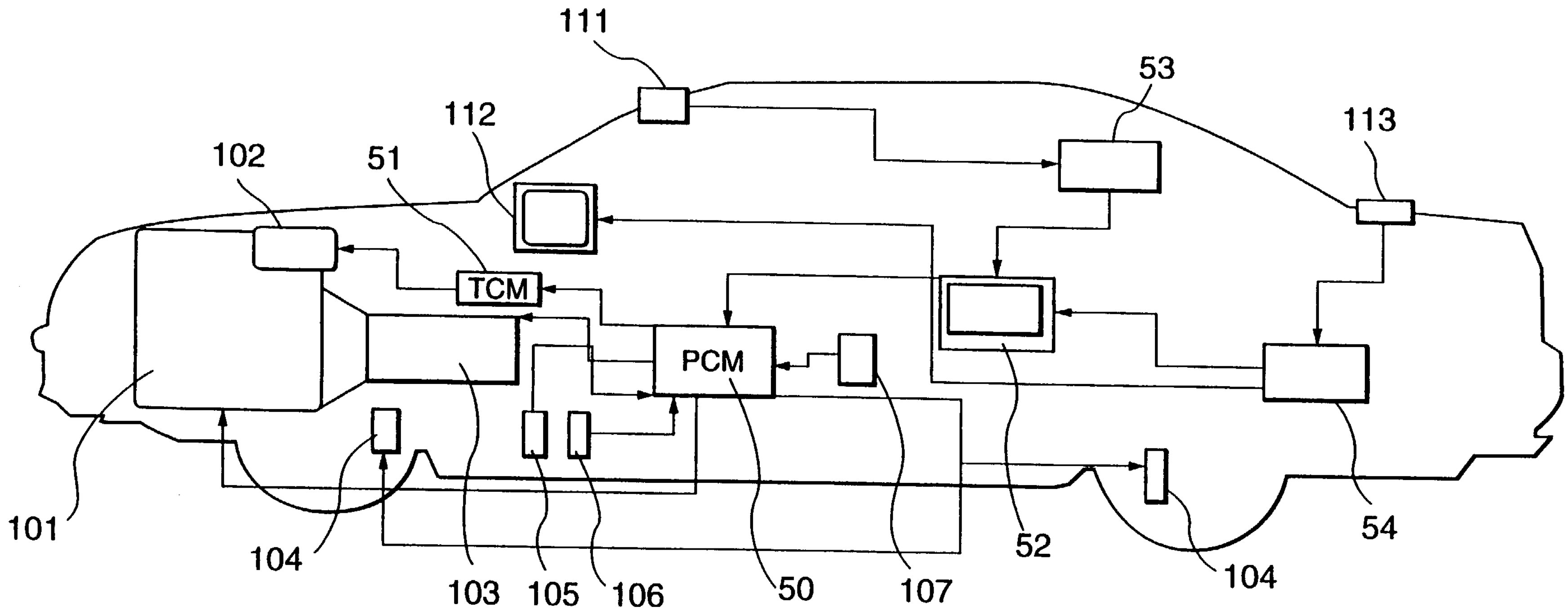


FIG.1

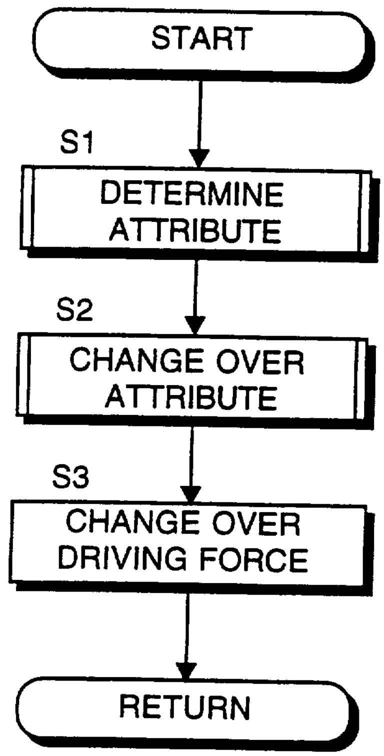

START
S1
DETERMINE ATTRIBUTE
S2
CHANGE OVER ATTRIBUTE
S3
CHANGE OVER DRIVING FORCE
RETURN

FIG. 2

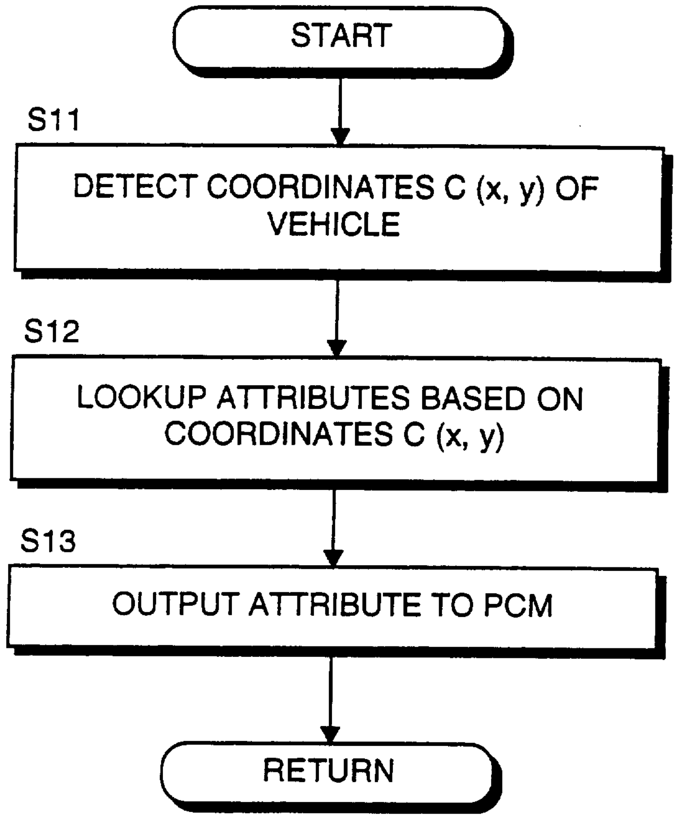

START
S11
DETECT COORDINATES C (x, y) OF VEHICLE
S12
LOOKUP ATTRIBUTES BASED ON COORDINATES C (x, y)
S13
OUTPUT ATTRIBUTE TO PCM
RETURN

FIG. 3

FIG. 4A

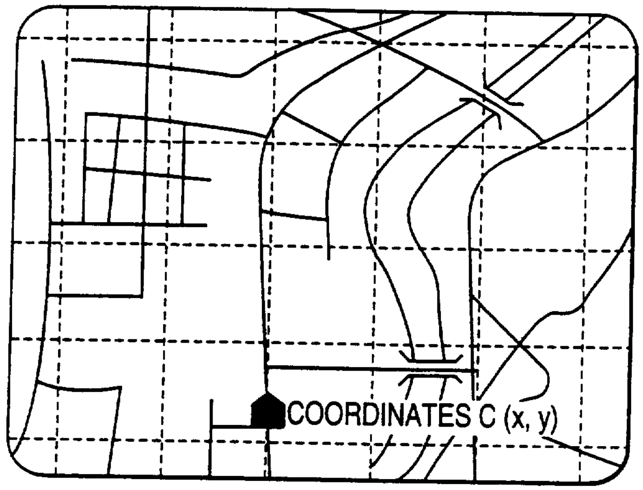
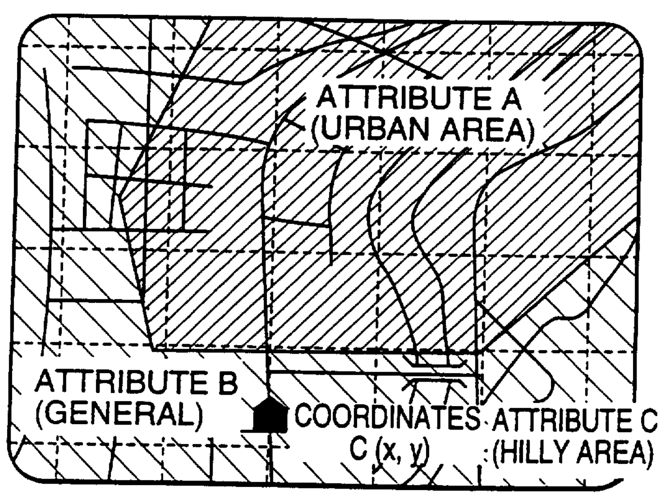

COORDINATES C (x, y)

FIG. 4B


ATTRIBUTE A
(URBAN AREA)
ATTRIBUTE B
(GENERAL)
COORDINATES
C (x, y)
ATTRIBUTE C
(HILLY AREA)

