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VEHICLE CONTROL SYSTEM AND VEHICLE

Abstract

A vehicle control system includes a portable terminal in which application software associated with a vehicle equipped with an engine is installed, and an on-vehicle control device is configured to store a plurality of torque upper limit maps each defining an upper limit of torque of the engine for each version of the application software, and to communicate with the portable terminal. The on-vehicle control device is configured to change a first torque upper limit map among the plurality of torque upper limit maps to a second torque upper limit map among the plurality of torque upper limit maps, on a basis of an update of the version of the application software installed in the portable terminal, and to use the second torque upper limit map for controlling the vehicle.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2024-023863, filed on Feb. 20, 2024, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to a vehicle control system and a vehicle.

BACKGROUND

[0003] A control device called an electronic control unit (ECU) is mounted on a vehicle. The control device includes a control unit such as a central processing unit (CPU). The control device includes a storage unit that stores one or more programs. The control unit executes one or more programs stored in the storage unit to achieve a function of the control device. In order to improve the function of the control device, it has been proposed to rewrite and update the program stored in the storage unit to a newer version.

[0004] For example, a method of updating a program (hereinafter, referred to as software) for executing control of a vehicle, such as an engine control program, has been proposed. In this updating method, when the download of the installation package of the new version of the software is completed, a notification that the software update process is executed is sent to an information terminal of a user of the vehicle. Thereafter, the update process is started at least when the information terminal receives a predetermined operation by the user, such as an operation of accepting the start of the update process, and when the vehicle is locked (see, for example, Japanese Unexamined Patent Application Publication No. 2022-033188).

[0005] As described above, before the software for executing the control of the vehicle is actually updated, the preprocess, such as the download of the installation package and the notification to the information terminal that the software update process is executed, is needed. However, when such preprocess is needed, it is difficult to smoothly update the software. For example, when the upper limit of the torque of the engine is changed by updating software, if the above-described preprocess occurs every time the upper limit of the torque is changed, it might take time until the software is actually updated.

SUMMARY

[0006] It is therefore an object of the present disclosure to provide a vehicle control system and a vehicle that change an upper limit of engine torque without updating software controlling the vehicle.

[0007] The above object is achieved by a vehicle control system including: a portable terminal in which application software associated with a vehicle equipped with an engine is installed; and an on-vehicle control device is configured to store a plurality of torque upper limit maps each defining an upper limit of torque of the engine for each version of the application software, and to communicate with the portable terminal, wherein the on-vehicle control device is configured to change a first torque upper limit map among the plurality of torque upper limit maps to a second torque upper limit map among the plurality of torque upper limit maps, on a basis of an update of the version of the application software installed in the portable terminal, and to use the second torque upper limit map for controlling the vehicle.

[0008] The on-vehicle control device may be configured to change the first torque upper limit map to the second torque upper limit map every time the version is updated.

[0009] The on-vehicle control device may be configured to change the first torque upper limit map to the second torque upper limit map, when a shift to a circuit mode in which driving performance of the vehicle is improved in a circuit is requested from the portable terminal while the vehicle is

