United States Patent Application Publication	20250256701
Kind Code	A1
Publication Date	August 14, 2025
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HYBRID VEHICLE

Abstract

The controller of a hybrid vehicle maintains the normal driving mode even if there is a request to switch to the motor driving mode based on the driving support plan until a predetermined time has elapsed when the mode is switched to the normal driving mode by operating the mode selection switch. As a result, the driver's sense of discomfort can be reduced by switching to the motor driving mode within a short time after switching to the normal driving mode by operating the mode selection switch.

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Appl. No.: **19/051993**

Filed: **February 12, 2025**

Foreign Application Priority Data

JP	2024-020352	Feb. 14, 2024

Publication Classification

Int. Cl.: **B60W20/40** (20160101); **B60W50/14** (20200101)

U.S. Cl.:

CPC **B60W20/40** (20130101); **B60W50/14** (20130101); B60W2050/146 (20130101)

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present disclosure claims priority to Japanese Patent Application No. 2024-020352 filed Feb. 14, 2024, which is incorporated herein by reference in its entirety including specification, drawings and claims.

TECHNICAL FIELD

[0002] The present disclosure relates to a hybrid vehicle.

BACKGROUND

[0003] Conventional hybrid vehicles of this type have been proposed that switch between an electric vehicle mode in which the electric motor runs alone, an engine mode in which the engine runs alone, and a combined mode in which both run together according to the mode-switching vehicle speed (see, for example, Patent Document 1). This hybrid vehicle can be driven in an environmentally compatible manner by switching the mode-switching vehicle speed for each environment, such as urban, suburban, highway, tunnel, and so on.

CITATION LIST

Patent Document

[0004] [Patent Document 1] Japanese Patent Application Laid Open No. H06-187595

SUMMARY

[0005] In such hybrid vehicles, there is a mode selection switch that switches between a motor driving mode, in which the vehicle is driven by power from the motor with the engine stopped, and a normal driving mode, in which the vehicle is driven by power from the engine and the motor as necessary, the driver can freely choose between driving in the motor driving mode and driving in the normal driving mode by operating the mode selection switch. In addition, a driving support plan has been proposed that assigns the motor driving mode and the normal driving mode to each driving section of the driving route in order to drive the set or estimated driving route in an energy-efficient manner, and a hybrid vehicle that switches the driving mode based on this driving support plan has also been proposed. When the vehicle is travelling in the motor driving mode and the driver switches to the normal driving mode using the mode selection switch, and then switches back to the motor driving mode using the driving support plan or something similar within a short period of time, the driver may feel a sense of discomfort because the driver's intention is not reflected in the switch operation. In addition, when the driver switches to the motor driving mode by operating the mode selection switch on the vehicle, if the motor driving mode is switched to within a short period of time after the switch to the motor driving mode is rejected, the driver will feel uncomfortable about the switch to the motor driving mode despite the rejection of the switch to the motor driving mode. The same also applies when the motor driving mode is cancelled while driving in the motor driving mode, and then switched back to the motor driving mode within a short period of time due to the driving support plan, etc.

[0006] The main purpose of the hybrid vehicle described in this disclosure is to reduce the sense of discomfort that drivers experience when switching between driving modes.

[0007] The hybrid vehicle of the present disclosure has adopted the following measures to achieve the main objectives described above.

[0008] The first hybrid vehicle of the present disclosure comprises: [0009] an engine capable of outputting power for driving; [0010] a motor capable of outputting power for driving; [0011] a power storage device capable of exchanging electric power with the motor; [0012] a mode selection switch that switches between a motor driving mode, in which the vehicle is driven by the power from the motor while the engine is stopped, and a normal driving mode, in which the vehicle is driven by the power from the engine and the power from the motor as necessary; [0013] a

controller configured to create a driving support plan that assigns the motor driving mode and the normal driving mode to each driving section of the set or estimated driving route, and executes driving support control that controls the engine and the motor such that they drive based on the driving support plan; [0014] wherein the controller maintains the normal driving mode even if there is a request to switch to the motor driving mode based on the driving support plan until a predetermined time has elapsed when the controller switches the motor driving mode to the normal driving mode by operating the mode selection switch.