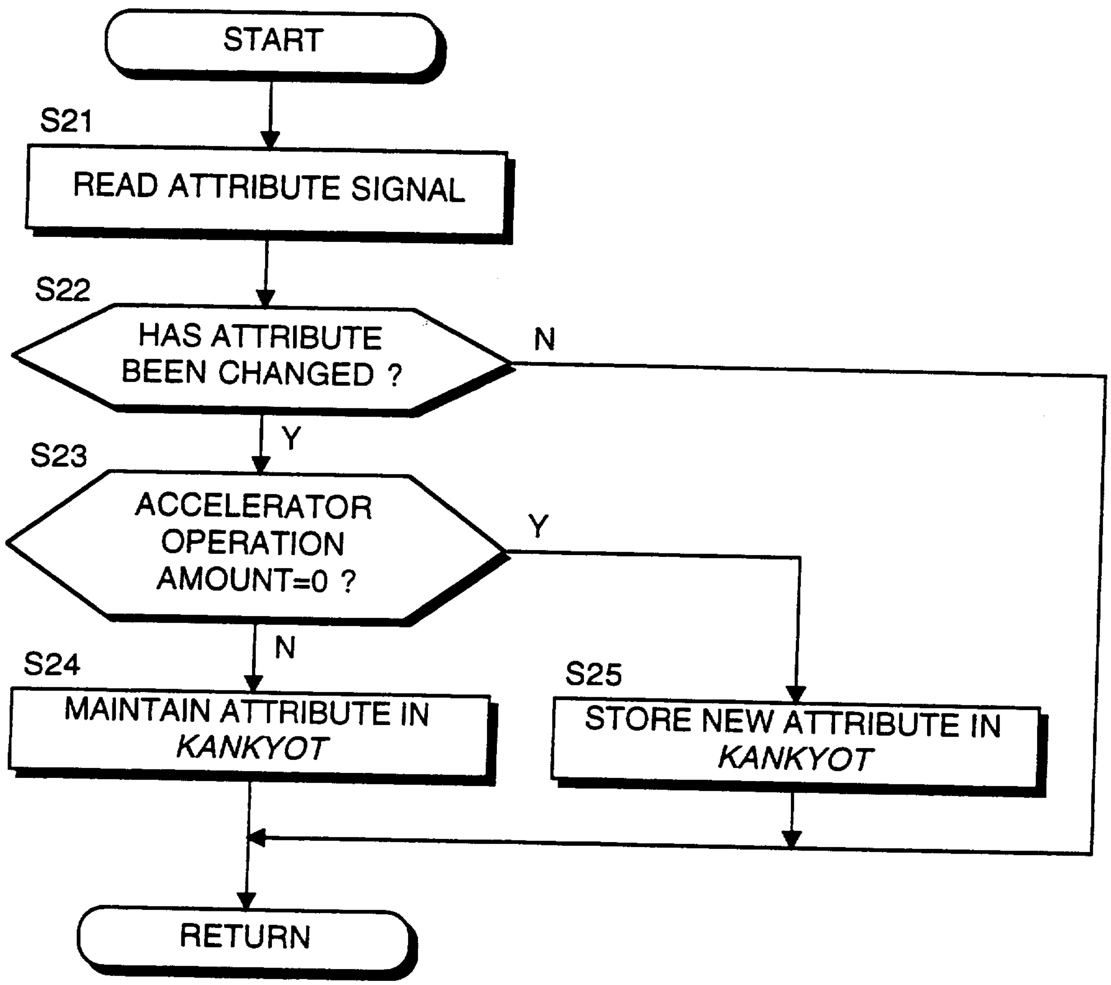

START
S21
READ ATTRIBUTE SIGNAL
S22
HAS ATTRIBUTE BEEN CHANGED ?
N
Y
S23
ACCELERATOR OPERATION AMOUNT=0 ?
Y
N
S24
MAINTAIN ATTRIBUTE IN *KANKYOT*
S25
STORE NEW ATTRIBUTE IN *KANKYOT*
RETURN