stopped.
[0010] Also, the above object is achieved by a vehicle including: an engine; a storage device configured to store a plurality of torque upper limit maps each defining an upper limit of torque of the engine for each version of application software installed in a portable terminal and associated with a vehicle equipped with the engine; and a control device configured to communicate with the portable terminal, to change a first torque upper limit map among the plurality of torque upper limit maps to a second torque upper limit map among the plurality of torque upper limit maps on a basis of an update of the version of the application software installed in the portable terminal, and to use the second torque upper limit map for controlling the vehicle.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0011] FIG. **1** is a view illustrating an example of a vehicle control system;
[0012] FIG. **2**A is a view illustrating an example of a correspondence table held in a portable terminal;
[0013] FIG. **2**B is a view illustrating an example of a hardware configuration of an engine ECU;
[0014] FIG. **3**A is a view illustrating an example of a first torque upper limit map, FIG. **3**B is a view illustrating an example of a second torque upper limit map, and FIG. **3**C is a view illustrating an example of a third torque upper limit map; and
[0015] FIG. **4** is a processing sequence diagram illustrating an example of an operation of the vehicle control system.
DETAILED DESCRIPTION
[0016] Hereinafter, embodiments of the present disclosure will be described with reference to the drawings.
[0017] As illustrated in FIG. **1**, a vehicle control system ST includes a vehicle **10**, a server **20**, and a portable terminal **30**. Although a smartphone is illustrated as an example of the portable terminal **30** in FIG. **1**, a tablet terminal may be used instead of the smartphone. The vehicle **10**, the server **20**, and the portable terminal **30** cooperate with one another, whereby the vehicle control system TS provides a driver **10**D of the vehicle **10** with a service specific to the circuit station C**1**.
[0018] For example, when the vehicle **10** enters a circuit C**1** and the driver **10**D operates the portable terminal **30** in an office C**2** of the circuit C**1** to activate a circuit application, the portable terminal **30** acquires GPS information including a current position of the vehicle **10** via the server **20**. The circuit application is application software installed in the portable terminal **30** and is associated with the vehicle **10**. The circuit application is used when the vehicle **10** is controlled in a circuit mode.
[0019] The vehicle **10** includes a data communication module (DCM) **11** as a wireless communication device to which an antenna ATN is connected, a DCM-ECU **12**, and a global positioning system (GPS) **13**. The GPS **13** measures the position of the vehicle **10** and holds GPS information including the measured position. The DCM-ECU **12** acquires GPS information from the GPS **13** and transmits the GPS information to the server **20** by radio wave WL via the DCM **11** and the antenna ATN. Therefore, when the server **20** requests the vehicle **10** to transmit the GPS information, the server **20** acquires the GPS information from the vehicle **10**. The GPS information reaches the server **20** via a base station BS and a communication network NW. The communication network NW includes one or both of the Internet and a local area network (LAN). When the portable terminal **30** requests the server **20** to transmit the GPS information, the server **20** transmits the GPS information to the portable terminal **30** by the radio wave WL via the communication network NW and the base station BS. Thus, the portable terminal **30** acquires the GPS information of the vehicle **10**.

[0020] The server **20** also holds map information (hereinafter referred to as circuit information) including the position or area of the circuit C**1**. When the portable terminal **30** requests the server **20** to transmit the circuit information, the server **20** transmits the circuit information to the portable terminal **30** by the radio wave WL via the communication network NW and the base station BS. Thus, the portable terminal **30** acquires the circuit information.
[0021] When the portable terminal **30** acquires the GPS information and the circuit information, the portable terminal **30** determines whether or not the current position of the vehicle **10** is within the circuit C**1** on the basis of the circuit information and the GPS information. When the vehicle **10** is not in the circuit C**1**, the portable terminal **30** rejects a shift to the circuit mode and presents the fact to the driver **10**D on the screen.
[0022] On the other hand, when the vehicle **10** is located in the circuit C**1**, the portable terminal **30** presents a notice of the shift to the circuit mode to the driver **10**D and requests the driver **10**D to accept the shift. In this way, in the circuit mode, it is determined whether or not the position of the vehicle **10** is within the circuit **1** on the basis of the circuit information and the GPS information. Therefore, the circuit mode is different from a sport mode (or a sport driving mode) in which the driving performance is improved only by switching of a switch provided in the vehicle cabin of the vehicle **10** without executing such determination.
[0023] When the portable terminal **30** receives the approval of the shift from the driver **10**D, the portable terminal **30** transmits circuit-mode request information (hereinafter, referred to as request ID (Identifier)), including the approval of the shift, to the server **20**. The request IDs are identification information for requesting the vehicle **10** to shift to the circuit mode. Each of the request IDs is prepared and defined for each version of the circuit application. Therefore, when the version of the circuit application is updated, different independent request ID is transmitted on the basis of the update of the version.
[0024] When the request ID is transmitted from the portable terminal **30** to the server **20**, the server **20** generates switching information including the request ID and transmits the switching information to the vehicle **10**. The switching information is information for switching the driving performance of the vehicle **10** to driving performance specialized for the circuit C**1**, which will be described in detail later. For example, the server **20** transmits the switching information to the vehicle **10** by a short message service (SMS).
[0025] In the vehicle **10**, the DCM-ECU **12** receives the switching information from the server **20** via the DCM **11** and the antenna ATN. The vehicle **10** includes an engine **14**, an engine ECU **15**, a display device **16**, and a meter ECU **17**. The engine ECU **15** is an example of an on-vehicle control device. The display device **16** is provided in the vehicle cabin of the vehicle **10**.
[0026] When the DCM-ECU **12** receives the switching information, the DCM-ECU **12** transmits the switching information to the engine ECU **15** by use of a controller area network (CAN) signal. When the engine ECU **15** receives the switching information, the engine ECU**15** changes the control of the engine **14** based on the request ID included in the switching information. For example, the engine ECU **15** changes a torque upper limit map (hereinafter, simply referred to as torque map) that defines an upper limit of the torque of the engine **14**. Thus, the engine **14** is operated in the circuit mode in which high torque is output. In this way, the driving performance of the vehicle **10** is improved in the circuit mode as compared with the normal driving mode.
[0027] When the engine ECU **15** changes the control of the engine **14**, the engine ECU **15** transmits meter display control information to the meter ECU **17**. The meter display control information is information for controlling display of a tachometer provided in the display device **16**. For example, when the engine ECU **15** changes the torque map, the engine ECU **15** generates meter display control information and transmits the meter display control information to the meter ECU **17**. The meter ECU **17** controls the display of the tachometer based on the meter display control information. When the circuit mode is selected, a boundary rotational speed between a first meter display region and a second meter display region on the high rotational speed side adjacent to

