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## DISPLAYING CONTROL APPARATUS


### Abstract

A displaying control apparatus displays an economy level image indicating an economy level acquired based on a first evaluation value until an environmental parameter reaches an increase side threshold greater than a predetermined switching threshold when the environmental parameter changes from a value equal to or smaller than the predetermined switching threshold to a value greater than the predetermined switching threshold while executing a following moving control. The apparatus displays the economy level image indicating the economy level acquired based on a second evaluation value until the environmental parameter reaches a decrease side threshold smaller than the predetermined switching threshold when the environmental parameter changes from a value greater than the predetermined switching threshold to a value equal to or smaller than the predetermined switching threshold while executing the following moving control.



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## Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Japanese patent application No. JP 2024-017857 filed on Feb. 8, 2024, the content of which is hereby incorporated by reference in its entirety.

BACKGROUND

Field

[0002] The present invention relates to a displaying control apparatus.

Description of the Related Art

[0003] There is known a displaying control apparatus which displays an economy level image indicating an economy level (i.e. a level of a low energy consumption to move an own vehicle) on a meter display. There is also known a displaying control apparatus which switches the displayed economy level image between the economy level image for the relatively great economy level and the economy level image for the relatively small level which are different. In cases where such a displaying control apparatus is configured to determine that the economy level is relatively great when a detection data detected by sensors is equal to or smaller than a threshold value, and to determine that the economy level is relatively small when an inter-vehicle distance is greater than a threshold, when the detection data frequently increases and decreases across the threshold value, the economy level image is frequently switched, and there is a possibility that a driver of the own vehicle feels annoyed. As a technique for absorbing frequent increases and decreases in the detection data, it is known that the Kalman filter processing is applied to the detection data (see, for example, Japanese Patent No. 3380497).

[0004] When the Kalman filter is applied to the detection data, it is possible to suppress the frequent switching of the economy level image to a certain extent, but when the detection data actually crosses the threshold and repeatedly increases and decreases frequently, the economy level image is switched frequently.

SUMMARY

[0005] An object of the present invention is to provide a displaying control apparatus which can suppress the frequent switching of the economy level image.

[0006] A displaying control apparatus according to the present invention comprises an electronic control unit which displays an economy level image by a displaying device while the electronic control unit executes a following moving control. The economy level image indicates an economy level showing a level of a low energy consumption to move an own vehicle. The following moving control is a control to autonomously move the own vehicle, allowing a distance between the own vehicle and a preceding vehicle to change within a set inter-vehicle distance range. The electronic control unit is configured to, while the electronic control unit executes the following moving control, acquire a value of at least one environmental parameter which indicates a moving environment of the own vehicle and which defines the economy level, acquire an evaluation value corresponding to the acquired value of the at least one environmental parameter, acquire the economy level based on the acquired evaluation value, and display the economy level image indicating the acquired economy level by the displaying device. In the displaying control apparatus, a first evaluation value which is the evaluation value corresponding to the value of the at least one environmental parameter which is equal to or smaller than a predetermined switching threshold, and a second evaluation value which is the evaluation value corresponding to the value of the at least one environmental parameter which is greater than the predetermined switching threshold, are different values. The electronic control unit is configured to, when the value of the at least one environmental parameter changes from a value equal to or smaller than the predetermined switching threshold to a value greater than the predetermined switching threshold while the electronic control unit executes the following moving control, display the economy level image indicating the economy level acquired based on the first evaluation value by the displaying device until the value of the at least one environmental parameter reaches an increase side threshold greater than the predetermined switching threshold. Further, the electronic control unit is configured to, when the value of the at least one environmental parameter changes from a value greater than the predetermined switching threshold to a value equal to or smaller than the predetermined switching threshold while the electronic control unit executes the following moving control, display the economy level image indicating the economy level acquired based on the second evaluation value by the displaying device until the value of the at least one environmental parameter reaches a decrease side threshold smaller than the predetermined switching threshold.

[0007] With the displaying control apparatus according to the present invention, even when the value of the environmental parameter frequently increases or decreases, crossing the predetermined switching threshold while the following moving control is executed, the economy level is acquired based on the evaluation value before the value of the environmental parameter first crosses the predetermined switching threshold, and the economy level image indicating the acquired economy level is displayed. Therefore, frequent switching of the economy level image can be suppressed.

[0008] In the displaying control apparatus according to an aspect of the present invention, the electronic control unit may be configured to, when the value of the at least one environmental parameter changes from a value equal to or smaller than the predetermined switching threshold value, exceeds the predetermined switching threshold value, and reaches the increase side threshold while the electronic control unit executes the following moving control, display the economy level image indicating the economy level acquired based on the second evaluation value by the displaying device. In this aspect, the electronic control unit may be configured to, when the value of the at least one environmental parameter changes from a value greater than the predetermined switching threshold value, falls below the predetermined switching threshold value, and reaches the decrease side threshold while the electronic control unit executes the following moving control, display the economy level image indicating the economy level acquired based on the first evaluation value by the displaying device.

[0009] With the displaying control apparatus according to this aspect of the present invention, when the value of the environmental parameter exceeds the predetermined switching threshold and reaches the increase side threshold, the economy level image indicating the economy level acquired based on the second evaluation value is displayed. On the other hand, when the value of the environmental parameter falls below the predetermined switching threshold and reaches the decrease side threshold, the economy level image indicating the economy level acquired based on the first evaluation value is displayed. Therefore, when the value of the environmental parameter reaches the increase side threshold or the value of the environmental parameter reaches the decrease side threshold, the economy level image indicating a more accurate economy level is displayed.

[0010] In the displaying control apparatus according to another aspect of the present invention, the electronic control unit may be configured to, when the value of the at least one environmental parameter changes from a value equal to or smaller than the predetermined switching threshold to a value greater than the predetermined switching threshold while the electronic control unit executes the following moving control, correct the value of the at least one environmental parameter to a value equal to or smaller than the predetermined switching threshold until the value of the at least one environmental parameter reaches the increase side threshold, and display the economy level image indicating the economy level acquired based on the evaluation value corresponding to the corrected value of the at least one environmental parameter by the displaying device. In this aspect, the electronic control unit may be configured to, when the value of the at least one environmental parameter changes from a value greater than the predetermined switching threshold to a value equal to or smaller than the predetermined switching threshold while the electronic control unit executes the following moving control, correct the value of the at least one environmental parameter to a value greater than the predetermined switching threshold until the value of the at least one environmental parameter reaches the decrease side threshold, and display the economy level image indicating the economy level acquired based on the evaluation value corresponding to the corrected value of the at least one environmental parameter by the displaying device.