FIG. 5

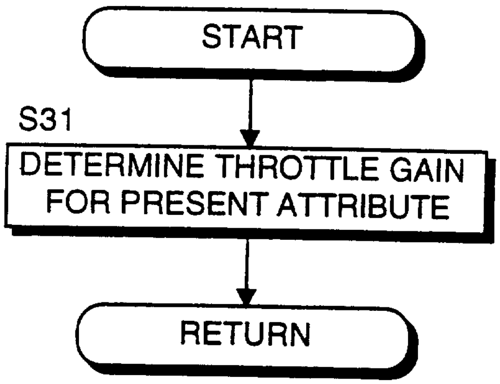


FIG. 6

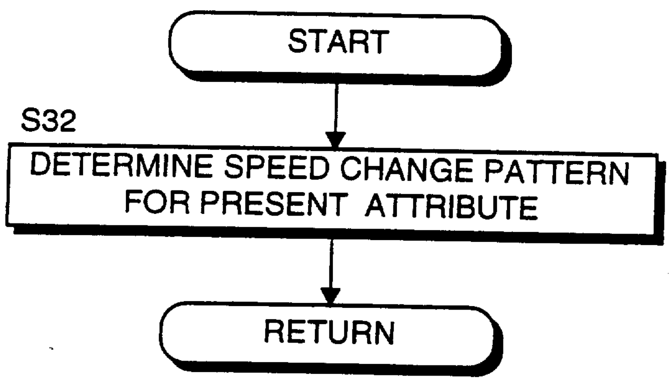


FIG. 9

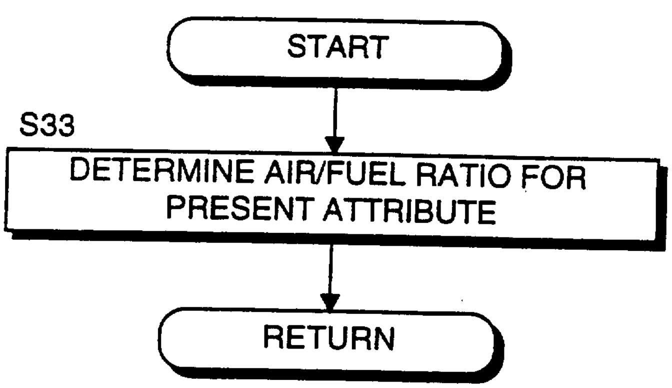


FIG. 12

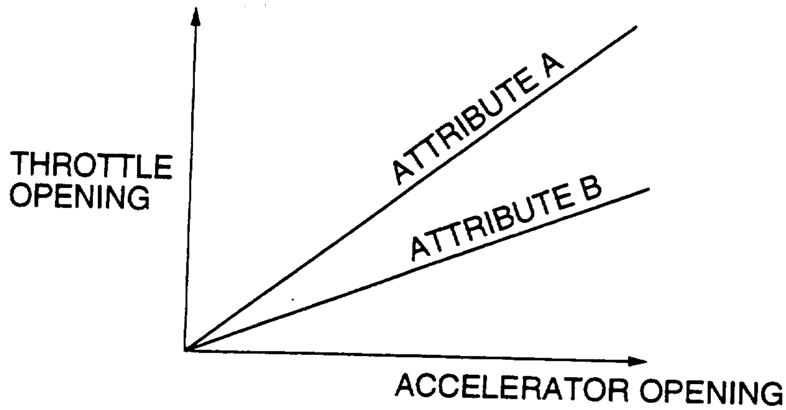

THROTTLE
OPENING
ATTRIBUTE A
ATTRIBUTE B
ACCELERATOR OPENING

FIG. 7

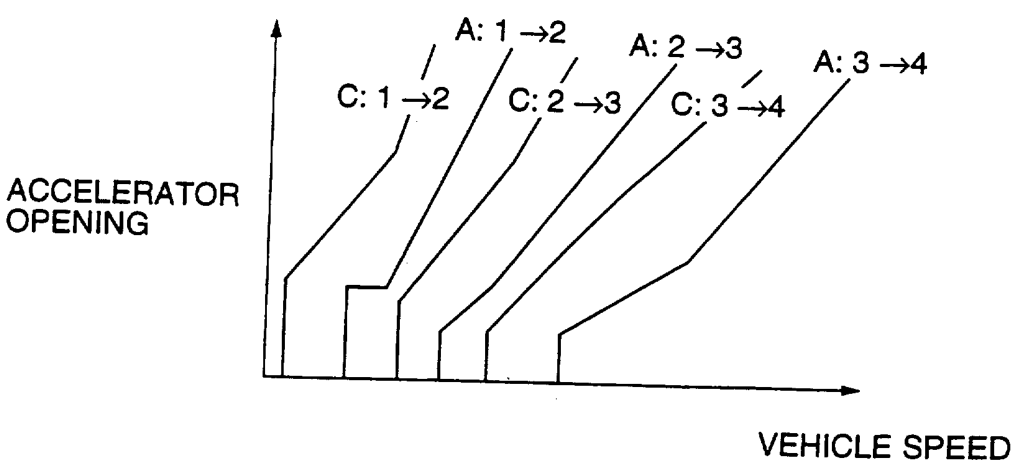

A: 1 →2
C: 1 →2
A: 2 →3
C: 2 →3
A: 3 →4
C: 3 →4
ACCELERATOR
OPENING
VEHICLE SPEED

FIG. 10

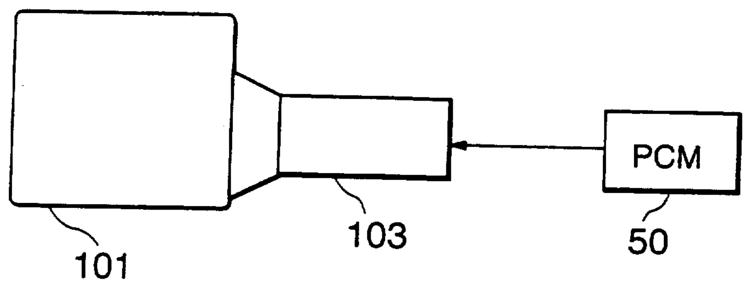


FIG.8

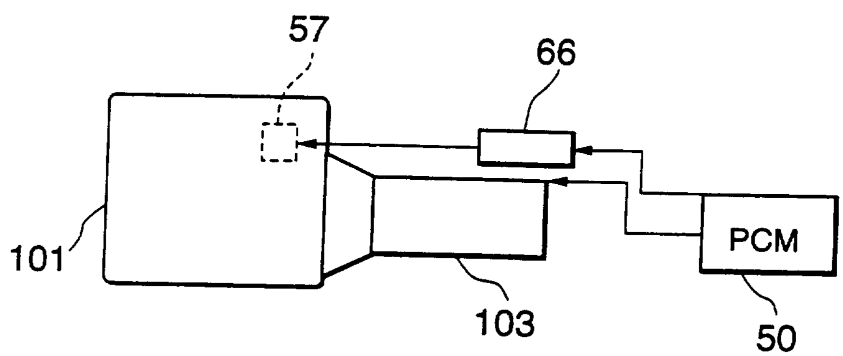


FIG.11

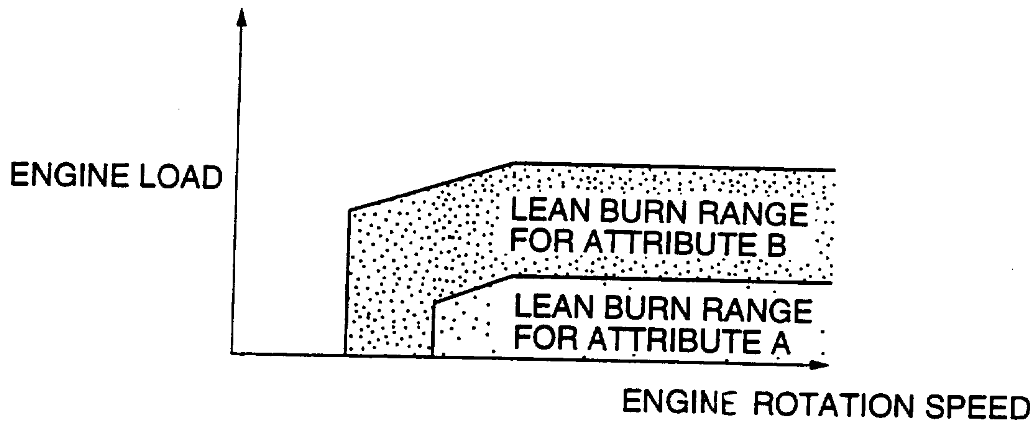

ENGINE LOAD
LEAN BURN RANGE
FOR ATTRIBUTE B
LEAN BURN RANGE
FOR ATTRIBUTE A
ENGINE ROTATION SPEED

FIG. 13

FIG. 14A

FIG. 14B

FIG. 14C

FIG. 14D

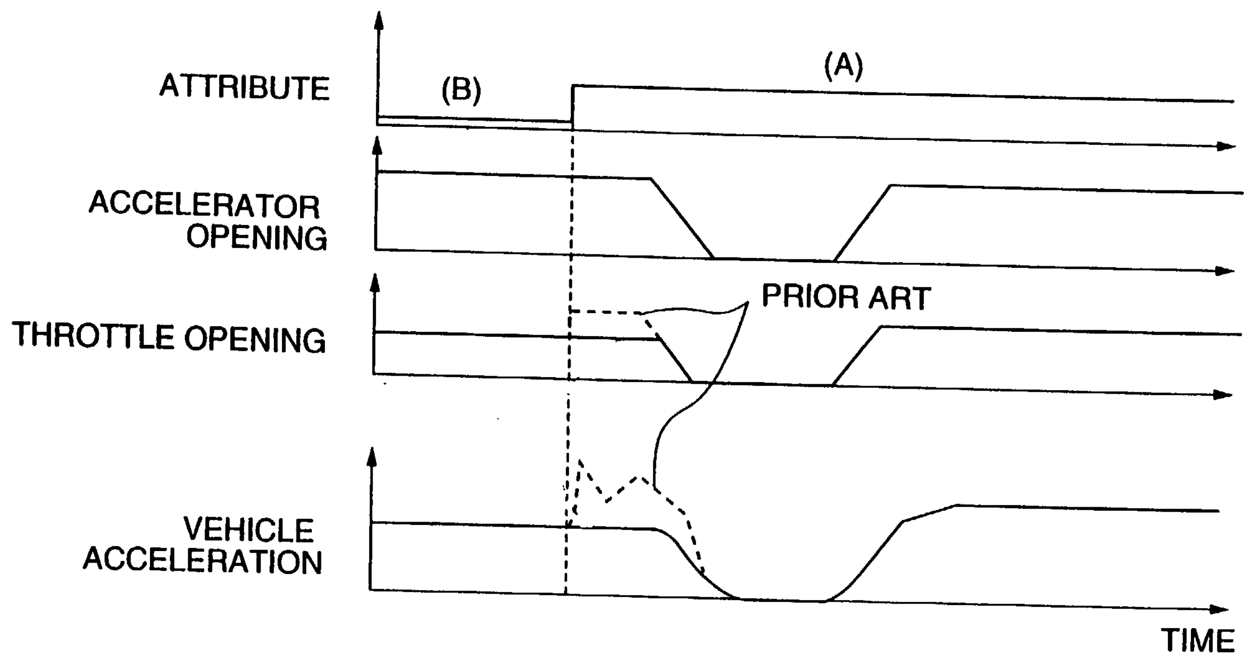


FIG. 15A
FIG. 15B
FIG. 15C
FIG. 15D

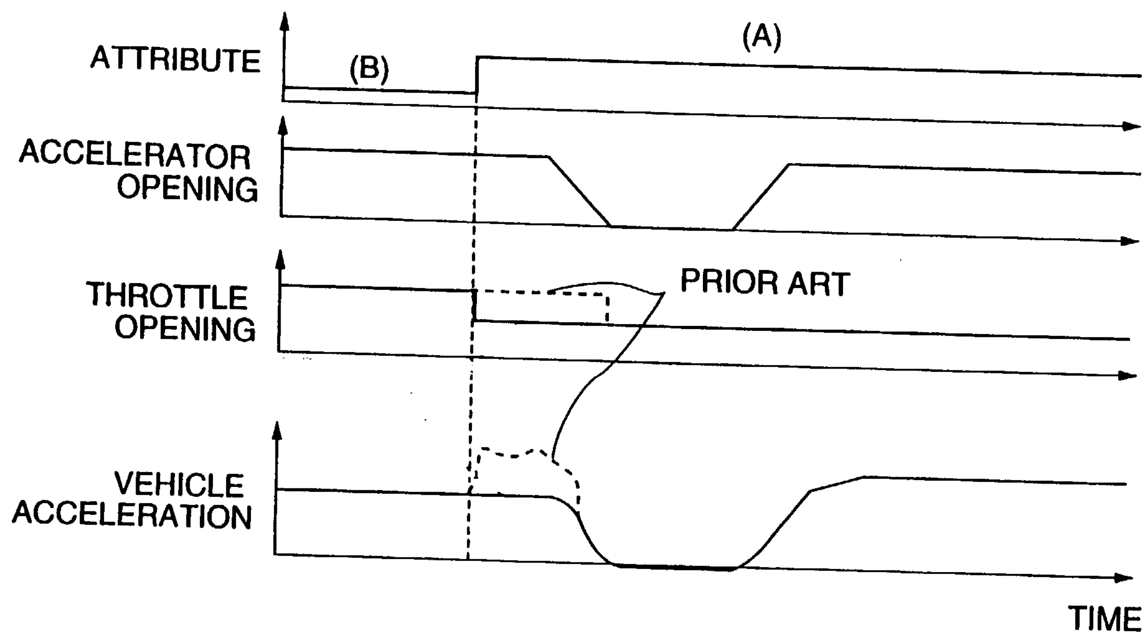
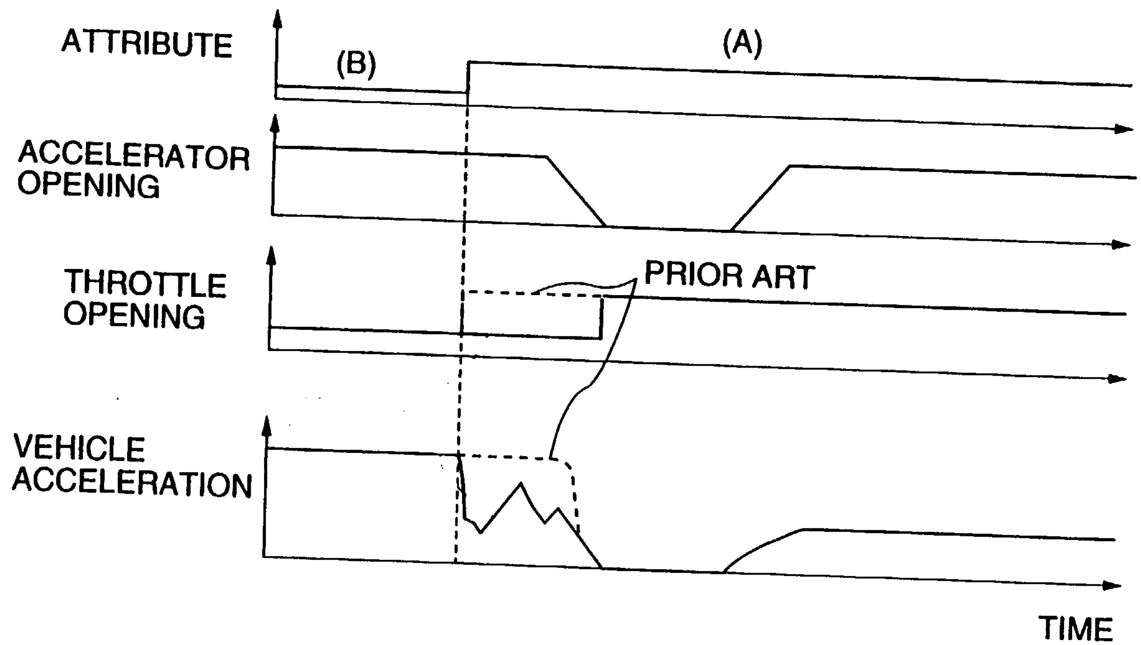