the first meter display area is changed to the high rotational speed side. The first and second meter display regions indicate a rotational speed of the engine **14**.
[0028] Thus, the meter display is shifted from the normal driving mode to the circuit mode. As a result, the driver **10**D recognizes that the circuit mode is selected. In this way, the circuit mode is selected, whereby the service of conveying the enjoyment of the motor sports to the driver **10**D is provided.
[0029] Next, the portable terminal **30** will be described in detail with reference to FIG. **2**A.
[0030] As illustrated in FIG. **2**A, the portable terminal **30** includes a non-volatile memory (NVM) **31**. The NVM **31** stores a correspondence table of version IDs for identifying versions of the circuit application and the request IDs. For example, a request ID “#1” is associated with a version ID “Ver1”. A request ID “#2” is associated with a version ID “Ver2”. Thus, when the version of the circuit application is updated from, for example, the version ID “Ver1” to the version ID “Ver2”, the portable terminal **30** transmits the request ID “#2”.
[0031] Next, referring to FIGS. **2**B and **3**A to **3**C, the engine ECU **15** will be described in detail. Hardware configurations of the DCM-ECU **12** and the meter ECU **17** are basically the same as the hardware configuration of the engine ECU **15**, and thus detailed description thereof will be omitted. The engine ECU **15** indirectly communicates with the portable terminal **30** via the DCM-ECU **12**, the server **20**, or the like.
[0032] The engine ECU **15** is a hardware circuit including a CPU **15**A, a random access memory (RAM) **15**B, a read only memory (ROM) **15**C, and an input and output interface (I/F) **15**D. The CPU **15**A is an example of a control device such as a processor, and indirectly communicates with the portable terminal **30**. The ROM **15**C is an example of a storage device. The CPU **15**A, the RAM **15**B, the ROM **15**C, and the input and output I/F **15**D are connected to one another via an internal bus **15**E. Although omitted in FIG. **2**B, the input and output I/F **15**D is connected to the DCM-ECU **12**, the engine **14**, and the meter ECU **17**. At least the CPU **15**A and the RAM **15**B cooperate with each other to achieve a computer.
[0033] In the RAM **15**B mentioned above, the software pre-stored in the ROM **15**C is stored by the CPU **15**A. The CPU **15**A executes the stored software, and then the CPU **15**A executes a series of processes described later. The software may be in accordance with a processing sequence diagram described later.
[0034] The ROM **15**C stores a plurality of torque maps for respective of the request IDs. Each of the torque maps defines an upper limit of the torque of the engine **14**. The request IDs are prepared and defined for respective versions of the circuit application. This means that the plurality of torque maps is stored in the ROM **15**C for respective versions of the circuit application.
[0035] For example, as illustrated in FIG. **3**A, a first torque map MP**1** is stored in the ROM **15**C as one of the plurality of torque maps. The first torque map MP**1** is associated with the request ID “#1”. In the first torque map MP**1**, the upper limit of the torque is defined by a constant torque “TQ**1**” from the engine speed “NE**1**” to the engine speed “NE**2**”. When the engine speed is lower than the engine speed “NE**1**”, the upper limit of the torque increases. When the engine speed is higher than the engine speed “NE**2**”, the upper limit of the torque decreases. In this way, the first torque map MP**1** is defined in a trapezoidal shape excluding a lower bottom.
[0036] As illustrated in FIG. **3**B, a second torque map MP**2** is stored in the ROM **15**C as one of the plurality of torque maps. The second torque map MP**2** is associated with the request ID “#2”. In the second torque map MP**2**, the upper limit of the torque is defined as a constant torque “TQ**2**” higher than the torque “TQ**1**”, from the engine speed “NE**1**” to the engine speed “NE**2**”.
[0037] In the second torque map MP**2**, when the engine speed is lower than the engine speed “NE**1**”, the upper limit of the torque increases in a stepwise manner. Specifically, when the engine speed is lower than the engine speed “NE**0**”, the upper limit of the torque increases at the same gradient as the first torque map MP**1**. On the other hand, the upper limit of the torque increases at a gradient steeper than the gradient of the first torque map MP**1** from the engine speed “NE**0**” to the

engine speed "NE**1**".