[0015] The first hybrid vehicle disclosed in this document is equipped an engine capable of outputting power for driving, a motor capable of outputting power for driving, a power storage device capable of exchanging electric power with the motor, a mode selection switch that switches between a motor driving mode, in which the vehicle is driven by the power from the motor while the engine is stopped, and a normal driving mode, in which the vehicle is driven by the power from the engine and the power from the motor as necessary, a controller configured to create a driving support plan that assigns the motor driving mode and the normal driving mode to each driving section of the set or estimated driving route, and executes driving support control that controls the engine and the motor such that they drive based on the driving support plan. The controller maintains the normal driving mode even if there is a request to switch to the motor driving mode based on the driving support plan until a predetermined time has elapsed when the normal driving mode is switched to the motor driving mode by operating the mode selection switch. This reduces the driver's sense of discomfort when the mode selection switch is used to switch to the motor driving mode within a short time after switching to the normal driving mode.

[0016] The second hybrid vehicle of the present disclosure comprises: [0017] an engine capable of outputting power for driving; [0018] a motor capable of outputting power for driving; [0019] a power storage device capable of exchanging electric power with the motor; [0020] a mode selection switch that switches between a motor driving mode, in which the vehicle is driven by the power from the motor while the engine is stopped, and a normal driving mode, in which the vehicle is driven by the power from the engine and the power from the motor as necessary; [0021] a controller configured to create a driving support plan that assigns the motor driving mode and the normal driving mode to each driving section of the set or estimated driving route, and executes driving support control that controls the engine and the motor such that they drive based on the driving support plan; [0022] wherein the controller maintains the normal driving mode even if there is a request to switch to the motor driving mode based on the driving support plan until the first predetermined time has elapsed, where the switch to the motor driving mode is rejected when the motor driving mode is switched to by operating the mode selection switch, or where the motor driving mode is cancelled while driving in the motor driving mode.

[0023] The second hybrid vehicle disclosed in this document is equipped an engine capable of outputting power for driving, a motor capable of outputting power for driving, a power storage device capable of exchanging electric power with the motor, a mode selection switch that switches between a motor driving mode, in which the vehicle is driven by the power from the motor while the engine is stopped, and a normal driving mode, in which the vehicle is driven by the power from the engine and the power from the motor as necessary, a controller configured to create a driving support plan that assigns the motor driving mode and the normal driving mode to each driving section of the set or estimated driving route, and executes driving support control that controls the engine and the motor such that they drive based on the driving support plan. The controller maintains the normal driving mode even if there is a request to switch to the motor driving mode based on the driving support plan until the first predetermined time has elapsed, where the switch to the motor driving mode is rejected when the motor driving mode is switched to by operating the mode selection switch, or where the motor driving mode is cancelled while driving in the motor driving mode. This reduces the driver's sense of discomfort when the motor driving mode is switched to after the motor driving mode has been rejected or cancelled.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0024] FIG. **1** shows a block diagram of the hybrid vehicle **20** as one embodiment of the present disclosure, with the hybrid ECU **50** shown as a central block.

[0025] FIG. **2** shows a flowchart of an example of driving support control executed by the hybrid ECU **50**.

[0026] FIG. **3** shows a flowchart of an example of the driving support control for a variant.

[0027] FIG. **4** shows a flowchart of an example of the driving support control for a variant.

DESCRIPTION OF EMBODIMENTS

[0028] The following is a description of the embodiment of this disclosure. FIG. **1** shows a block diagram of the hybrid vehicle **20** as one embodiment of the present disclosure, showing the hybrid electronic control unit **50** (hereinafter referred to as hybrid ECU **50**). as a block at the center. The hybrid vehicle **20** of the embodiment is equipped with the engine EG and the motor MG as a power source, as shown in the figure. The hybrid vehicle **20** of the embodiment has two driving modes: the motor driving mode in which the vehicle is driven by the power from the motor MG with the engine EG operation stopped, and the normal driving mode in which the vehicle is driven by the power from the engine EG and the power from the motor MG, operating the engine EG as necessary.

[0029] The hybrid vehicle **20** of the embodiment is equipped with in addition to a power source, the ignition switch **21**, GPS (Global Positioning System, Global Positioning Satellite) **22**, the on-board camera **24**, the millimeter wave radar **26**, the accelerometer **28**, the vehicle speed sensor **30**, the acceleration sensor **32**, the brake sensor **34**, the mode selection switch **36**, the battery actuator **38**, the battery **40**, the electronic control unit for air conditioners (hereinafter referred to as “air conditioner ECU”) **42**, the air conditioner compressor **44**, the hybrid ECU **50**, the acceleration actuator **60**, the brake actuator **62**, the brake device **64**, the display device **66**, the motor driving indicator **67**, the meter **68**, the DCM (Data Communication Module) **70**, the navigation system **80**.