[0011] With the displaying control apparatus according to the present invention, the frequent switching of the economy level image can be suppressed by a method of correcting the value of the environmental parameter.

[0012] In the displaying control apparatus according to further another aspect of the present invention, the electronic control unit may store a first map and a second map for acquiring the evaluation value using the value of the at least one environmental parameter as an argument. In this aspect, the first map may be a map in which (i) the evaluation value corresponding to the value of the at least one environmental parameter which is equal to or smaller than the predetermined switching threshold and (ii) the evaluation value corresponding to the value of the at least one environmental parameter which is greater than the predetermined switching threshold, are set to the same values. Further, the second map may be a map in which (i) the evaluation values corresponding to the value of the at least one environmental parameter equal to or smaller than the predetermined switching threshold and (ii) the evaluation value corresponding to the value of the at least one environmental parameter greater than the predetermined switching threshold are set to different values. In this aspect, the electronic control unit may be configured to, when the value of the at least one environmental parameter changes from a value equal to or smaller than the predetermined switching threshold to a value greater than the predetermined switching threshold while the electronic control unit executes the following moving control, display the economy level image indicating the economy level acquired based on the evaluation value acquired from the first map using the value of the at least one environmental parameter as the argument by the displaying device until the value of the at least one environmental parameter reaches the increase side threshold. Further, the electronic control unit may be configured to, when the value of the at least one environmental parameter changes from a value greater than the predetermined switching threshold to a value equal to or smaller than the predetermined switching threshold while the electronic control unit executes the following moving control, display the economy level image indicating the economy level acquired based on the evaluation value acquired from the first map using the value of the at least one environmental parameter as the argument by the displaying device until the value of the at least one environmental parameter reaches the decrease side threshold.

[0013] With the displaying control apparatus according to the present invention, when the value of the environmental parameter changes from a value equal to or smaller than the predetermined switching threshold to a value greater than the predetermined switching threshold while the following moving control is executed, the economy level image does not change until the value of the environmental parameter reaches the increase side threshold. Similarly, when the value of the environmental parameter changes from a value greater than the predetermined switching threshold to a value equal to or smaller than the predetermined switching threshold while the following moving control is executed, the economy level image does not change until the value of the environmental parameter reaches the decrease side threshold. Thus, the frequent switching of the economy level image can be suppressed.

[0014] Elements of the invention are not limited to elements of embodiments and modified examples of the invention described with reference to the drawings. The other objects, features and accompanied advantages of the invention can be easily understood from the embodiments and the modified examples of the invention.

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## Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a view which shows a vehicle driving assistance apparatus which includes a displaying control apparatus according to an embodiment of the present invention.

[0016] FIG. **2** is a view which shows a scene where a preceding vehicle exists.

[0017] FIG. **3** is a flowchart which shows a routine executed by the vehicle driving assistance apparatus according to the embodiment of the present invention.

[0018] FIG. **4** is a view which shows evaluation values according to an air resistance reduction effect.

[0019] FIG. **5** is a view which shows an overall evaluation image.

[0020] FIG. **6** is a view which shows the overall evaluation images corresponding to a first evaluation (or a lowest evaluation), a second evaluation, a third evaluation, a fourth evaluation, and a fifth evaluation (or a highest evaluation).

[0021] FIG. **7** is a view used for explaining a backlash processing.

[0022] FIG. **8** is a view which shows a change of an inter-vehicle distance after the backlash processing.

[0023] FIG. **9** is a view which shows the evaluation values according to the air resistance reduction effect according to a modified example of the embodiment of the present invention.

DETAILED DESCRIPTION

[0024] Below, a displaying control apparatus according to an embodiment of the present invention will be described with reference to the drawings. FIG. **1** shows the vehicle driving assistance apparatus **10** according to the embodiment of the present invention. A displaying control apparatus according to the embodiment of the present invention is included in the vehicle driving assistance apparatus **10**. However, the vehicle driving assistance apparatus **10** and the displaying control apparatus may be configured separately, and some of functions of the vehicle driving assistance apparatus **10** (in particular, a function of controlling an operation of a displaying device described below) may be performed by the displaying control apparatus, while the remaining functions are performed by the vehicle driving assistance apparatus **10**.

[0025] The vehicle driving assistance apparatus **10** is installed in an own vehicle **100**. Hereinafter, the vehicle driving assistance apparatus **10** will be described, using the case where an operator of the own vehicle **100** is a person who rides in the own vehicle **100** and drives the own vehicle **100** (i.e., a driver of the own vehicle **100**). However, the operator of the own vehicle **100** may be a person who does not ride in the own vehicle **100** and remotely operates the own vehicle **100** (i.e., a remote operator of the own vehicle **100**).

[0026] In addition, the present invention can also be applied to vehicles which are driven automatically without a driving operation by the driver or the remote operator. Therefore, when the own vehicle **100** is a vehicle which is moved automatically, a display of results of an overall evaluation using a displaying device described below is performed for occupants who ride in the own vehicle **100** or for remote observers who monitor a moving of the own vehicle **100** at a remote control equipment.

[0027] As shown in FIG. **1**, the vehicle driving assistance apparatus **10** includes an ECU (electronic control unit) **90** as a control device. The ECU **90** includes a microcomputer as a main component. The microcomputer includes a storage medium including a CPU, a ROM, a RAM, and a non-volatile memory, as well as an interface and other components. The CPU executes instructions, programs, or routines stored in the storage medium to realize various functions. In particular, in this embodiment, the vehicle driving assistance apparatus **10** stores in the storage medium the programs which realize various controls executed by the vehicle driving assistance apparatus **10**.