FIG. 16A
FIG. 16B
FIG. 16C
FIG. 16D



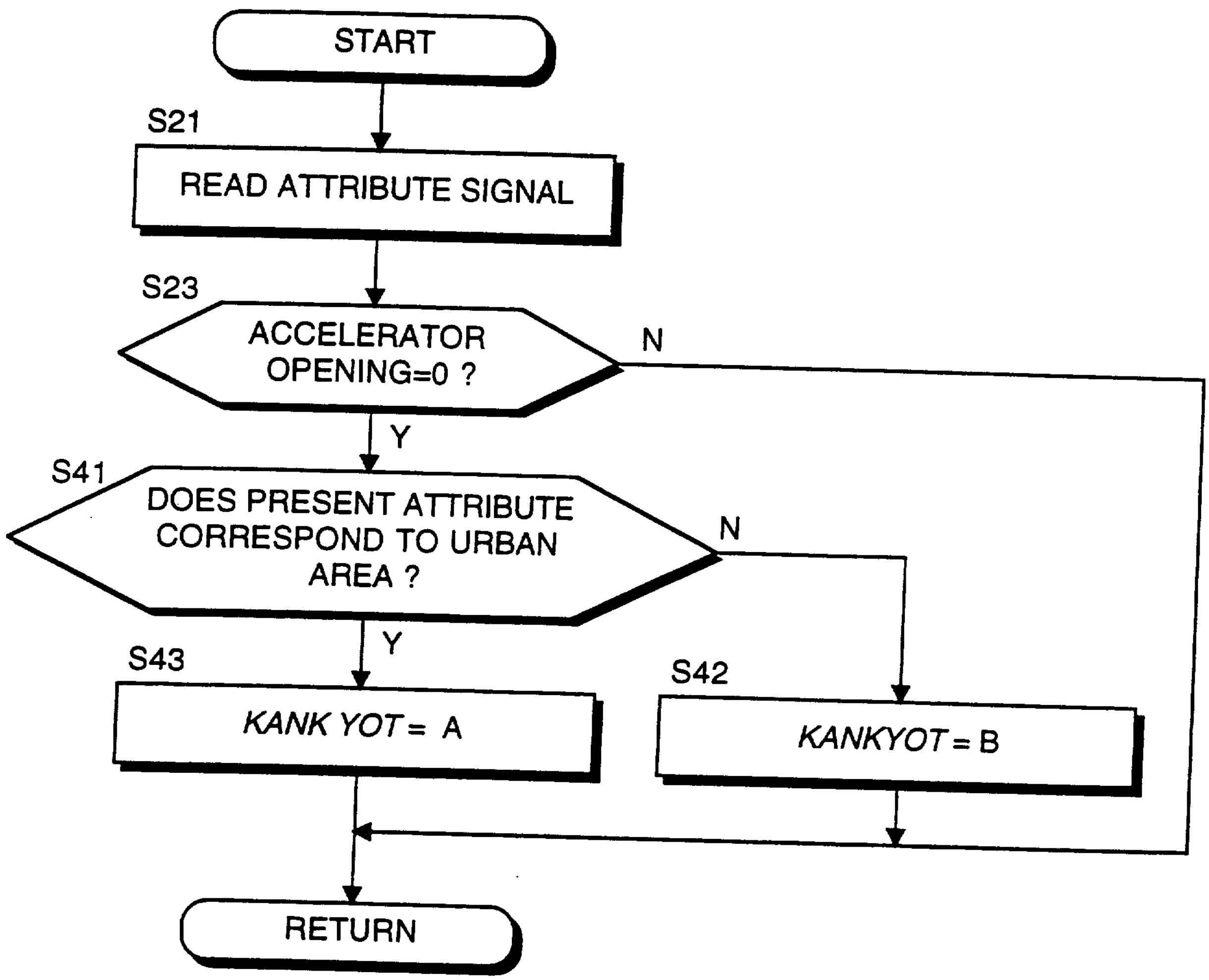

START
S21
READ ATTRIBUTE SIGNAL
S23
ACCELERATOR OPENING=0 ?
N
Y
S41
DOES PRESENT ATTRIBUTE CORRESPOND TO URBAN AREA ?
N
Y
S43
KANK YOT= A
S42
KANKYOT= B
RETURN

FIG. 17

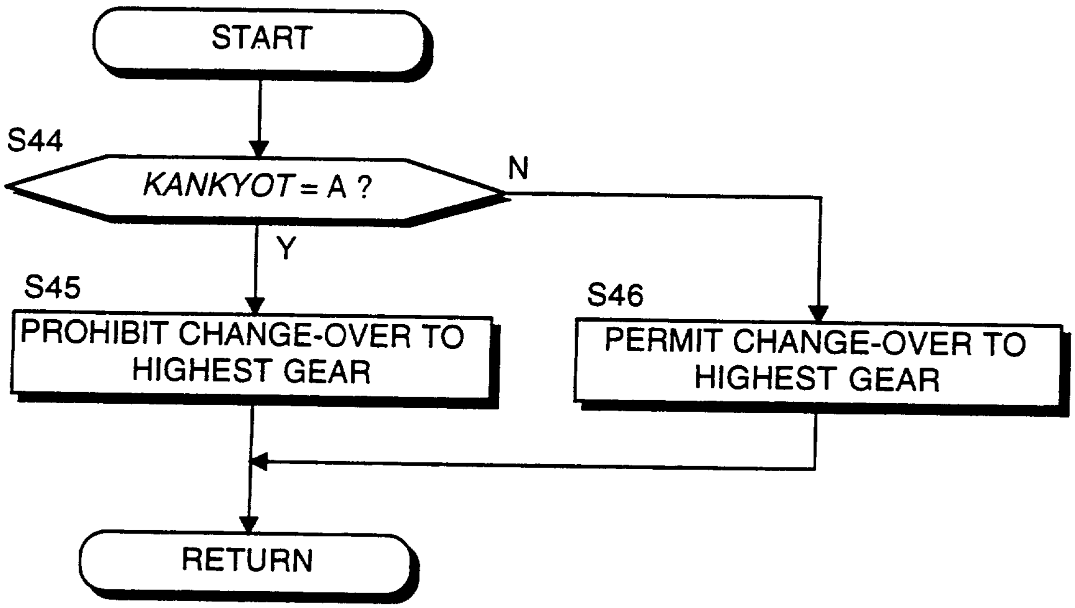

START
S44
KANKYOT = A ?
N
Y
S45
PROHIBIT CHANGE-OVER TO HIGHEST GEAR
S46
PERMIT CHANGE-OVER TO HIGHEST GEAR
RETURN

FIG. 18

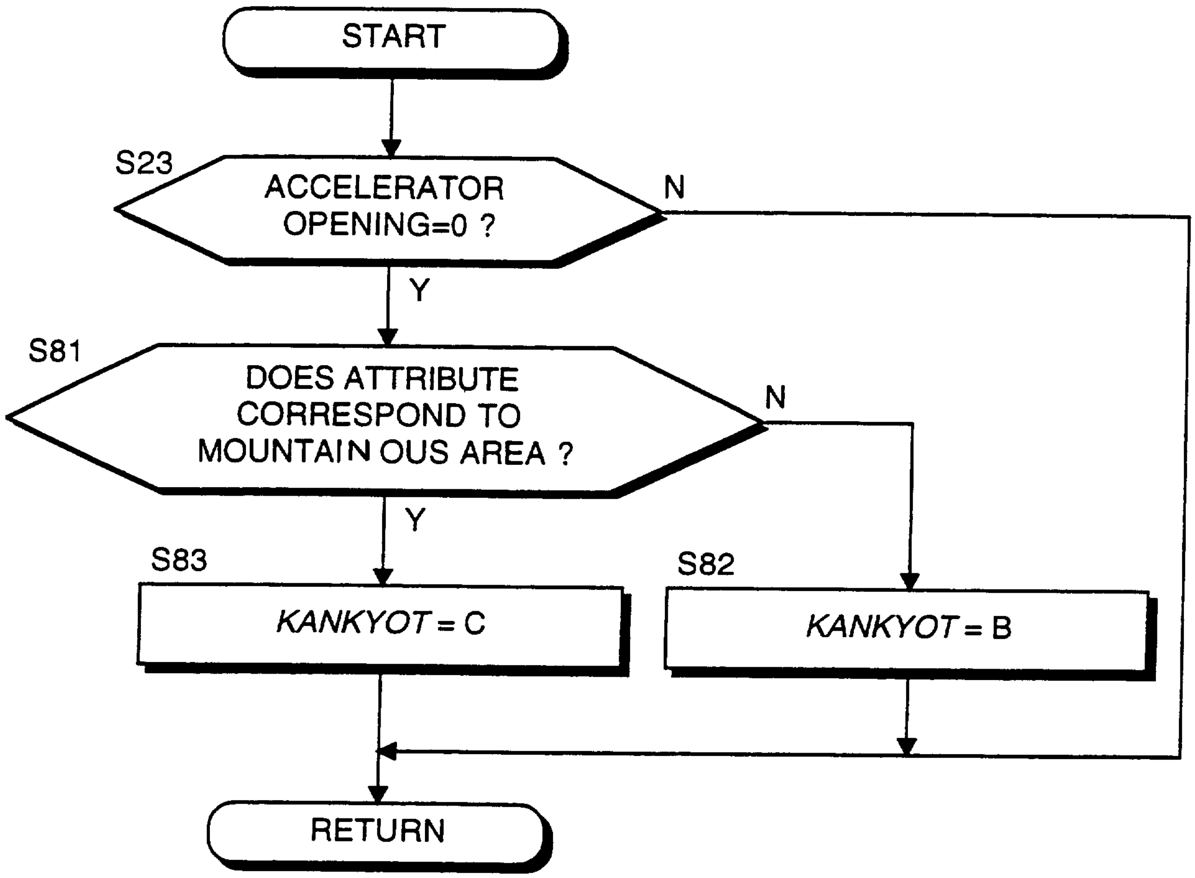

START
S23
ACCELERATOR OPENING=0 ?
N
Y
S81
DOES ATTRIBUTE CORRESPOND TO MOUNTAIN OUS AREA ?
N
Y
S83
KANKYOT = C
S82
KANKYOT = B
RETURN

FIG. 19

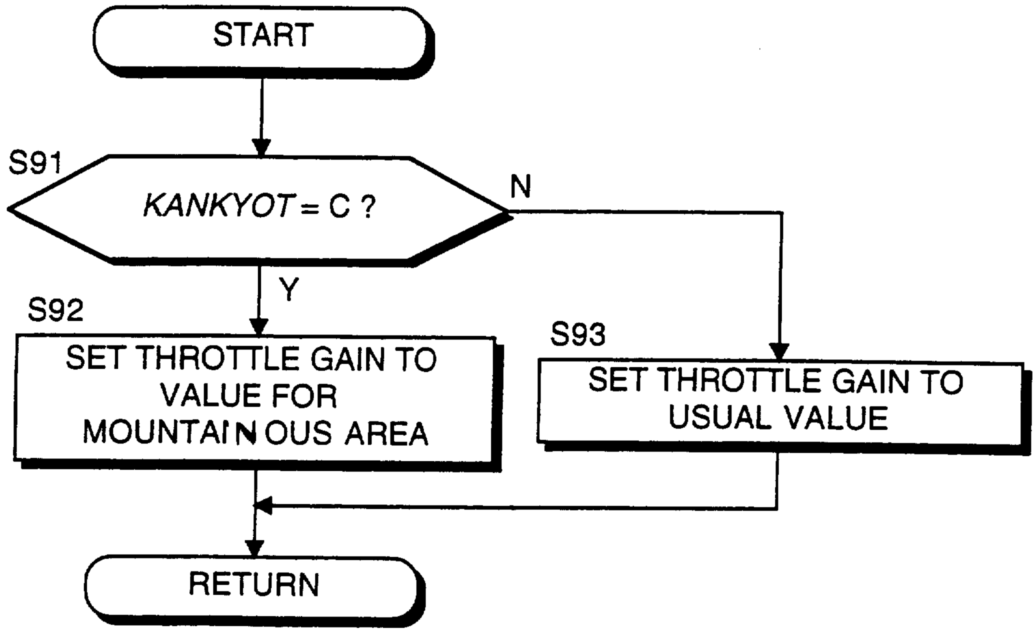

START
S91
KANKYOT = C ?
N
Y
S92
SET THROTTLE GAIN TO VALUE FOR MOUNTAINOUS AREA
S93
SET THROTTLE GAIN TO USUAL VALUE
RETURN