[0038] When the engine speed is higher than the engine speed "NE**2**", the upper limit of the torque decreases in a stepwise manner. Specifically, when the engine speed is higher than the engine speed "NE**3**", the upper limit of the torque decreases at the same gradient as the first torque map MP**1**. On the other hand, the upper limit of the torque decreases at a gradient steeper than the gradient of the first torque map MP**1** from the engine speed "NE**2**" to the engine speed "NE**3**". Thus, the second torque map MP**2** is defined in a shape different from that of the first torque map MP**1**.

[0039] In addition, as illustrated in FIG. **3**C, a third torque map MP**3** is stored in the ROM **15**C as one of the plurality of torque maps. The third torque map MP**3** is associated with the request ID "#3". In the third torque map MP**3**, the upper limit of the torque is defined by a constant torque "TQ**3**" higher than the torque "TQ**2**" from the engine speed "NE**1**" to the engine speed "NE**2**".

[0040] In the third torque map MP**3**, the upper limit of the torque increases in a stepwise manner when the engine speed is lower than the engine speed "NE**1**". Specifically, when the engine speed is lower than the engine speed "NE**0**", the upper limit of the torque increases at the same gradient as the first torque map MP**1**. On the other hand, the upper limit of the torque increases at a gradient steeper than the gradient of the second torque map MP**2** from the engine speed "NE**0**" to the engine speed "NE**1**".

[0041] When the engine speed is higher than the engine speed "NE**2**", the upper limit of the torque decreases in a stepwise manner. In concrete terms, when the engine speed is higher than the engine speed "NE**3**", the upper limit of the torque decreases at the same gradient as the first torque map MP**1**. On the other hand, the upper limit of the torque decreases at a gradient steeper than the gradient of the second torque map MP**2** from the engine speed "NE**2**" to the engine speed "NE**3**". In this way, the third torque map MP**3** is defined in a shape different from those of the first torque map MP**1** and the second torque map MP**2**.

[0042] Next, the operation of the vehicle control system ST will be described with reference to FIG. **4**.

[0043] First, the portable terminal **30** waits until the circuit application is activated (step S**1**: NO). For example, the portable terminal **30** waits until the driver **10**D performs a predetermined operation to instruct activation of the circuit application on an icon of the circuit application displayed on the portable terminal **30**. When a predetermined operation is performed on the icon of the circuit application and the circuit application is activated (step S**1**: YES), the portable terminal **30** requests determination information from the server **20** and the DCM-ECU **12** (step S**2**). The determination information is information for determining whether or not the position of the vehicle **10** is within the circuit C**1**.

[0044] For example, the portable terminal **30** directly requests the server **20** to transmit the determination information. On the other hand, the portable terminal **30** indirectly requests the DCM-ECU **12** for the determination information. That is, the portable terminal **30** requests the DCM-ECU **12** for the determination information via the server **20**. When the determination information is requested from the portable terminal **30**, the server **20** transmits the circuit information as the determination information to the portable terminal **30** (step S**3**). When the determination information is requested from the portable terminal **30** via the server **20**, the DCM-ECU **12** transmits the GPS information as the determination information to the portable terminal **30** via the server **20** (step S**4**).

[0045] When the portable terminal **30** acquires the GPS information and the circuit information, the portable terminal **30** determines whether or not the current position of the vehicle **10** is within the circuit C**1** (step S**5**). If the current position is not within the circuit C**1** (step S**5**: NO), the portable terminal **30** skips the subsequent process. In this case, the portable terminal **30** rejects the shift to the circuit mode, and thus the control of the vehicle **10** in the circuit mode is stopped.

[0046] On the other hand, if the current position is within the circuit C**1** (step S**5**: YES), the portable terminal **30** determines whether or not there is an approval for the shift to the circuit mode (step S**6**). For example, the portable terminal **30** presents a notice of the shift to the circuit mode to the driver **10**D on the screen of the portable terminal **30**, and requests the driver **10**D to accept the shift. The notes include, for example, an explanation about deterioration of the engine **14**. When the driver **10**D performs an operation to reject the shift to the circuit mode, the portable terminal **30** determines that the driver **10**D does not accept the shift to the circuit mode (step S**6**: NO). In this case, the portable terminal **30** rejects the shift to the circuit mode, and thus the control of the vehicle **10** in the circuit mode is stopped.