[0028] It should be noted that, In this embodiment, the vehicle driving assistance apparatus **10** includes only one ECU **90**, but it may be configured to include multiple ECUs and to have each ECU perform the functions of the vehicle driving assistance apparatus **10** described below. Further, the vehicle driving assistance apparatus **10** may also be configured to be able to update the programs stored in the storage medium by wireless communication (e.g., Internet communication) with external devices.

[0029] The own vehicle **100** is equipped with a power apparatus **20**, a braking apparatus **30**, a displaying device **40**, a surrounding information detection device **50**, and an assistance switch **60**.

[0030] The power apparatus **20** is an apparatus which generates power applied to the own vehicle **100** (in particular, driven wheels of the own vehicle **100**), and in this embodiment, the power apparatus **20** includes an internal combustion engine **21** and at least one electric motor **22**. The power apparatus **20** is electrically connected to the ECU **90**. The vehicle driving assistance apparatus **10** controls the power applied to the own vehicle **100** by controlling operations of the internal combustion engine **21** and the at least one electric motor **22**.

[0031] The braking apparatus **30** is an apparatus which applies a braking force to the own vehicle **100** (in particular, wheels of the own vehicle **100**), and in this embodiment, the braking apparatus **30** includes a hydraulic brake device **31**. The braking apparatus **30** is electrically connected to the ECU **90**. The vehicle driving assistance apparatus **10** controls the braking force applied to the own vehicle **100** by controlling an operation of the hydraulic brake device **31**.

[0032] The displaying device **40** is a device which displays various images to the driver of the own vehicle **100**, and in this embodiment, the displaying device **40** includes a display **41**. The displaying device **40** is electrically connected to the ECU **90**. The vehicle driving assistance apparatus **10** displays various images on the display **41** by the displaying device **40**.

[0033] The surrounding information detection device **50** is a device which detects information on surroundings of the own vehicle **100**, and in this embodiment, the surrounding information detection device **50** includes electromagnetic wave sensors **51** and image sensors **52**. The surrounding information detection device **50** is electrically connected to the ECU **90**. The electromagnetic wave sensor **51** is, for example, a radar sensor such as a millimeter wave radar. The vehicle driving assistance apparatus **10** acquires information on objects around the own vehicle **100** by the electromagnetic wave sensors **51** as surrounding detection information IS. In addition, the image sensor **52** is, for example, a camera sensor. The vehicle driving assistance apparatus **10** acquires image information on a vicinity of the own vehicle **100** by the image sensor **52** as the surrounding detection information IS.

[0034] The assistance switch **60** is a device which is operated by the driver of the own vehicle **100** to request an execution of an economy following moving control described below or to request a stop of the economy following moving control. The assistance switch **60** is electrically connected to the ECU **90**. The driver can request the execution of the economy following moving control to the vehicle driving assistance apparatus **10** or request the stop of the economy following moving control to the vehicle driving assistance apparatus **10** by operating the assistance switch **60**.

Operation of Vehicle Driving Assistance Apparatus

[0035] Next, an operation of the vehicle driving assistance apparatus **10** will be described. The vehicle driving assistance apparatus **10** is configured to execute an economy following moving control when an execution of the economy following moving control is requested. It should be noted that the vehicle driving assistance apparatus **10** is configured to stop executing the economy following moving control when a stop of the execution of the economy following moving control is requested.

[0036] The economy following moving control is one of automatic driving controls. As shown in FIG. **2**, the economy following moving control is one of the following moving controls which autonomously accelerates and decelerates the own vehicle **100** such that the own vehicle **100** moves, following a preceding vehicle **200** when the preceding vehicle **200** exists. In this embodiment, the economy following moving control includes a coasting mode and a powering mode as control modes.

[0037] The coasting mode is a mode which decelerates the own vehicle **100** by disconnecting a connection between the power apparatus **20** and the driven wheels of the own vehicle **100** to cause the own vehicle **100** to coast. The powering mode is a mode which accelerates the own vehicle **100**. In particular, the powering mode is an optimal powering mode which powers the own vehicle **100** by operating the power apparatus **20** with an optimal energy efficiency.

[0038] When an inter-vehicle distance D (i.e., a distance between the preceding vehicle **200** and the own vehicle **100**) decreases and reaches a lower limit value Dlower of a set inter-vehicle distance range Rdset while the economy following moving control is executed in the powering mode, the control mode is switched from the powering mode to the coasting mode. On the other hand, when the inter-vehicle distance D increases and reaches an upper limit value Dupper of the set inter-vehicle distance range Rdset while the economy following moving control is executed in coasting mode, the control mode is switched from the coasting mode to the powering mode.

[0039] The set inter-vehicle distance range Rdset is a range of the inter-vehicle distance D where the lower limit value Dlower is set to a set inter-vehicle distance Dset and the upper limit value Dupper is set to a distance which is a predetermined distance AD longer than the set inter-vehicle distance Dset. The set inter-vehicle distance Dset is set in advance by the driver of own vehicle **100**. The preceding vehicle **200** is another vehicle which is moving in an own vehicle moving lane (i.e., a lane in which the own vehicle **100** is moving) within a certain distance D**200** ahead of the own vehicle **100**. The preceding vehicle **200** is detected based on the surrounding detection information IS. The inter-vehicle distance D is acquired based on the surrounding detection information IS.

[0040] In addition, the vehicle driving assistance apparatus **10** is configured to, when a predetermined condition is satisfied, perform an overall evaluation on an economy level achieved by the economy following moving control, and to display a result of that overall evaluation by the displaying device **40** by executing a routine shown in FIG. **3** at a predetermined calculation interval. In other words, the vehicle driving assistance apparatus **10** is configured to display an overall evaluation image T (or an economy level image) indicating the economy level showing a level of a low energy consumption of moving the own vehicle **100** by the displaying device **40** while the economy following moving control is executed. It should be noted that the economy level corresponds to an evaluation value E described below. The economy level increases as the evaluation value E increases.

[0041] At a predetermined timing, the vehicle driving assistance apparatus **10** starts processing from a step S**300** of the routine shown in FIG. **3**, and advances the processing to a step S**305** to determine whether or not the economy following moving control is executed.