[0030] GPS**22** is a device that detects the position of a vehicle based on signals transmitted from multiple GPS satellites. The on-board camera **24** is the camera that captures images of the vehicle's surroundings, such as a front camera that captures images of the front of the vehicle and a rear camera that captures images of the rear of the vehicle. The millimeter wave radar **26** detects the distance and relative speed between the vehicle and the vehicle in front of it or between the vehicle and the vehicle behind it.

[0031] The accelerometer **28** is, for example, a sensor that detects acceleration in the front-back direction of the vehicle or in the left-right (lateral) direction of the vehicle. The speed sensor **30** detects the vehicle speed of the vehicle based on wheel speed and other factors. The acceleration sensor **32** detects the acceleration opening degree, etc., according to the amount of the acceleration pedal depressed by the driver. The brake sensor **34** detects the brake position etc. as the amount the driver depresses the brake pedal. The mode selection switch **36** is located near the steering wheel in the driver's seat and is used to switch between the motor driving mode and the normal driving mode. Basically, when the mode selection switch **36** is operated in the motor driving mode, it switches to the normal driving mode, and when the mode selection switch **36** is operated in the normal driving mode, it switches to the motor driving mode.

[0032] The battery actuator **38** detects the state of the battery **40**, e for example, the voltage between terminals, the charging and discharging currents, and the battery temperature, and manages the battery **40** based on these. The battery actuator **38** calculates the storage ratio SOC as the ratio of the remaining storage capacity to the total storage capacity based on the charge/discharge current. The battery actuator **38** calculates the maximum allowable output power (the output limit Wout) that may be output from the battery **40** and the maximum allowable input

power (the input limit Win) that may be input to the battery **40** based on the storage ratio SOC and the battery temperature. The battery **40** is configured as a rechargeable battery that can be charged and discharged, for example, a lithium-ion battery, a nickel-metal hydride battery, or a lead-acid battery.

[0033] The air conditioner ECU **42** is configured as a microcomputer centered on a CPU, which is not shown in the figure, and is equipped with ROM, RAM, the flash memory, the input port, the output port, and the communication port, etc. in addition to the CPU. The air conditioner ECU **42** is incorporated in the air conditioning unit that air-conditions the passenger compartment, and drives and controls the air conditioner compressor **44** in the air conditioning unit such that the temperature in the passenger compartment becomes the set temperature.

[0034] The engine EG is configured, for example, as an internal combustion engine. The motor MG is configured as the electric motor that also functions as the generator, for example, the synchronous starting electric motor. The motor MG is connected to the battery **40** via an inverter, not shown in the figure, and can output driving power using the power supplied by the battery **40** or charge the battery **40** with the generated power.

[0035] The hybrid ECU **50**, which is not shown in the figure, is configured as a microcomputer with a CPU at its core, and is equipped with ROM, RAM, the flash memory, the input port, the output port, and the communication port, etc., in addition to the CPU. The hybrid ECU **50** sets the driving mode and also sets the target operating point (the target rotation speed and the target torque) of the engine EG and the torque command of the motor MG based on the set driving mode, the acceleration opening degree from the acceleration sensor **32**, the brake position from the brake sensor **34**, and the output limit and input limit from the battery actuator **38**. The hybrid ECU **50** does not start with accessory on, but with ready on.

[0036] The hybrid ECU **50** sets the required driving force and the required power based on the acceleration opening degree from the accelerometer **28** and the vehicle speed from the speed sensor **30** when the vehicle is running on the motor. So, the hybrid ECU **50** sets the torque command of the motor MG to output the required driving force and the required power to the vehicle, and transmits the set torque command to the acceleration actuator **60**. The hybrid ECU **50** sets the target operating point of the engine EG and the torque command of the motor MG to output the required driving force and the required power to the vehicle when hybrid driving, and transmits the target operating point and the torque command to the acceleration actuator **60**. The hybrid ECU **50** also sets the required braking force based on the brake position from the brake sensor **34** and the vehicle speed from the speed sensor **30** when the brake pedal is depressed. The hybrid ECU **50** also sets the torque command for regenerative control of the motor MG based on the required braking force and the vehicle speed, and also sets the target braking force by the brake device. The hybrid ECU **50** then transmits the torque command to the acceleration actuator **60** and the target braking force to the brake actuator **62**.