FIG. 20

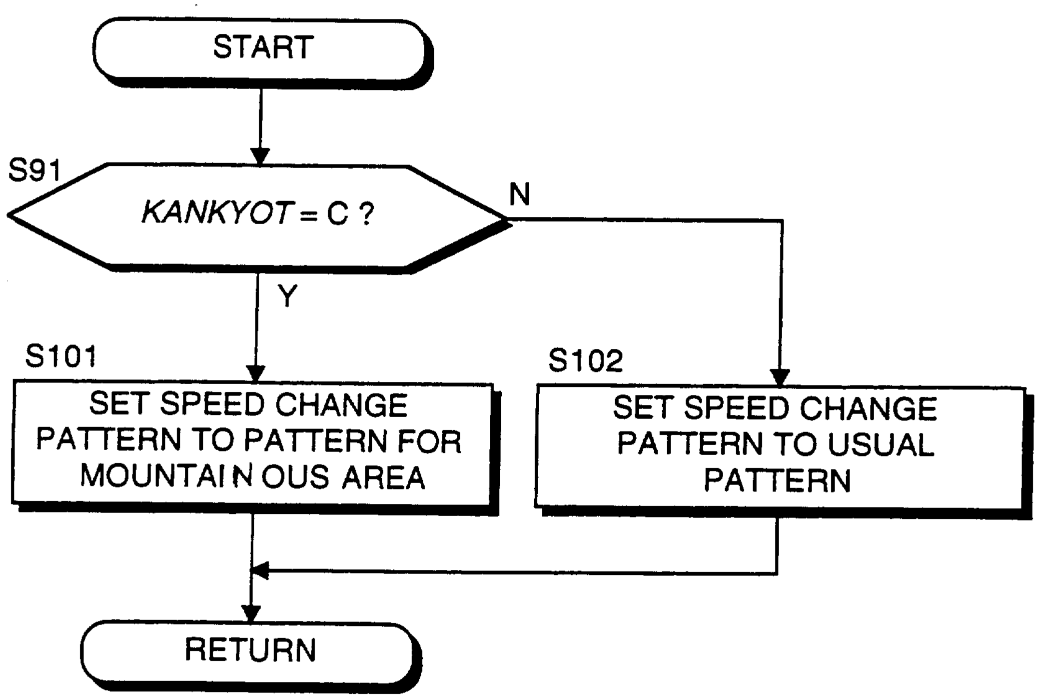

START
S91
KANKYOT = C ?
N
Y
S101
SET SPEED CHANGE PATTERN TO PATTERN FOR MOUNTAINOUS AREA
S102
SET SPEED CHANGE PATTERN TO USUAL PATTERN
RETURN

FIG. 22

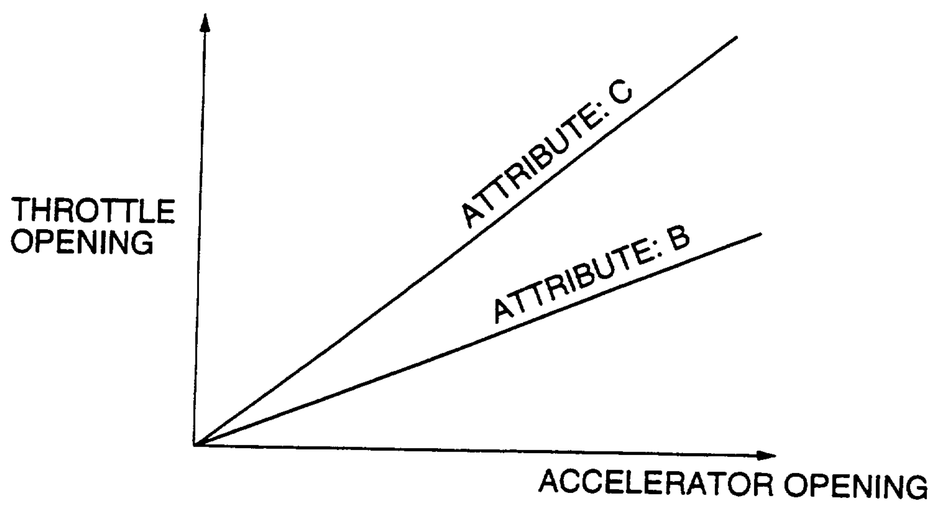

THROTTLE OPENING
ATTRIBUTE: C
ATTRIBUTE: B
ACCELERATOR OPENING

FIG. 21

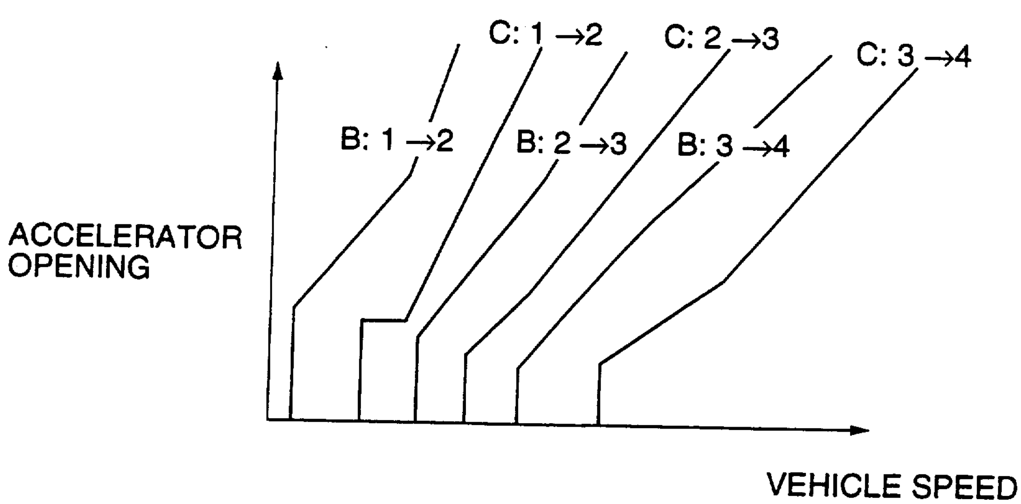

C: 1 →2
C: 2 →3
C: 3 →4
B: 1 →2
B: 2 →3
B: 3 →4
ACCELERATOR OPENING
VEHICLE SPEED

FIG. 23

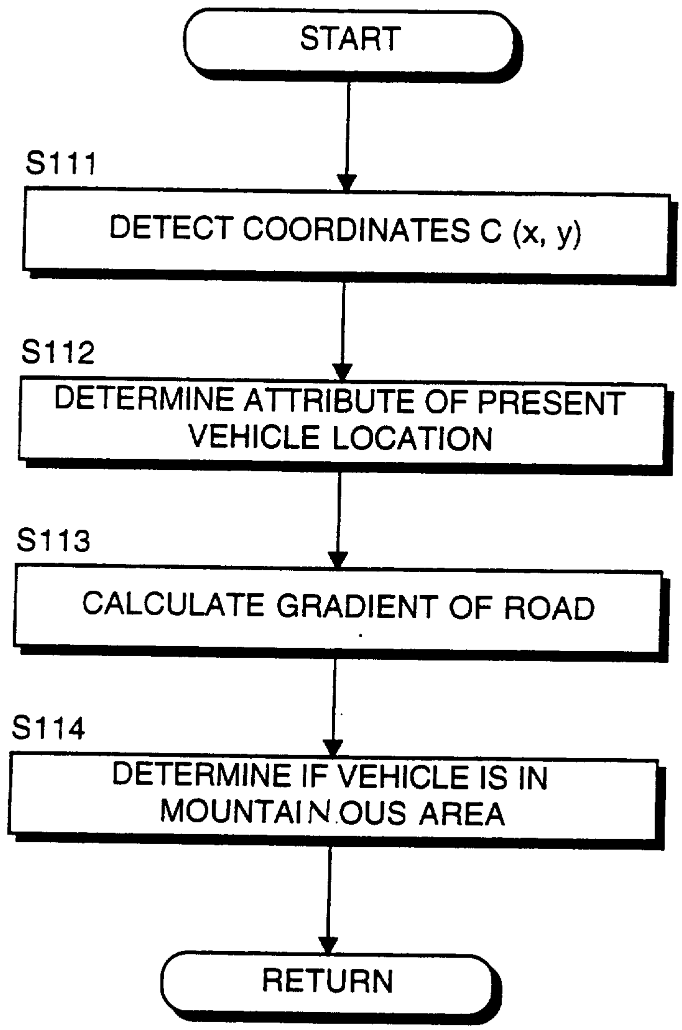

START
S111
DETECT COORDINATES C (x, y)
S112
DETERMINE ATTRIBUTE OF PRESENT VEHICLE LOCATION
S113
CALCULATE GRADIENT OF ROAD
S114
DETERMINE IF VEHICLE IS IN MOUNTAINOUS AREA
RETURN