[0042] When the vehicle driving assistance apparatus **10** determines “Yes” at the step S**305**, the vehicle driving assistance apparatus **10** proceeds to a step S**310** and acquires environmental parameters relating to a moving environment of the own vehicle **100**. In this embodiment, the environmental parameters are the inter-vehicle distance D and a projected area A. The projected area A is an area of the preceding vehicle **200** projected onto a vertical plane perpendicular to a longitudinal and horizontal line of the preceding vehicle **200** (a line extending horizontally in a longitudinal direction of the preceding vehicle **200**). The projected area A is acquired based on the surrounding detection information IS.

[0043] The vehicle driving assistance apparatus **10** then proceeds to a step S**315** and acquires the evaluation value E (or an environmental evaluation value Ee) relating to an air resistance reduction effect based on the inter-vehicle distance D and the projected area A. The air resistance reduction effect is an effect of reducing an air resistance which the own vehicle **100** receives by executing the

economy following moving control. The air resistance reduction effect changes according to the inter-vehicle distance D and the projected area A. In other words, when the own vehicle **100** is moving, following the preceding vehicle **200**, the shorter the inter-vehicle distance D, the smaller the air resistance the own vehicle **100** experiences. Also, when the own vehicle **100** is moving, following the preceding vehicle **200**, the greater the projected area A of the preceding vehicle **200**, the smaller the air resistance the own vehicle **100** experiences. Therefore, the environmental evaluation value Ee tends to increase as the inter-vehicle distance D decreases for the same projected area A. In addition, the environmental evaluation value Ee tends to increase as the projected area A increases for the same inter-vehicle distance D. It should be noted that the smaller the air resistance experienced by the own vehicle **100**, the less energy it consumes, and the higher its economy level.
[0044] For example, the environmental evaluation value Ee is set for each combination of the inter-vehicle distance D and the projected area A as shown in FIG. **4**.
[0045] In FIG. **4**, reference symbols Rd**1** to Rd**4** indicate ranges of the inter-vehicle distance D, respectively. The inter-vehicle distance D within the range Rd**1** is shorter than the inter-vehicle distance D within the range Rd**2**. In addition, the inter-vehicle distance D within the range Rd**2** is shorter than the inter-vehicle distance D within the range Rd**3**. In addition, the inter-vehicle distance D within the range Rd**3** is shorter than the inter-vehicle distance D within the range Rd**4**. In addition, the ranges Rd**1** and Rd**2**, the ranges Rd**2** and Rd**3**, and the ranges Rd**3** and Rd**4** are each continuous ranges.
[0046] In this embodiment, when the inter-vehicle distance D is equal to or smaller than an upper limit value DU of the range Rd**1**, the inter-vehicle distance D is a value within the range Rd**1**. When the inter-vehicle distance D is greater than the upper limit value DU of the range Rd**1** (i.e. it is equal to or greater than a lower limit value DL of the range Rd**2**) and is equal to or smaller than an upper limit value DU of the range Rd**2**, the inter-vehicle distance D is a value within the range Rd**2**. When the inter-vehicle distance D is greater than the upper limit value DU of the range Rd**2** (i.e. it is equal to or greater than a lower limit value DL of the range Rd**3**) and is equal to or smaller than an upper limit value DU of the range Rd**3**, the inter-vehicle distance D is a value within the range Rd**3**. When the inter-vehicle distance D is greater than the upper limit value DU of range Rd**3** (i.e., it is equal to or greater than a lower limit value DL of the range Rd**4**), the inter-vehicle distance D is a value within the range Rd**4**.
[0047] In addition, in FIG. **4**, reference symbols Ra**1** to Ra**4** each indicate ranges of the projected area A, respectively. The projected area A within the range Ra**1** is smaller than the projected area A within the range Ra**2**. The projected area A within the range Ra**2** is smaller than the projected area A within the range Ra**3**. The projected area A within range Ra**3** is smaller than the projected area A within the range Ra**4**. The ranges Ra**1** and Ra**2**, the ranges Ra**2** and Ra**3**, and the ranges Ra**3** and Ra**4** are each continuous ranges.
[0048] It should be noted that, in this embodiment, when the projected area A is equal to or smaller than an upper limit AU of the range Ra**1**, the projected area A is a value within the range Ra**1**. When the projected area A is greater than the upper limit AU of the range Ra**1** (i.e., it is equal to or greater than a lower limit AL of the range Ra**2**) and is equal to or smaller than an upper limit AU of the range Ra**2**, the projected area A is a value within the range Ra**2**. When the projected area A is greater than the upper limit AU of the range Ra**2** (i.e. it is equal to or greater than a lower limit AL of the range Ra**3**) and is equal to or smaller than an upper limit AU of the range Ra**3**, the projected area A is a value within the range Ra**3**. When the projected area A is greater than the upper limit AU of the range Ra**3** (i.e., it is equal to or greater than a lower limit AL of the range Ra**4**), the projected area A is a value within the range Ra**4**.
[0049] In an example shown in FIG. **4**, when the projected area A is a value within the same range, the environmental evaluation value Ee tends to increase as the inter-vehicle distance D decreases. When the inter-vehicle distance D is within the same range, the environmental evaluation value Ee

tends to increase as the projected area A increases. For example, when the inter-vehicle distance D is within the range Rd**1**, and the projected area A is within the range Ra**1**, the environmental evaluation value Ee is "1.". As such, the environmental evaluation value Ee is set to a greater value the greater a contribution to reducing the energy consumption associated with the movement of the own vehicle **100**.

[0050] Next, the vehicle driving assistance apparatus **10** proceeds to a step S**320** and acquires the evaluation value E (or a mode evaluation value Em) relating to the control mode. The mode evaluation value Em is set to a greater value when the economy following moving control is executed in the coasting mode than when the economy following moving control is executed in the powering mode.

[0051] When the economy following moving control is executed in the coasting mode, the energy consumption relating to the movement of own vehicle **100** is very small. Therefore, in this embodiment, the mode evaluation value Em when the economy following moving control is executed in the coasting mode is set to "3."