[0037] The acceleration actuator **60** drives and controls the engine EG and the motor MG according to the target operating point and the torque command set by the hybrid ECU **50**. The acceleration actuator **60** performs the intake air volume control, the fuel injection control, the ignition control, and the intake valve open/close timing control such that the engine EG is operated at the target operating point (the target rotation speed and the target torque). The acceleration actuator **60** also controls the switching of the switching elements of the inverter to drive the motor MG such that the torque corresponding to the torque command is output from the motor MG.

[0038] The brake actuator **62** controls the brake device **64** such that the target braking force set by the hybrid ECU **50** is applied to the vehicle by the brake device **64**. The brake device **64** is configured as the hydraulically driven friction brake, for example.

[0039] The display device **66** is built into the installation panel in front of the driver's seat, for example, and displays various information and also functions as a touch panel. The motor driving indicator **67**, which is not shown, is built into the installation panel in front of the driver's seat, and

lights up when the motor is running and goes out when the motor is not running.
[0040] The DCM (Data Communication Module) **70** transmits the vehicle information to the traffic information management center **100** and receives the road traffic information from the traffic information management center **100**. The vehicle information can include, for example, the vehicle's position, the vehicle's speed, the driving power, the driving mode, and so on. The road traffic information can include, for example, the information on current and future traffic congestion, the information on the current average vehicle speed and predicted future average vehicle speed in the section on the travel route, the information on traffic regulations, the information on weather, the information on road surface conditions, and the information on maps. The DCM **70** communicates with the traffic information management center **100** at predetermined intervals (e.g., every 30 seconds, 1 minute, 2 minutes, etc.).
[0041] The navigation system **80** is the system that guides the vehicle to the set target destination, and is equipped with the display unit **82** and the map information database **84**. The display unit **82** is a functional block that has the function of displaying the route to the target destination, the vehicle's position, and other information on the display device **66** based on map information. The navigation system **80** communicates with the traffic information management center **100** via the DCM **70**. The navigation system **80** sets the route based on the information of the target destination or the transit destination, the information of the current location (the current position of the own vehicle) obtained by the GPS **22**, and the information stored in the map information database **84**, when the target destination or the transit destination is set. The navigation system **80** communicates with the traffic information management center **100** at predetermined intervals (e.g., every 3 or 5 minutes) to obtain the road traffic information, and provides the route guidance based on the road traffic information. The map information stored in the map information database **84** includes not only data as the map, but also the road grade, the road type, and the elevation for each driving segment.
[0042] The navigation system **80**, when providing the route guidance, generates the predictive information such as the load information necessary for traveling each travel segment every time it acquires the road traffic information from the traffic information management center **100** (or every predetermined time) based on the information on each travel segment in the travel route in the road traffic information acquired from the traffic information management center **100**, the information on the driving load, the vehicle speed of the own vehicle, the driving power of the own vehicle, the driving mode of the own vehicle, etc., and transmits the information to the hybrid ECU **50**. The predictive information includes the information about the vehicle, such as the current position, the vehicle speed, the driving power, the driving mode, and so on, the Information about current and future traffic jams, the information about the current average vehicle speed and predicted average vehicle speed in the future along the travel route, the Information about the traffic restrictions, the information on weather conditions, the information about the road surface condition, the information about maps. The information on the map includes areas that should be driven by the motor (the motor driving area), which are defined by the municipality and other factors. The navigation system **80** can also set the motor driving area by specifying an area, such as an area near the home, through user operation. The navigation system **80** sends a signal to the hybrid ECU **50** to determine whether or not the vehicle is in the motor driving area when driving.
[0043] The next section describes the operation of the hybrid vehicle **20** configured in this way, in particular the operation when driving with driving support control. FIG. **2** shows a flowchart of an example of driving support control executed by the hybrid ECU **50**. This control is executed from when the ignition switch **21** is turned on and the system is started until the end processing is performed.
[0044] When the driving support control is executed, the hybrid ECU **50** first determines whether the predictive information has been updated (step S**100**). In the embodiment, the determination of whether the predictive information has been updated is performed by determining whether an