FIG. 24

FIG. 25A

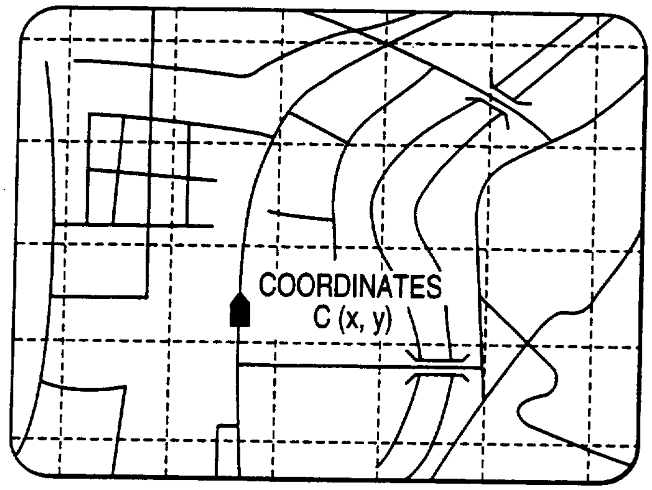
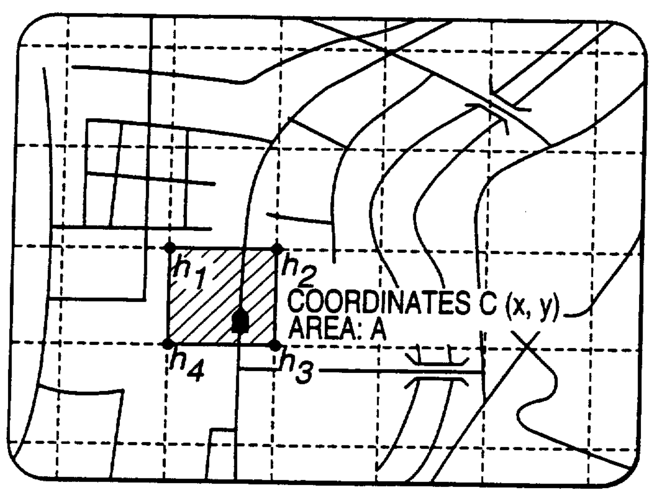


FIG. 25B



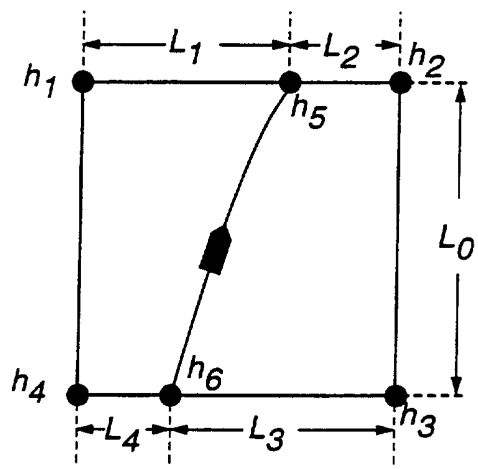


FIG. 26

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VEHICLE DRIVE FORCE CONTROLLER

This invention relates to the control of driving force of a vehicle, and in particular, to the control of driving force according to regional attributes of vehicle running conditions.

Examples of devices which vary the travel characteristics of a vehicle according to a driver operation amount comprise power steering systems which adjust a steering weight, an electronic control throttle of an engine of which a target opening can be varied according to an accelerator opening, an electronic control transmission which varies speed change characteristics, a traction control system which varies a traction of front and rear wheels, and a four-wheel steering system which varies the ratio of a rear wheel steering angle relative to a front wheel steering angle.

In these devices, the driver selects a preferred mode by suitably operating control switches provided in front of the driver's seat so as to manually vary travel characteristics according to road conditions, etc.

Due to diversification of travel preferences in recent years and to various kinds of innovation, these devices are diversifying so that the number of travel characteristics to be set is increasing, and as a result, the number of switches for setting travel characteristics is also continually increasing. It is very complicated for a driver to manipulate all these control switches, and as it is also difficult to operate control switches while vehicle is traveling, it often occurred that the superior functions of travel characteristic modifying devices were not fully utilized.

In order to avoid such a complication, a drive force controller which automatically controls an engine output of a vehicle according to road conditions obtained from a navigation device using a global positioning system (GPS) is disclosed , for example, in Tokkai Hei 5-180023 published by the Japanese Patent Office in 1993.

In this device, when for example the navigation detects that the vehicle is traveling along a narrow road or winding road, the engine output is decreased accordingly.

However, if the drive force characteristics change according to the road conditions, the drive force of the vehicle may change abruptly and the speed will suddenly decrease or increase , even if the driver maintains a constant accelerator pedal depression amount.

When the vehicle is traveling in an urban area, the travel speed is relatively low, but a quick response is often necessary. In this case, the drive force may be insufficient due to decrease of engine output.

When road conditions improve, the drive force increases even in a traffic jam, but increase of drive force in a traffic jam actually makes driving more difficult.

Also, under conditions when a large drive force is required even if there are bends such as on a mountain road, decreasing the drive force leads to inadequate hill climbing ability.

Conditions such as these make the driver uncomfortable, and contribute to making driving more difficult.

It would therefore be desirable to be able to adjust vehicle drive force characteristics not only to road conditions or regional attributes during travel, but also to various running conditions of the vehicle.

The present invention provides a vehicle drive force controller wherein at least one drive force characteristic of a vehicle is modified according to a regional attribute of a region in which the vehicle is traveling, comprising:

a navigation device comprising a global positioning system for detecting the present position of the vehicle, and a memory for storing altitude data for an area surrounding the present position;

a microprocessor programmed to:

calculate a slope of a road on which the vehicle is traveling from the altitude data for the area surrounding the present position,

select a drive force characteristic for a mountainous area when the slope is equal to or greater than a predetermined value, and

select a drive force characteristic different from those for a mountainous area when the slope is less than the predetermined value; and

a drive force control device for controlling the drive force of the vehicle according to the drive force characteristic selected by the microprocessor.

It is preferable that the drive force control device comprises an electronic throttle for varying an engine output at a predetermined throttle gain relative to an accelerator operation amount, the drive force characteristic comprises the throttle gain, and the microprocessor is programmed to select a throttle gain set such that an opening of the electronic throttle is larger when the slope is equal to or greater than a predetermined value than when the slope is less than the predetermined value.

It is also preferable that the drive force control device comprises an automatic transmission for transmitting an engine rotation according to a predetermined speed change pattern, the drive force characteristic comprises the speed change pattern, and the microprocessor is programmed to select a speed change set so that a lower gear is applied when the slope is equal to or greater than a predetermined value than when the slope is less than the predetermined value.

The details as well as other features and advantages of this invention are set forth in the remainder of the specification and are shown in the accompanying drawings, in which:

Fig. 1 is a schematic diagram of a drive force controller;

Fig. 2 is a flowchart explaining a change-over process of drive force characteristics performed by the drive force controller;

Fig. 3 is a flowchart explaining a regional attribute determining process performed by the drive force controller;

Figs. 4A and 4B are schematic representations of a monitor display of a navigation device;

Fig. 5 is a flowchart describing a regional attribute change-over process performed by the drive force controller.

Fig. 6 is a flowchart explaining a throttle gain setting process performed by the drive force controller.

Fig. 7 is a graph showing throttle gain characteristics set by the drive force controller.

Fig. 8 is a schematic diagram of the essential parts of a drive force controller according to a second embodiment.

Fig. 9 is a flowchart explaining a speed change pattern setting process according to the second embodiment.

Fig. 10 is a diagram showing a speed change pattern according to the second embodiment.

Fig. 11 is a schematic diagram of the essential parts of a drive force controller according to a third embodiment.

Fig. 12 is a flowchart describing a target air-fuel ratio setting process according to the third embodiment.

Fig. 13 is diagram describing a difference of lean burn region characteristics according to the third embodiment.

Figs. 14A - 14D are timing charts describing changes of an accelerator operation amount, throttle opening and vehicle acceleration when there is a change of regional attribute according to the first embodiment.

Figs. 15A - 15D are timing charts describing changes of an accelerator operation amount, gear position and vehicle acceleration when there is a change of regional attribute according to the second embodiment.

Figs. 16A - 16D are timing charts describing changes of an accelerator operation amount, target air-fuel ratio and vehicle acceleration when there is a change of regional attribute according to the third embodiment

Fig. 17 is a flowchart describing a regional attribute change-over process according to a fourth embodiment.

Fig. 18 is a flowchart explaining a speed change characteristic change-over process according to the fourth embodiment.

Fig. 19 is a flowchart describing a regional attribute change-over process according to a fifth embodiment.

Fig. 20 is a flowchart describing a throttle gain setting process according to the fifth embodiment.

Fig. 21 is a graph showing throttle gain characteristics according to the fifth embodiment.

Fig. 22 is a flowchart describing a speed change pattern setting process according to a sixth embodiment.

Fig. 23 is a diagram showing a speed change pattern according to the sixth embodiment.

Fig. 24 is a flowchart describing a regional attribute determining process according to an embodiment of this invention.

Figs. 25 A and 25 B are schematic representations of a monitor display of a navigation device describing a road gradient calculating method.

Fig. 26 is a diagram illustrating the calculation details of a road gradient.

Referring to Fig. 1 of the drawings, an output of an engine 101 of a vehicle is transmitted to drive wheels via an automatic transmission 103 comprising a torque converter.

An electronic control throttle 102 that it is opened and closed by a motor or the like, is installed in an intake passage of the engine 101. An intake air volume of the engine 101 varies according to an opening of the electronic control throttle 102, and the output torque of the engine 101 varies accordingly. The electronic control throttle 102 operates according to a control signal from a throttle control module (abbreviated hereafter as TCM) 51.

An opening command signal commanding an opening of the electronic control throttle 102 is output from a power train control module (abbreviated hereafter as PCM) 50 to the TCM 51. The TCM 51 converts this opening command signal to a motor drive voltage, and feedback controls the electronic control throttle 102 so that the opening of the throttle valve 102 coincides with the opening command signal from the PCM 50.

An accelerator pedal operation amount from an accelerator pedal operation amount sensor 105, a brake operation signal from a brake operation switch 106, and a select range signal from a range selection lever 107 of an automatic transmission 103 are input to the PCM 50. Based on these input signals, the PCM50 performs control of a fuel supply to the engine 101, control of the ignition timing of the engine 101, gear position control or oil pressure control of the automatic transmission 103, and control of wheel brake hydraulic pressure of a brake actuator 104.