[0052] When the economy following moving control is executed in the powering mode, energy is consumed in the movement of own vehicle **100**. However, an execution of the economy following moving control in the powering mode is essential for executing the economy following moving control in the coasting mode afterwards. Therefore, the execution of the economy following moving control in the powering mode allows the economy following moving control in the coasting mode to be executed afterwards. In other words, the economy following moving control in the powering mode contributes to reducing the energy consumption relating to the movement of own vehicle **100**. Therefore, in this embodiment, the mode evaluation value Em is set to "1" when the economy following moving control is executed in the powering mode.

[0053] In this way, the mode evaluation value Em is set to a greater value the greater the extent to which it contributes to reducing the energy consumption relating to the movement of own vehicle **100**.

[0054] Next, the vehicle driving assistance apparatus **10** proceeds to a step S**325**, and acquires a total evaluation value Et as a total of the environmental evaluation value Ee acquired in the step S**315** and the mode evaluation value Em acquired in the step S**320**.

[0055] The vehicle driving assistance apparatus **10** then proceeds to a step S**330**, and determines an overall evaluation on the economy level which is achieved by the economy following moving control based on the total evaluation value Et. In this embodiment, the overall evaluation is a four-level evaluation (i.e., a first evaluation, a second evaluation, a third evaluation, and a fourth evaluation) from a lowest overall evaluation (or a lowest evaluation) to a highest overall evaluation (or a highest evaluation). When the total evaluation value Et is "1", the overall evaluation is the first evaluation (i.e., the lowest evaluation). When the total evaluation value Et is "2", the overall evaluation is the second evaluation. When the total evaluation value Et is "3", the overall evaluation is the third evaluation. When the total evaluation value Et is "4" or more, the overall evaluation is the fourth evaluation (i.e., the highest evaluation).

[0056] The vehicle driving assistance apparatus **10** then proceeds to a step S**335** and displays an image indicating the overall evaluation (i.e., an overall evaluation image T) by the displaying device **40**. The vehicle driving assistance apparatus **10** then proceeds to a step S**395** and ends the processing of this routine. In this embodiment, the overall evaluation image T is an image shown in FIG. **5**.

[0057] The overall evaluation image T shown in FIG. **5** includes a main image M and four sub-images S (namely, a first sub-image S**1**, a second sub-image S**2**, a third sub-image S**3**, and a fourth sub-image S**4**). The main image M is an image which resembles a single leaf. The sub-images S are bar-shaped images, and the first sub-image S**1**, the second sub-image S**2**, the third sub-image S**3**, and the fourth sub-image S**4** are arranged in a row from left to right.

[0058] As shown in FIG. **6**, the overall evaluation image T**1** corresponding to the first evaluation is displayed with the main image M and the first sub-image S**1** turned on and the second sub-image S**2**, the third sub-image S**3**, and the fourth sub-image S**4** turned off. The overall evaluation image T**2** corresponding to the second evaluation is displayed with the main image M, the first sub-image S**1**, and the second sub-image S**2** turned on, and the third sub-image S**3** and the fourth sub-image S**4** turned off. The overall evaluation image T**3** corresponding to the third evaluation is displayed with the main image M, the first sub-image S**1**, the second sub-image S**2**, and the third sub-image S**3** turned on, and the fourth sub-image S**4** turned off. The overall evaluation image T**4** corresponding to the fourth evaluation is displayed with all of the main image M, the first sub-image S**1**, the second sub-image S**2**, the third sub-image S**3**, and the fourth sub-image S**4** turned on.

[0059] When the vehicle driving assistance apparatus **10** determines “No” at the step S**305**, the vehicle driving assistance apparatus **10** proceeds to step S**340**, and when the displaying device **40** is displaying the overall evaluation image T at this point, the vehicle driving assistance apparatus **10** stops displaying the overall evaluation image T. The vehicle driving assistance apparatus **10** then proceeds to the step S**395** and ends the processing of this routine.

[0060] In this way, while the vehicle driving assistance apparatus **10** executes the economy following moving control, the vehicle driving assistance apparatus **10** (i) acquires the inter-vehicle distance D and the projected area A (i.e., the values of the environmental parameters, which are parameters which define the economy level and indicate the moving environment of the own vehicle **100**), (ii) acquires the evaluation value E corresponding to the acquired inter-vehicle distance D and the acquired projected area A, (iii) acquires the total evaluation value Et (i.e., the economy level) based on the acquired evaluation value E, and (iv) display the total evaluation value Et as the overall evaluation image T (i.e., the economy level image) by the displaying device **40**.

[0061] According to this, the overall evaluation image T is displayed by the displaying device **40**. Therefore, the driver of the own vehicle **100** can know the economy level relating to the moving of the own vehicle **100** by looking at the overall evaluation image T.

[0062] By the way, the vehicle driving assistance apparatus **10** acquires the environmental evaluation value Ee in accordance with the inter-vehicle distance D and the projected area A. In this regard, for example, when the projected area A is a value within the range Ra**3**, and the inter-vehicle distance D repeatedly increases and decreases across a boundary between the range Rd**1** and the range Rd**2**, the environmental evaluation value Ee repeatedly fluctuates between “3” and “2.” As a result, the overall evaluation image T may change repeatedly, and the driver may feel annoyed by this.

[0063] Therefore, the vehicle driving assistance apparatus **10** is configured to use the inter-vehicle distance D acquired by performing a backlash processing on the inter-vehicle distance D acquired based on the surrounding detection information IS to acquire the environmental evaluation value Ee when the inter-vehicle distance D increases and exceeds the upper limit value DU of any of the ranges Rd**1** to Rd**3**, or when the inter-vehicle distance D decreases and falls below the lower limit value DL of any of the ranges Rd**2** to Rd**4**. Similarly, the vehicle driving assistance apparatus **10** is configured to use the projected area A acquired by performing the backlash processing on the projected area A acquired based on the surrounding detection information IS to acquire the environmental evaluation value Ee when the projected area A increases and exceeds the upper limit AU of any of the ranges Ral to Ra**3**, or when the projected area A decreases and falls below the lower limit AL of any of the ranges Ra**2** to Ra**4**.