update signal has been received from the navigation system **80** when the predictive information is generated by the navigation system **80**. When it is determined that the predictive information has been updated, information on the planned or estimated driving route within a predetermined range from the current location is acquired (step S**110**). The predetermined range can be 5 km, 10 km, 15 km, etc. The planned driving route is the driving route planned by the navigation system **80** as route guidance from the current location to the destination by setting the destination, and the estimated driving route is the driving route that is estimated to be traveled from the current location. The information to be acquired includes, in addition to the predictive information described above, the existence of a motor driving area, and if a motor driving area exists, the start and end points of the motor driving area. Then, a driving support plan is created that assigns motor drive mode or normal drive mode to each driving section of the driving route based on the driving route information (step S**120**), and the created driving support plan is started (step S**130**). A driving support plan can be created as follows, for example. First, the motor drive mode is assigned to the driving sections of the driving route that fall within the motor drive area. Next, for the driving sections that do not fall within the motor drive area, the motor drive mode is assigned in order of the driving section load, until the storage ratio SOC of the battery **40** reaches the predetermined stored electricity ratio. Then, the normal drive mode is assigned to the remaining driving sections.

[0045] The hybrid ECU **50** determines whether the vehicle is being driven in motor drive mode (step S**140**) when it determines in step S**100** that the predictive information has not been updated, or after performing the processing from step S**100** to S**130**. The hybrid ECU **50** determines whether the mode selection switch **36** has been operated by the driver (step S**150**) when it has determined that the vehicle is being driven in motor drive mode. The hybrid ECU **50** switches the driving mode to the normal driving mode (step S**160**) and sets the flag Fm to 1 (step S**170**) when it determines that the mode selection switch **36** has been operated by the driver, that is, when it determines that the mode selection switch **36** has been operated by the driver while driving in the motor driving mode. The initial value of the flag Fm is 0, and when the mode selection switch **36** is operated by the driver to switch to the normal driving mode, the value 1 is set, and it is set to the value 0 in the step S**210** described later.

[0046] Next, the hybrid ECU **50** determines whether or not there is a request to switch to motor drive mode based on the driving support plan (step S**180**). The request to switch to motor drive mode is made when driving in normal drive mode and driving through a section of road where motor drive mode is assigned. When the hybrid ECU **50** determines that there is a request to switch to motor drive mode, it determines whether or not the flag Fm has a value of 1 (step S**190**), and when it determines that the flag Fm has a value of 1, it determines whether or not a predetermined time has elapsed since the mode selection switch **36** was operated by the driver to switch to the normal driving mode (when the flag Fm was set to 1) (step S**200**). The predetermined time is a time that the driver does not feel too much of a difference when the mode is switched from motor drive mode to normal drive mode and then back to motor drive mode again by operating the mode selection switch **36**, and can be set to a time such as 5 seconds, 10 seconds, or 15 seconds. When the Hybrid ECU **50** determines that the predetermined time has elapsed in Step S**200**, it sets the value 0 to the flag Fm (Step S**210**), switches the driving mode to motor driving mode (Step S**220**), and determines whether or not control has ended (Step S**230**). The determination of whether or not control has ended is made when the destination is reached or when the ignition switch **21** is turned off. When the hybrid ECU **50** determines that control has not ended, it returns to the process of determining whether or not the predictive information in step S**100** has been updated, and when it determines that control has ended, it ends the driving support control.

[0047] When the hybrid ECU **50** determines that a predetermined time has not elapsed since the mode selection switch **36** was operated by the driver in the step S**200** to switch to the normal driving mode (when the flag Fm is set to 1), it determines whether or not the control has ended without switching the driving mode to the motor driving mode and retains the normal driving mode

(step S**230**). On the other hand, if it is determined that the control has not ended, it returns to step S**100**, and if it is determined that the control has ended, the driving support control is ended. That is, the normal driving mode is maintained without switching to the motor driving mode until a predetermined time has elapsed from the time the mode selection switch **36** is operated by the driver to switch to the normal driving mode (when the flag Fm is set to 1). As a result, the driver can be relieved of any discomfort caused by the mode selection switch **36** being operated by the driver to switch to the normal driving mode and then being switched to the motor driving mode within a short period of time.

[0048] When the hybrid ECU **50** determines that the flag Fm is not equal to 1 (it is equal to 0) in step S**190**, it immediately switches the driving mode from the normal driving mode to the motor driving mode (step S**220**), and then determines whether or not the control has ended (step S**230**). Then, if it is determined that the control has not ended, it returns to step S**100**, and if it is determined that the control has ended, it ends the driving support control.