A camera 111 for photographing the situation in front of the vehicle is disposed above the windshield of the vehicle. An image photographed by the camera 111 is input to an image processing unit 53, and information such as road conditions in front of the vehicle, traffic and obstacles, etc., is transmitted to an external environment information processing module 52.

A GPS antenna 113 for receiving output signals from satellites for a global positioning system (GPS), is disposed at the rear of the vehicle.

A signal from the GPS antenna 113 is input to a position information processing module 54. The position information processing module 54 comprises GPS receiver which converts signals from the GPS antenna 113 into information, and a recording medium such as a CD-ROM for storing map information into which regional attributes or the like are previously built in. Based on this map information and a signal from the GPS antenna 113, the position information processing module 54 detects a current position of a vehicle on a map. This detection result is transmitted to the external environment information processing module 52. The current position is also indicated together with the map on a monitor 112 in front of the driver's seat.

Based on a signal input from the image processing unit 53 and position information processing module 54, the external environment information processing module 52 transmits a signal representing the current environment of the vehicle to the PCM 50. The PCM 50 receives this signal, and controls the output of engine 101 or speed change of the automatic transmission 103 accordingly.

The PCM 50 also outputs information such as torque information from the engine 101, gear position information from the automatic transmission 103, a signal from the accelerator pedal operation amount sensor 105 and a signal from the brake operation switch 106 to the external environment information processing module 52. The external environment information processing module 52 uses this information for enhancing the determining precision of the external environment, or evaluating the psychological state of the driver.

Of the above processes, the drive force control process will now be described referring to Figs. 2, 3 and 5.

The flowchart of Fig. 2 describes an overall flow of the drive force control.

This process is executed at an interval of, for example, ten milliseconds.

At first in a step S1, the position information processing module 54 determines an attribute of the region where the vehicle is currently traveling. For example, as shown in Fig. 4B, regional attributes are classified as attribute A (urban areas), attribute B (ordinary traveling conditions) and attribute C (mountainous ground), and this classification is previously stored as part of the map data on the storage medium in the position information processing module 54.

This regional attribute determination is performed by a subroutine of Fig. 3.

First, in a step S11, the position information processing module 54 detects position coordinates C(x,y) of the vehicle on a map based on the signal from the GPS antenna 113. Based on these coordinates, the road on which the vehicle is running is detected, as shown in Fig. 4A.

In a step S12, by comparing with the map data stored on the recording medium, the position information processing module 54 determines which attribute the position coordinates C(x,y) belong to of the regional attributes mentioned above (urban areas, non-urban areas, etc.).

For example, when the coordinates C(x,y) correspond to a position shown in Figs. 4A and 4B, it is determined that they belong to attribute B (ordinary traveling conditions).

The determination result is transmitted to the external environment processing module 52 from the position information processing module 54.

In a step S13, the external environment information processing module 52 transmits a signal showing the regional attribute to the PCM 50, and the subroutine is terminated.

After the processing of the step S1 is terminated in this way, in a step S2, the PCM 50 performs regional attribute change-over processing. This processing is performed according to a subroutine shown in Fig. 5.

First referring to Fig. 5, in a step S21, the PCM 50 reads a regional attribute signal input from the external environment information processing module 52.

In a step S22, it is determined whether or not the regional attribute input in the step S1 is identical to the regional attribute input on the immediately preceding occasion when the process was executed. For this purpose, the PCM 50 comprises a memory *KANKYOT* for storing that regional attributes. When the regional attribute is the same, the process is terminated. In this case, the regional attribute stored in *KANKYOT* is not modified. When the regional attribute is not the same, the routine proceeds to a step S23.

In a step S23, based on the input signal from the accelerator pedal operation amount sensor 105, it is determined whether or not the accelerator operation amount is zero. When the accelerator operation amount is zero, the routine proceeds to a step S25, and when the accelerator operation amount is not zero, the routine proceeds to a step S24.

In the step S24, the regional attribute stored in the memory *KANKYOT* on the immediately preceding occasion when the routine was executed is maintained, and the process is terminated.

In the step S25, the stored contents of the memory *KANKYOT* are updated by the regional attribute input in the step S21 and the process is terminated.

Hence, after the processing of the step 2 of Fig. 3 is complete, in the next step S3, the PCM 50 issues a vehicle drive force change-over command, based on the stored contents of the memory *KANKYOT*, for changing the drive force control process that is being executed in the background.

As is clear from the above process, in this vehicle drive force controller, even when the regional attribute changes and an accelerator operation is performed, the regional attribute in the process that was executed on the immediately preceding occasion is applied, and therefore, there is no abrupt change of drive force and sudden vehicle speed change contrary to the driver's intentions during accelerator operation. Further, when the driver is aware of a change of regional attribute from the display on the monitor 112, he can change the drive force characteristics of the vehicle to a new regional attribute by returning the accelerator operation amount to zero. In other words, change-over of drive force characteristics is performed with a timing in accordance with the driver's intentions.

Next, referring to Figs. 6, 7, 14A - 14D, the change-over of drive force characteristics performed by the PCM 50 will be explained. Fig. 6 shows a drive force characteristic change-over process due to a change of throttle gain. Drive force control is itself executed in the background, but as a vehicle drive force change-over command is issued every 10 milliseconds as described hereabove, this change-over process is also executed at an interval of 10 milliseconds. In a step S31, the PCM 50 changes a magnification *TVOG* of the throttle opening signal relative to the signal from the accelerator operation amount sensor 105 according to the regional attribute information stored in the memory *KANKYOT* described above. For example, as shown in Fig. 7, the magnification *TVOG* is set larger for the attribute A corresponding to urban areas than for the attribute B corresponding to non-urban areas.

Due to this, the change of engine output torque relative to change of throttle opening is made large when the vehicle is traveling in an urban region. As a result, a good driving response is obtained when accelerating and decelerating in urban regions. For example, a desirable mobility is obtained for evading people or cars which jump out from side roads.

The result of the above-mentioned control is shown by the timing charts of Figs. 14A - 14D. In these figures,

the broken line corresponds to the aforesaid prior art example.

When the regional attribute is changed in the prior art example, the magnification *TVOG* is changed regardless of accelerator operation. When the magnification *TVOG* is varied in the increase direction, the vehicle speed increases, and as the acceleration *G* of the vehicle varies largely contrary to the driver's intentions, the driver tended to experience discomfort.

On the other hand, a change of the magnification *TVOG* is not performed until the accelerator operation amount is 0. Due to this arrangement the change-over of drive force is performed according to the driver's intention.

Figs. 7 - 9, 15A - 15D show a second embodiment relating to drive force characteristics change-over processing. According to this embodiment, the PCM 50 controls drive force by modifying the speed change pattern of the automatic transmission 103, instead of by control of throttle gain as in the first embodiment.

For this purpose, the process shown in Fig. 9 is used instead of the process shown in Fig. 6 for changing over drive force characteristics which is performed by the PCM 50 in the background. In a step S32 of Fig. 9, a speed change pattern is applied according to a regional attribute stored in the memory *KANKYOT*. A speed change ratio of the automatic transmission 103 is changed by a change-over signal output by the PCM 50 according to the accelerator opening and traveling speed. The speed change pattern that specified this change-over timing according to the accelerator opening and traveling speed, is previously stored in the PCM50. According to this embodiment, two kinds of pattern are stored, i.e. a pattern for attribute A corresponding to an urban region, and a pattern for attribute C corresponding to a mountainous region, as shown in Fig. 10. Compared to the pattern for attribute A, the pattern for attribute C is set so that a lower gear is used for the same vehicle speed and the same accelerator opening. Due to this, in the attribute C region, more drive force is available for each gear than in the attribute A region, and drive force characteristics suited to climbing up hills are obtained. The result of control according to the second embodiment is shown in Figs. 15A - 15D. The solid line in the figures corresponds to this embodiment, and the broken line is equivalent to the aforesaid prior art example.

According to the prior art, when the regional attribute was changed, the speed change pattern was changed regardless of accelerator operation. When for example, a gear shift down was performed, the acceleration *G* of the vehicle changed although the accelerator operation amount did not change, and the driver experienced a sense of discomfort. According to the second embodiment, however, the speed change pattern is not changed until the accelerator operation amount is 0.

Due to this arrangement, the change-over of drive force characteristics takes place in accordance with the driver's intentions.

Figs. 11 - 13, 16A - 16D show a third embodiment relating to change-over of drive force characteristics. In this case, the PCM 50 controls drive force by changing the target air-fuel ratio of the engine 101 instead of changing the throttle gain or the speed change pattern. The engine 101 comprises a fuel injection valve 57 and a fuel injection control unit 56 which controls an injection amount and an injection timing of the valve 57, as shown in Fig. 11. In this engine 101, lean burn is performed according to the running conditions.

In a step of Fig. 12, the PCM 50 varies the target air-fuel ratio according to the regional attribute, and the modified target air-fuel ratio is transmitted to the fuel injection control unit 56. The fuel injection control unit 56 feedback controls the fuel injection amount of the fuel injection valve 57 so as to obtain the received target air-fuel ratio.

For example, as shown in Fig. 13, the target air-fuel ratio is changed so that the lean burn region is wider for regional attribute B designating a non-urban region than for regional attribute A designating an urban region. As a result, the fuel consumption rate becomes less when the vehicle is traveling in non-urban areas whereas high driving mobility is obtained due to sufficient fuel supply in urban regions.

The result of control according to the third embodiment is shown by the timing charts of Figs. 16A - 16D. The solid line in the figures corresponds to this embodiment, and the broken line corresponds to the aforesaid prior art example.

According to the prior art, when the regional attribute was changed, the target air-fuel ratio changed regardless of accelerator operation. When the target air-fuel ratio was varied towards rich, the vehicle speed increased, and as the acceleration *G* of the vehicle varies largely contrary to the driver's intentions, the driver tended to experience discomfort.

On the other hand, according to the third embodiment a change of target air-fuel ratio is not performed until the accelerator operation amount is 0. Due to this arrangement, the change-over of drive force is performed according to the driver's intention.