[0064] The backlash processing is a process to correct an input value Vi (i.e., a value input to the backlash processing) and outputs the corrected value as an output value Vo as shown in FIG. **7**. In other words, when the backlash processing for the input value Vi is started when the input value Vi increases to reach a third value V**3** (time t**70**), the output value Vo is maintained at the third value V**3** until the input value Vi increases to reach a fourth value V**4** (time t**71**). Then, when the input value Vi reaches the fourth value V**4**, the output value Vo begins to increase, and thereafter, the output value Vo increases as the input value Vi increases. At this time, the output value Vo is a value which is smaller than the input value Vi by a difference between the fourth value V**4** and the third value V**3** (Vo=Vi−(V**4**−V**3**)).

[0065] After that, when the input value Vi reaches a fifth value V**5** and the output value Vo reaches the fourth value V**4** (time t**72**), the input value Vi begins to decrease, and the output value Vo is maintained at the fourth value V**4** until the input value Vi reaches the third value V**3** (time t**73**). After that, when the input value Vi reaches the third value V**3**, the output value Vo begins to decrease, and then the output value Vo decreases as the input value Vi decreases. At this time, the output value Vo is a value which is smaller than the input value Vi by the difference between the fourth value V**4** and the third value V**3** (Vo=Vi−(V**4**−V**3**)).

[0066] After that, when the input value Vi reaches the first value V**1** and the output value Vo reaches the second value V**2** (time t**74**), the input value Vi starts to increase, and the output value Vo is maintained at the second value V**2** until the input value Vi reaches the third value V**3** (time t**75**). After that, when the input value Vi reaches the third value V**3**, the output value Vo begins to increase, and then the output value Vo increases as the input value Vi increases. At this time, the output value Vo is a value which is smaller than the input value Vi by the difference between the fourth value V**4** and the third value V**3** (Vo=Vi−(V**4**−V**3**)).

[0067] In this way, when the backlash processing starts when the input value Vi increases and reaches the third value V**3**, the output value Vo is maintained at the third value V**3** as long as the input value Vi fluctuates between the fourth value V**4** and the second value V**2**.

[0068] It should be noted that when the backlash processing for the input value Vi is started when the input value Vi decreases and reaches the third value V**3**, the input value Vi is corrected such that the output value Vo is maintained at the third value V**3** as long as the input value Vi fluctuates between the fourth value V**4** and the second value V**2**, and the corrected value is output as the output value Vo by the backlash processing.

[0069] Therefore, when an input inter-vehicle distance Di changes as shown in FIG. **8**, an output inter-vehicle distance Do is maintained at the upper limit value DU of the range Rd**1**. The input inter-vehicle distance Di is the inter-vehicle distance D acquired by the vehicle driving assistance apparatus **10** based on the surrounding detection information IS. The output inter-vehicle distance Do is the inter-vehicle distance D output by the backlash processing.

[0070] FIG. **8** shows an example of how the input inter-vehicle distance Di varies when the projected area A is a value within the range Ra**3**. That is, in the example shown in FIG. **8**, the input inter-vehicle distance Di increases and reaches the upper limit value DU of the range Rd**1** (time t**80**). After that, the input inter-vehicle distance Di continues to increase and then starts to decrease before exceeding an increase side inter-vehicle distance Dth_U (time t**81**). The increase side inter-vehicle distance Dth_U corresponds to the fourth value V**4** in the example shown in FIG. **7**. After that, the input inter-vehicle distance Di reaches the upper limit value DU of the range Rd**1** (time t**82**), and continues to decrease and then starts to decrease before falling below a decrease side inter-vehicle distance Dth_L (time t**83**). The decrease side inter-vehicle distance Dth_L corresponds to the second value V**2** in the example shown in FIG. **7**. This increase and decrease is repeated. In the example shown in FIG. **8**, when the input inter-vehicle distance Di increases and reaches the upper limit value DU of the range Rd**1** (time t**80**), the backlash processing for the input inter-vehicle distance Di is started.

[0071] According to this, while the input inter-vehicle distance Di is increasing or decreasing across the upper limit value DU of the range Rd**1**, the output inter-vehicle distance Do is maintained at the upper limit value DU of the range Rd**1**. Therefore, the environmental evaluation value Ee is maintained at the evaluation value E corresponding to the inter-vehicle distance D being a value within the range Rd**1**. Thus, a range between the increase side inter-vehicle distance Dth_U and the decrease side inter-vehicle distance Dth_L is a dead zone for the input inter-vehicle distance Di.