[0049] When the Hybrid ECU **50** determines that there is no request to switch to motor drive mode in Step S**180**, it retains the current driving mode and determines whether or not control should end (Step S**230**). Then, if it determines that control should not end, it returns to Step S**100**, and if it determines that control should end, it ends the driving support control.

[0050] When the Hybrid ECU **50** determines that the vehicle is not being driven in motor drive mode (it is being driven in normal drive mode) in Step S**140**, or when it determines that the vehicle is being driven in motor drive mode in Step S**140** but that the driver has not operated the mode selection switch **36** in Step S**150**, it retains the drive mode and carries out the processing from Step S**180** onwards.

[0051] In the hybrid vehicle **20** described above, when the mode selection switch **36** is operated by the driver while the vehicle is running in motor drive mode to switch to normal drive mode, the normal drive mode is maintained even if the motor drive mode is requested based on the driving support plan until a predetermined time has elapsed. This reduces the sense of discomfort experienced by the driver when the mode selection switch **36** is operated by the driver to switch to normal driving mode and then switched to motor driving mode within a short period of time.

[0052] In the embodiment of the hybrid vehicle **20**, when the mode selection switch **36** is operated by the driver while driving in motor drive mode to switch to normal drive mode, normal drive mode is maintained until a predetermined time has elapsed. However, it may also be the case that the normal driving mode is maintained until the predetermined time has elapsed even when the driver attempts to switch the driving mode to the motor driving mode by operating the mode selection switch **36** while driving in the normal driving mode, but the system refuses to switch to the motor driving mode for its own reasons. Also, when the motor drive mode is cancelled and the normal drive mode is switched to while driving in the motor drive mode, the normal drive mode may be maintained until the predetermined time has elapsed. An example of driving support control when the switch to the motor drive mode is rejected is shown in FIG. **3**, and an example of driving support control when the motor drive mode is cancelled is shown in FIG. **4**. The following will be explained in order.

[0053] In the driving support control shown in FIG. **3**, in the same way as steps S**100** to S**130** of the driving support control shown in FIG. **2**, when the predictive information is updated (step S**300**), obtain information on the planned or estimated driving route within a predetermined range from the current location (Step S**310**), create a driving support plan that assigns motor drive mode or normal drive mode to each driving section of the driving route based on the driving route information (Step S**320**), and start executing the created driving support plan (Step S**330**).

[0054] Next, the hybrid ECU **50** determines whether the vehicle is being driven in normal driving mode (step S**340**). When the hybrid ECU **50** determines that the vehicle is being driven in normal driving mode, it determines whether the mode selection switch **36** has been operated by the driver (step S**350**). When the hybrid ECU **50** determines that the mode selection switch **36** has been

operated by the driver, that is, when it determines that the mode selection switch **36** has been operated by the driver while driving in the normal driving mode, it determines whether or not the switchover to the motor driving mode has been rejected (step S**360**). The rejection of the switch to motor drive mode is due to an event that makes it difficult to drive using the motor drive mode, and the following events can be cited as examples, the catalyst is warming up, the state of charge (SOC) of the battery **40** is below a specified value, the temperature of the battery **40** is low, the vehicle speed Vis above a specified speed, and the accelerator opening angle Acc is above a specified angle. When the Hybrid ECU **50** determines that the driver has rejected the switch to motor drive mode, it will light a caution to inform the driver that the switch to motor drive mode has been rejected (step S**380**), and set the flag Fr to 1 (step S**390**). The caution light is set to turn on for a shorter time than the predetermined time (step S**420**) described below. The flag Fr has an initial value of 0, and when the driver rejects the mode selection switch **36** operation to switch to the motor drive mode, the value 1 is set, and it is set to 0 in the step S**430** described below. When the hybrid ECU **50** determines that the switch to motor drive mode has not been rejected in step S**360**, it switches the drive mode from normal drive mode to motor drive mode (step S**370**).