In the aforesaid embodiments, the determination of regional attribute in the step S1 of the main routine is performed by the position processing module 54. Change-over of regional attribute of the step S2, change-over of drive force characteristics of the step S3, and the drive force control performed in the background, are performed by the PCM 50. These processes may however be performed by one control unit.

Figs. 17 and 18 show a fourth embodiment.

According to this embodiment, as in the case of the first embodiment, the processes of Fig. 2 and Fig. 3 are executed, but a process shown in Fig. 17 is applied to a subroutine for changing over the regional attribute performed in the step S2 of the first embodiment. Drive force is also controlled via the automatic transmission 103 as in the case of the second embodiment. A process shown in Fig. 18 is applied to change-over of drive force characteristics performed by the PCM 50 in the background.

Steps S21 and S23 of Fig. 17 are the same as in the flowchart of Fig. 5 of the first embodiment. In a step S41 following the step S23, it is determined whether or not a regional attribute signal indicates an urban area. For urban areas, the attribute A is stored in the memory *KANKYOT* in a step S43, and in other cases, the attribute B is stored in the memory *KANKYOT* in the step S42.

First, in a step S44 of the process of Fig. 18, it is determined whether or not the attribute A is stored in the memory *KANKYOT*. When the attribute A is stored in *KANKYOT*, a change-over to the highest gear of the automatic transmission 103 is prohibited in a step S45. When the attribute A is not stored in *KANKYOT*, a change-over to the highest gear of the automatic transmission is permitted in the step S46.

Due to the above process, the highest stage gear is not used when the vehicle is traveling in an urban area, and good driving response is therefore obtained.

As in the case of the aforesaid second embodiment, the speed change pattern may be changed instead of prohibiting change-over to the highest gear.

Figs. 19 - 21 show a fifth embodiment.

According to this embodiment, it is determined whether or not the regional attribute corresponds to mountainous ground, and when the vehicle is traveling on mountainous ground, the drive force is increased.

The hardware construction, main routine and regional attribute determining process are the same as those of the first embodiment.

Fig. 19 shows a regional attribute change-over process performed instead of the process of Fig. 5 of the first embodiment.

First, in the step S23, it is determined whether or not the accelerator operation amount is 0.

When the accelerator operation amount is 0, the routine proceeds to a following step S81, and when the accelerator operation amount is not 0, the process is terminated. This is in order to prevent the drive force from changing abruptly, thereby giving a sense of discomfort to the driver, when the accelerator operation amount is not 0.

In the step S81, it is determined whether or not the vehicle is traveling on mountainous ground. This determining process is the same as the process shown in Fig. 3 of the aforesaid first embodiment.

When it is determined that the vehicle is traveling on mountainous ground, the routine proceeds to a step S83, and when it is determined that the vehicle is traveling in a region other than mountainous ground, the routine proceeds to a step S82.

In the step S82, the regional attribute stored in the memory *KANKYOT* is set to, e.g. attribute B showing that the vehicle is traveling in a region other than mountainous ground, and the process is terminated.

In the step S83, the regional attribute stored in the memory *KANKYOT* is set to, e.g. attribute C indicating mountainous ground, and the process is terminated.

Fig. 20 shows the drive force change-over process performed by the PCM 50 in the background.

First, in a step S91, it is determined whether or not the regional attribute C is stored in the memory *KANKYOT*.

When the attribute C is stored, in a step S92, the throttle gain is set to a value for mountainous ground and the process is terminated. When another attribute, i.e. the attribute B is stored, the throttle gain is set to the usual value in a step S93, and the process is terminated.

The throttle gain set in this case is shown in Fig. 21. Compared to the usual throttle gain, the throttle gain for a mountainous region is set so that the throttle opening is larger for the same accelerator opening. In other words, the engine output responds sensitively to a small depression of the accelerator pedal. As a result, the vehicle is driven at high output on mountains ground, and sufficient drive force is obtained on a hill.

Figs, 22 and 23 show a sixth embodiment.

This embodiment differs from the fifth embodiment in that modification of drive force is performed not by setting the throttle gain, but by setting the speed change pattern. The remaining features of the construction are the same as those of the fifth embodiment.

According to this embodiment, the flowchart of Fig. 22 is applied instead of the flowchart of Fig. 20.

First, it is determined whether or not the attribute stored in the memory *KANKYOT* in the step S91 is the attribute C.

When the attribute C is stored, the speed change pattern is set to a pattern for mountainous ground in a step S101, and the process is terminated. When another attribute, i.e., the attribute B is stored, the speed change is set to the usual pattern in a step S102, and the process is terminated.

As shown in Fig. 23, compared to the usual pattern, the speed change pattern for mountainous ground is set so that a lower gear is used for the same vehicle speed and same accelerator opening. As a result, in mountainous terrain, more drive force is obtained for each gear, and suitable drive force characteristics are obtained when traveling up a hill.

Figs. 24 - 26 show an embodiment of this invention.

According to this embodiment, the current terrain is compared with a previously stored regional attribute, and instead of determining a regional attribute where the vehicle is currently traveling, a road slope is detected, and the determination is performed based on the road slope. The flowchart of Fig. 24 is therefore applied instead of the regional attribute determining process of Fig. 3.

First, in a step S111, position coordinates C(x,y) on the vehicle on a map are detected from the position information processing module 54 and a signal from the GPS antenna 113.

In a step S112, the area on the map in which the vehicle is located is determined from map data stored by the position information processing module 54. When the vehicle is located at the coordinates C(x,y) shown in Fig. 25A, for example, it is determined that the position of the vehicle is located in a region A shown in Fig. 25B.

In a step S113, the slope of the road on which the vehicle is traveling is calculated using previously stored altitude information for the points h1 - h4 at the four corners of the region A.

For example when the vehicle is traveling at a position shown in Fig. 26, if the point at which the travel direction of the vehicle intersects with a straight line linking the points h1, h2 is h5, and the point at which the vehicle path intersects with a straight line linking the points h3, h4 is h6, the slope of the road is expressed by the following equation (1).

$$k = \frac{h_5 - h_6}{L_0} \qquad (1)$$

where, $h_5 = \frac{L_1 \cdot h_2 + L_2 \cdot h_1}{L_1 + L_2}$

$h_6 = \frac{L_3 \cdot h_4 + L_4 \cdot h_3}{L_3 + L_4}$

L_0 = length of side of area A

L_1 = length of line joining h1, h5

L_2 = length of line joining h5, h2

L_3 = length of line joining h3, h6

L_4 = length of line joining h6, h4

In a step S114, the slope of the road calculated in this way is compared with a predetermined value, and when it is larger than the predetermined value, it is determined that the regional attribute is attribute C denoting mountainous terrain. The determination result is transmitted to the external environment processing module 52 from the position information processing module 54. The predetermined value is set to a smaller value than the average slope of the mountainous ground.

Attention is directed to our co-pending application No. 9724570.8 (Publication No. 2 319 635) from which the application has been divided and which claims A vehicle drive force controller wherein at least one drive force characteristic of a vehicle is modified according to a regional attribute of a region in which the vehicle is travelling, comprising:

a navigation device for detecting the regional attribute of the region in which the vehicle is travelling;

an accelerator operation amount sensor for detecting an operation amount of an accelerator operated by a driver;

a microprocessor programmed to:

determine whether or not the accelerator operation amount is zero, and

determine the drive force characteristic so that the drive force characteristic is modified according to a change of the regional attribute when the accelerator operation amount is zero, and that the drive force characteristic is not modified when the accelerator operation amount is not zero; and

a drive force control device for controlling the drive force of the vehicle according to the drive force characteristic determined by the microprocessor.

Attention is also directed to our co-pending application No. which has also been divided from application No. 9724570.8 and which claims A vehicle drive force controller wherein at least one drive force characteristic of a vehicle is modified according to a regional attribute of a region in which the vehicle is traveling, comprising:

a navigation device for determining whether or not the vehicle is traveling in a mountainous area;

a microprocessor programmed to determine the drive force characteristic depending on whether or not the vehicle is traveling in a mountainous area; and

a drive force control device for controlling the drive force of the vehicle according to the drive force characteristic determined by the microprocessor.

Claims:-

1. A vehicle drive force controller wherein at least one drive force characteristic of a vehicle is modified according to a regional attribute of a region in which the vehicle is traveling, comprising:

a navigation device comprising a global positioning system for detecting the present position of the vehicle, and a memory for storing altitude data for an area surrounding the present position;

a microprocessor programmed to:

calculate a slope of a road on which the vehicle is traveling from the altitude data for the area surrounding the present position,

select a drive force characteristic for a mountainous area when the slope is equal to or greater than a predetermined value, and

select a drive force characteristic different from those for a mountainous area when the slope is less than the predetermined value; and

a drive force control device for controlling the drive force of the vehicle according to the drive force characteristic selected by the microprocessor.

2. A drive force controller as defined in claim 1, wherein drive force control device comprises an electronic throttle for varying an engine output at a predetermined throttle gain relative to an accelerator operation amount, the drive force characteristic comprises the throttle gain, and the microprocessor is programmed to select a throttle gain set such that an opening of the electronic throttle is larger when the slope is equal to or greater than the predetermined value than when the slope is less than the predetermined value.

3. A drive force controller as defined in claim 1, wherein the drive force control device comprises an automatic transmission for transmitting an engine rotation according to a predetermined speed change pattern, the drive force characteristic comprises the speed change pattern, and the microprocessor is programmed to select a speed change pattern set so that a lower gear is

applied when the slope is equal to or greater than the predetermined value than when the slope is less than the predetermined value.

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Claims searched: All
Examiner: James Porter
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Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): G3N (NGA, NGA3, NGCA1, NGCA4, NGCA5, NGCA)

Int Cl (Ed.6): F02D 35/00, 45/00; F16H 59/60, 59/66, 61/02; G05D 1/02

Other: Online database: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X, E	EP0869300 A1	(EQUOS) See abstract, col.11 lines 10-20 and col.22 lines 22-43.	1 & 3
A	EP0738946 A1	(HONDA) In particular, see col.6 line 47 to col.7 line 12.	-

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