[0072] In this embodiment, for example, when the inter-vehicle distance D (i.e., the value of the environmental parameter) changes from a value equal to or smaller than the upper limit value DU (i.e., a predetermined switching threshold) of the range Rd**1** to a value greater than said upper limit value DU while the economy following moving control is executed, the vehicle driving assistance apparatus **10** corrects the inter-vehicle distance D to the upper limit value DU of the range Rd**1** until the inter-vehicle distance D reaches the increase side inter-vehicle distance Dth_U (i.e., an increase side threshold), and displays the overall evaluation image T (i.e., an economy level image) indicating the total evaluation value Et (i.e., an economy level) acquired based on the evaluation value E corresponding to the corrected inter-vehicle distance D by the displaying device **40**. Further, when the inter-vehicle distance D changes from a value greater than the upper limit value DU of range Rd**1** to a value equal to or smaller than said upper limit value DU while the economy following moving control is executed, the vehicle driving assistance apparatus **10** corrects the inter-vehicle distance D to a value greater than the upper limit value DU of the range Rd**1** until the inter-vehicle distance D reaches the decrease side inter-vehicle distance Dth_L (i.e., a decrease side threshold), and displays the overall evaluation image T indicating the total evaluation value Et acquired based on the evaluation value E corresponding to the corrected inter-vehicle distance D by the displaying device **40**.
[0073] It should be noted that the backlash processing may be configured to correct the inter-vehicle distance D to a value within the range Rd**1** which is smaller than the upper limit value DU of the range Rd**1** until the inter-vehicle distance D reaches the increase side inter-vehicle distance Dth_U, for example, when the inter-vehicle distance D changes from a value which is equal to or smaller than the upper limit value DU of the range Rd**1** to a value which is greater than the upper limit value DU of the range Rd**1** while the economy following moving control is executed. Similarly, the backlash processing may be configured to correct the inter-vehicle distance D to a value greater than the upper limit value DU of the range Rd**1** until the inter-vehicle distance D reaches the decrease side inter-vehicle distance Dth_L (i.e., a decrease side threshold), for example, when the inter-vehicle distance D changes from a value greater than the upper limit value DU of the range Rd**1** to a value equal to or smaller than said upper limit value DU while the economy following moving control is executed. In this embodiment, for example, the evaluation value E (i.e., a first evaluation value) corresponding to the inter-vehicle distance D (i.e., a value of the environmental parameter) which is equal to or smaller than the upper limit value DU (i.e., a predetermined switching threshold) of the range Rd**1** and the evaluation value E (i.e., a second evaluation value) corresponding to the inter-vehicle distance D which is greater than the upper limit value DU of the range Rd**1** are different from each other. In addition, when the inter-vehicle distance D changes from a value equal to or smaller than the upper limit value DU of range Rd**1** to a value greater than said upper limit value DU while the following moving control is executed, the vehicle driving assistance apparatus **10** displays, by the displaying device **40**, the overall evaluation image T (i.e., the economy level image) indicating the economy level acquired based on the evaluation value E (i.e., the first evaluation value) corresponding to the inter-vehicle distance D which is equal to or smaller than the upper limit value DU of range Rd**1** until the inter-vehicle distance D reaches the increase side inter-vehicle distance Dth_U (i.e., the increase side threshold) which is a value greater than the upper limit value DU of range Rd**1**. Further, when the inter-vehicle distance D changes from a value which is greater than the upper limit value DU of the range Rd**1** to a value which is equal to or smaller than said upper limit value DU while the following moving control is executed, the vehicle driving assistance apparatus **10** displays, by the displaying device **40**, the overall evaluation image T indicating the economy level acquired based on the evaluation value E (i.e., the second evaluation value) corresponding to the inter-vehicle distance D which is greater than the upper limit value DU of the range Rd**1** until the inter-vehicle distance D reaches the decrease side inter-vehicle distance Dth_L (i.e., a decrease side threshold) which is smaller than the upper limit value DU of the range Rd**1**.

[0074] Accordingly, even when the inter-vehicle distance D frequently increases and decreases while crossing the upper limit value DU of the range Rd**1** while the economy following moving control is executed, the total evaluation value Et is acquired based on the evaluation value E before the inter-vehicle distance D first crosses the upper limit value DU of the range Rd**1**, and the overall evaluation image T indicating the acquired total evaluation value Et is displayed. As a result, frequent switching of the overall evaluation image T can be suppressed.

[0075] It should be noted that the present invention is not limited to the above embodiments, and various modified examples can be adopted within the scope of the present invention.

Modified Example

[0076] For example, instead of acquiring the environmental evaluation value Ee based on the inter-vehicle distance D and the projected area A with backlash processing, the vehicle driving assistance apparatus **10** may be configured to acquire the environmental evaluation value Ee based on two maps (or an increase direction map MapU and a decrease direction map MapD) for acquiring the environmental evaluation value Ee with the inter-vehicle distance D and the projected area A (i.e., the values of environmental parameters) as arguments as shown in FIG. **9**.

[0077] The vehicle driving assistance apparatus **10** acquires the environmental evaluation value Ee from the increase direction map MapU and the decrease direction map MapD, respectively when the inter-vehicle distance D increases, exceeds the upper limit value DU of the range Rd**1**, and becomes a value within the range Rd**2**, respectively in a situation where the projected area A is a value within the range Ra**3**. In this case, the environmental evaluation value Ee acquired from the increase direction map MapU is “3”, and the environmental evaluation value Ee acquired from the decrease direction map MapD is “2.” Here, the vehicle driving assistance apparatus **10** adopts the environmental evaluation value Ee which has the smaller difference with the environmental evaluation value Ee corresponding to the inter-vehicle distance D being a value within the range Rd**1** as the environmental evaluation value Ee at that time. In this embodiment, the environmental evaluation value Ee corresponding to the inter-vehicle distance D being a value within the range Rd**1** is “3.” Therefore, the vehicle driving assistance apparatus **10** adopts the environmental evaluation value Ee (“3”) acquired from the increase direction map MapU as the environmental evaluation value Ee at that time.

[0078] On the other hand, when the inter-vehicle distance D decreases, falls below the lower limit value DL of the range Rd**3**, and becomes a value within the range Rd**2**, the vehicle driving assistance apparatus **10** acquires the environmental evaluation value Ee from the increasing direction map MapU and the decreasing direction map MapD, respectively in the situation where the projected area A is a value within the range Ra**3**. In this case, the environmental evaluation value Ee acquired from the increase direction map MapU is “3”, and the environmental evaluation value Ee acquired from the decrease direction map MapD is “2.” As mentioned above, the vehicle driving assistance apparatus **10** adopts the environmental evaluation value Ee which has the smaller difference with the environmental evaluation value Ee corresponding to the inter-vehicle distance D being a value within the range Rd**1** as the environmental evaluation value Ee at that time. In this embodiment, the environmental evaluation value Ee corresponding to the inter-vehicle distance D being within the range Rd**3** is “2.” Therefore, the vehicle driving assistance apparatus **10** adopts the environmental evaluation value Ee (“2”) acquired from the decrease direction map MapD as the environmental evaluation value Ee at that time.

[0079] In this way, the increase direction map MapU is a map (i.e., a first map) in which the evaluation value E corresponding to the inter-vehicle distance D (i.e., the value of the environmental parameter) which is equal to or smaller than the upper limit value DU (i.e. the predetermined switching threshold) of the range Rd**1** and the evaluation value E corresponding to the inter-vehicle distance D which is greater than the upper limit value DU of the range Rd**1** are set to the same values, in a situation where the projected area A is a value within the range Ra**3**. In addition, the decreasing direction map MapD is a map (i.e., the first map) in which the evaluation value E corresponding to the inter-vehicle distance D which is equal to or smaller than the upper limit value DU (i.e., the predetermined switching threshold) of the range Rd**2** and the evaluation value E corresponding to the inter-vehicle distance D which is greater than the upper limit value DU of the range Rd**2** are set to the same values, in a situation where the projected area A is a value within the range Ra**3**.