[0055] Next, the hybrid ECU **50** determines whether or not there is a request to switch to motor drive mode based on the driving support plan (step S**400**). When the hybrid ECU **50** determines that there is a request to switch to motor drive mode, it determines whether or not the flag Fr has a value of 1 (step S**410**). When the flag Fr is determined to have a value of 1, it determines whether or not a predetermined time has elapsed since the driver's operation of the mode selection switch **36** to switch to motor drive mode was rejected (step S**420**). The predetermined time is a time long enough for the driver not to feel too much of a difference when the motor drive mode is switched to the motor drive mode by the driving support control after the switch to the motor drive mode is rejected, and is longer than the time for the caution lamp to light up in Step S**380**. The predetermined time can be 5, 10, or 15 seconds, for example. When the Hybrid ECU **50** determines that the predetermined time has elapsed in Step S**420**, it sets the flag Fr to 0 (Step S**430**), switches the driving mode from normal driving mode to motor driving mode (Step S**440**), and determines whether or not control has ended (Step S**450**). When it is determined that the control is not over, it returns to step S**300**, and when it is determined that the control is over, the driving support control is ended.

[0056] In this way, when the driver operates the mode selection switch **36** to switch to motor drive mode while driving in normal drive mode, but the system refuses to switch to motor drive mode, the system will maintain normal drive mode even if motor drive mode is requested based on the driving support plan until the predetermined time has elapsed. As a result, the discomfort caused to the driver by the system switching to motor drive mode within a short time after the driver has switched to motor drive mode based on operation of the mode selection switch **36** can be reduced. In addition, when the system refuses to switch to motor drive mode, a caution is lit to inform the driver that the system has refused to switch to motor drive mode. In this case, because the predetermined time is set to be longer than the time the caution is lit, the caution that notifies the driver that the switch to motor drive mode has been rejected will remain lit for a certain period of time before the switch to motor drive mode is made in response to a request for motor drive mode based on the driving support plan. In this way, the sense of discomfort experienced by the driver can be reduced even further.

[0057] In the driving support control shown in FIG. **4**, in the same way as steps S**100** to S**130** of the driving support control shown in FIG. **2**, when the predictive information is updated (step S**500**), the hybrid ECU **50** obtains information on the planned or estimated driving route within a predetermined range from the current location (step S**510**), creates a driving support plan that assigns motor drive mode or normal drive mode to each driving section of the driving route based on the driving route information (step S**520**), and starts executing the created driving support plan (step S**530**).

[0058] Next, the hybrid ECU **50** determines whether the vehicle is driving in motor drive mode (step S**540**). When it is determined that the vehicle is driving in motor drive mode, it is determined whether there is a request to cancel the motor drive mode (step S**550**). The request to cancel the motor drive mode is made due to an event that makes it difficult to continue the motor drive mode, for example, when the state of charge (SOC) of the battery **40** is below a specified value, when the vehicle speed V is above a specified speed, or when the accelerator opening angle Acc is above a specified angle. When it is determined that a request to cancel the motor drive mode has been made, the driving mode is switched from the motor drive mode to the normal driving mode (step S**560**), a caution is lit to inform the driver that the motor drive mode has been cancelled (step S**570**), and the flag Fc is set to 1 (step S**580**). The caution light is set to turn on for a shorter time than the predetermined time (step S**610**) described below. The flag Fc has an initial value of 0, and is set to 1 when the motor drive mode is cancelled, and is set to 0 in step S**620** described below. When it is determined that there is no request to cancel the motor drive mode in step S**550**, normal driving mode will continue.

[0059] Next, the hybrid ECU **50** determines whether or not there is a request to switch to motor drive mode based on the driving support plan (step S**590**). When it is determined that there is a request to switch to motor drive mode, it is determined whether or not flag Fc has a value of 1 (step S**600**). Then, when it is determined that flag Fc has a value of 1, it is determined whether or not a predetermined time has elapsed since the motor drive mode was cancelled (step S**610**). The predetermined time is a time that the driver does not feel too much of a difference when the motor drive mode is switched to the motor drive mode by the driving support control after the motor drive mode is cancelled, and it is a time that is longer than the caution lamp lighting time in step S**570**. The predetermined time can be 5 seconds, 10 seconds, 15 seconds, etc. for example. When the Hybrid ECU **50** determines that the predetermined time has elapsed in Step S**610**, it sets the value 0 to the flag Fc (Step S**620**), switches the driving mode from normal driving mode to motor driving mode (Step S**630**), and determines whether or not control has ended (Step S**640**). When it is determined that the control is not finished, it returns to step S**500**, and when it is determined that the control is finished, the driving support control is terminated.

[0060] When the motor drive mode is cancelled while the vehicle is travelling in motor drive mode, the motor drive mode is retained until the predetermined time has elapsed, even if the motor drive mode is requested based on the driving support plan. As a result, the sense of discomfort experienced by the driver when the motor drive mode is switched to within a short time after the motor drive mode is cancelled can be reduced. In addition, when the motor drive mode is cancelled, the caution light comes on, so the driver is notified that the motor drive mode has been cancelled. In this case, because the predetermined time is set to be longer than the time the caution is lit, the switch to motor drive mode based on the driving support plan is carried out after a certain amount of time has passed since the caution lighting to inform the driver that the motor drive mode has been cancelled has finished illuminating. This reduces the sense of discomfort for the driver.

[0061] In the hybrid vehicle of the present disclosure, the controller, when the switchover to the motor running mode described above is rejected, may provide notification that the switchover to the motor running mode has been rejected for a second predetermined time that is shorter than the first predetermined time, the controller, when the motor running mode is cancelled, may provide notification that the motor running mode has been cancelled for a second predetermined time that is shorter than the first predetermined time. This way, the driver can be informed of the refusal to switch to the motor driving mode or the cancellation of the motor driving mode.

[0062] The following is a description of the correspondence between the main elements of the embodiment and the main elements of the disclosure described in the section on means to solve the problem. In the embodiment, the engine EG corresponds to “the engine”, the motor MG corresponds to “the motor”, the battery **40** corresponds to the “the power storage device”, the mode selection switch **36** corresponds to “the mode selection switch”, and the hybrid electronic control

unit **50** corresponds to “the controller”.
[0063] The correspondence between the major elements of the embodiment and the major elements of the disclosure described in the means to solve a problem section is an example of how the embodiment can be used to specifically explain the embodiment of the disclosure described in the means to solve a problem section. This does not limit the elements of the disclosure described in the means to solve the problem section. In other words, interpretation of the disclosure described in the means to solve a problem section should be based on the description in that section, and the embodiment is only one specific example of the disclosure described in the means to solve a problem section.
[0064] The above is a description of the form for implementing this disclosure using the embodiment. However, the present disclosure is not limited in any way to these embodiments, and can of course be implemented in various forms within the scope that does not depart from the gist of the present disclosure.
INDUSTRIAL APPLICABILITY
[0065] This disclosure can be used in the hybrid vehicle manufacturing industry, for example.

Claims

1. A hybrid vehicle comprising: an engine capable of outputting power for driving; a motor capable of outputting power for driving; a power storage device capable of exchanging electric power with the motor; a power storage device capable of exchanging electric power with the motor; a mode selection switch that switches between a motor driving mode, in which the vehicle is driven by the power from the motor while the engine is stopped, and a normal driving mode, in which the vehicle is driven by the power from the engine and the power from the motor as necessary; and, a controller configured to create a driving support plan that assigns the motor driving mode and the normal driving mode to each driving section of the set or estimated driving route, and executes driving support control that controls the engine and the motor such that they drive based on the driving support plan; wherein the controller maintains the normal driving mode even if there is a request to switch to the motor driving mode based on the driving support plan until a predetermined time has elapsed when the controller switches the motor driving mode to the normal driving mode by operating the mode selection switch.
2. A hybrid vehicle comprising: an engine capable of outputting power for driving; a motor capable of outputting power for driving; a power storage device capable of exchanging electric power with the motor; a mode selection switch that switches between a motor driving mode, in which the vehicle is driven by the power from the motor while the engine is stopped, and a normal driving mode, in which the vehicle is driven by the power from the engine and the power from the motor as necessary; and, a controller configured to create a driving support plan that assigns the motor driving mode and the normal driving mode to each driving section of the set or estimated driving route, and executes driving support control that controls the engine and the motor such that they drive based on the driving support plan; wherein the controller maintains the normal driving mode even if there is a request to switch to the motor driving mode based on the driving support plan until the first predetermined time has elapsed, where the switch to the motor driving mode is rejected when the motor driving mode is switched to by operating the mode selection switch, or where the motor driving mode is cancelled while driving in the motor driving mode.
3. The hybrid vehicle according to claim 2, wherein the controller, when the switchover to the motor running mode is rejected, provides notification that the switchover to the motor running mode has been rejected for a second predetermined time that is shorter than the first predetermined time.
4. The hybrid vehicle according to claim 2, wherein the controller, when the motor running mode is

cancelled, provides notification that the motor running mode has been cancelled for a second predetermined time that is shorter than the first predetermined time.