[0080] On the other hand, the increase direction map MapU is a map (i.e., a second map) in which the evaluation value E corresponding to the inter-vehicle distance D (i.e., the value of the environmental parameter) which is equal to or smaller than the upper limit value DU (i.e., the predetermined switching threshold) of range Rd**2** and the evaluation value E corresponding to the inter-vehicle distance D which is greater than the upper limit value DU of range Rd**2** are set to different values, in a situation where the projected area A is a value within range Ra**3**. In addition, the decreasing direction map MapD is a map (i.e., the second map) in which the evaluation value E corresponding to the inter-vehicle distance D which is equal to or smaller than the upper limit value DU (i.e., the predetermined switching threshold) of the range Rd**1** and the evaluation value E corresponding to the inter-vehicle distance D which is greater than the upper limit value DU of the range Rd**1** are set to different values, in a situation where the projected area A is a value within the range Ra**3**.

[0081] Thereby, the frequent switching of the overall evaluation image T can be suppressed.

## Claims

**1**. A displaying control apparatus comprising an electronic control unit which displays an economy level image by a displaying device while the electronic control unit executes a following moving control, the economy level image indicating an economy level showing a level of a low energy consumption to move an own vehicle, the following moving control being a control to autonomously move the own vehicle, allowing a distance between the own vehicle and a preceding vehicle to change within a set inter-vehicle distance range, and the electronic control unit being configured to: while the electronic control unit executes the following moving control, acquire a value of at least one environmental parameter which indicates a moving environment of the own vehicle and which defines the economy level; acquire an evaluation value corresponding to the acquired value of the at least one environmental parameter; acquire the economy level based on the acquired evaluation value; and display the economy level image indicating the acquired economy level by the displaying device, wherein a first evaluation value which is the evaluation value corresponding to the value of the at least one environmental parameter which is equal to or smaller than a predetermined switching threshold, and a second evaluation value which is the evaluation value corresponding to the value of the at least one environmental parameter which is greater than the predetermined switching threshold, are different values, and the electronic control unit is configured to: when the value of the at least one environmental parameter changes from a value equal to or smaller than the predetermined switching threshold to a value greater than the predetermined switching threshold while the electronic control unit executes the following moving control, display the economy level image indicating the economy level acquired based on the first evaluation value by the displaying device until the value of the at least one environmental parameter reaches an increase side threshold greater than the predetermined switching threshold; and when the value of the at least one environmental parameter changes from a value greater than the predetermined switching threshold to a value equal to or smaller than the predetermined switching threshold while the electronic control unit executes the following moving control, display the economy level image indicating the economy level acquired based on the second evaluation value by the displaying device until the value of the at least one environmental parameter reaches a decrease side threshold smaller than the predetermined switching threshold.

**2**. The displaying control apparatus according to claim 1, wherein the electronic control unit is configured to: when the value of the at least one environmental parameter changes from a value equal to or smaller than the predetermined switching threshold value, exceeds the predetermined switching threshold value, and reaches the increase side threshold while the electronic control unit executes the following moving control, display the economy level image indicating the economy level acquired based on the second evaluation value by the displaying device; and when the value of the at least one environmental parameter changes from a value greater than the predetermined switching threshold value, falls below the predetermined switching threshold value, and reaches the decrease side threshold while the electronic control unit executes the following moving control, display the economy level image indicating the economy level acquired based on the first evaluation value by the displaying device.

**3**. The displaying control apparatus according to claim 1, wherein the electronic control unit is configured to: when the value of the at least one environmental parameter changes from a value equal to or smaller than the predetermined switching threshold to a value greater than the predetermined switching threshold while the electronic control unit executes the following moving control, correct the value of the at least one environmental parameter to a value equal to or smaller than the predetermined switching threshold until the value of the at least one environmental parameter reaches the increase side threshold, and display the economy level image indicating the economy level acquired based on the evaluation value corresponding to the corrected value of the at least one environmental parameter by the displaying device; and when the value of the at least one environmental parameter changes from a value greater than the predetermined switching threshold to a value equal to or smaller than the predetermined switching threshold while the electronic control unit executes the following moving control, correct the value of the at least one environmental parameter to a value greater than the predetermined switching threshold until the value of the at least one environmental parameter reaches the decrease side threshold, and display the economy level image indicating the economy level acquired based on the evaluation value corresponding to the corrected value of the at least one environmental parameter by the displaying device.

**4**. The displaying control apparatus according to claim 1, wherein the electronic control unit stores a first map and a second map for acquiring the evaluation value using the value of the at least one environmental parameter as an argument, the first map is a map in which (i) the evaluation value corresponding to the value of the at least one environmental parameter which is equal to or smaller than the predetermined switching threshold and (ii) the evaluation value corresponding to the value of the at least one environmental parameter which is greater than the predetermined switching threshold, are set to the same values, the second map is a map in which (i) the evaluation values corresponding to the value of the at least one environmental parameter equal to or smaller than the predetermined switching threshold and (ii) the evaluation value corresponding to the value of the at least one environmental parameter greater than the predetermined switching threshold are set to different values, and the electronic control unit is configured to: when the value of the at least one environmental parameter changes from a value equal to or smaller than the predetermined switching threshold to a value greater than the predetermined switching threshold while the electronic control unit executes the following moving control, display the economy level image indicating the economy level acquired based on the evaluation value acquired from the first map using the value of the at least one environmental parameter as the argument by the displaying device until the value of the at least one environmental parameter reaches the increase side threshold; and when the value of the at least one environmental parameter changes from a value greater than the predetermined switching threshold to a value equal to or smaller than the predetermined switching threshold while the electronic control unit executes the following moving control, display the economy level image indicating the economy level acquired based on the evaluation value acquired from the first map using the value of the at least one environmental parameter as the argument by the displaying device until the value of the at least one environmental parameter reaches the decrease side threshold.