[0047] On the other hand, when the driver **10**D performs an operation of accepting the shift to the circuit mode (for example, pressing of an "OK" button as illustrated in FIG. **1**), the portable terminal **30** determines that the driver **10**D accepts the shift to the circuit mode (step S**6**: YES). In this case, the portable terminal **30** transmits the request ID to the server **20** (step S**7**). More specifically, the portable terminal **30** checks a version ID for identifying the version of the current circuit application installed in the portable terminal **30**, and specifies and transmits the request ID corresponding to the version ID. For example, if the version of the circuit application identified by the version ID "Ver2" is installed in the portable terminal **30**, the portable terminal **30** transmits the request ID "#2".

[0048] When the server **20** receives the request ID, the server **20** transmits the switching information to the DCM-ECU **12** (step S**8**). More specifically, when the server **20** receives the request ID, the server **20** generates the switching information including the received request ID and transmits the switching information to the DCM-ECU **12**. When the DCM-ECU **12** receives the switching information, the DCM-ECU **12** transfers the switching information to the engine ECU **15** (step S**9**).

[0049] When the engine ECU **15** receives the switching information, the engine ECU **15** changes the torque map and immediately uses the changed torque map (step S**10**). More specifically, when the engine ECU **15** receives the switching information, the engine ECU **15** extracts the request ID from the switching information, and specifies and selects the torque map corresponding to the extracted request ID. For example, when the request ID "#2" is extracted, the engine ECU **15** specifies and selects the second torque map MP**2** associated with the request ID "#2".

[0050] If the first torque map MP**1** is used for the control of the vehicle **10** before the switching information is received, the engine ECU **15** changes the first torque map MP**1** to the second torque map MP**2** and uses the second torque map MP**2** for the control of the vehicle **10**. When the request ID "#3" is extracted in a state where the second torque map MP**2** is used for the control of the vehicle **10**, the engine ECU **15** changes the second torque map MP**2** to the third torque map MP**3** and uses the third torque map MP**3**.

[0051] As described above, according to the present embodiment, the engine ECU **15** includes the plurality of torque maps. Thus, the upper limit of the torque of the engine **14** is changed without updating software for controlling the vehicle **10** such as engine control software. The engine ECU **15** changes the torque map in conjunction with the version update each time the version of the circuit application is updated. Further, according to the present embodiment, the software is not updated, thereby avoiding the preprocess required for the software update. Therefore, the vehicle control system ST smoothly changes the torque map based on the update of the version of the circuit application.

[0052] Although some embodiments of the present disclosure have been described in detail, the present disclosure is not limited to the specific embodiments but may be varied or changed within the scope of the present disclosure as claimed.

Claims

1. A vehicle control system comprising: a portable terminal in which application software associated with a vehicle equipped with an engine is installed; and an on-vehicle control device is configured to store a plurality of torque upper limit maps each defining an upper limit of torque of the engine for each version of the application software, and to communicate with the portable terminal, wherein the on-vehicle control device is configured to change a first torque upper limit map among the plurality of torque upper limit maps to a second torque upper limit map among the plurality of torque upper limit maps, on a basis of an update of the version of the application software installed in the portable terminal, and to use the second torque upper limit map for controlling the vehicle.

2. The vehicle control system according to claim 1, wherein the on-vehicle control device is configured to change the first torque upper limit map to the second torque upper limit map every time the version is updated.

3. The vehicle control system according to claim 1, wherein the on-vehicle control device is configured to change the first torque upper limit map to the second torque upper limit map, when a shift to a circuit mode in which driving performance of the vehicle is improved in a circuit is requested from the portable terminal while the vehicle is stopped.

4. The vehicle control system according to claim 2, wherein the on-vehicle control device is configured to change the first torque upper limit map to the second torque upper limit map, when a shift to a circuit mode in which driving performance of the vehicle is improved in a circuit is requested from the portable terminal while the vehicle is stopped.

5. A vehicle comprising: an engine; a storage device configured to store a plurality of torque upper limit maps each defining an upper limit of torque of the engine for each version of application software installed in a portable terminal and associated with a vehicle equipped with the engine; and a control device configured to communicate with the portable terminal, to change a first torque upper limit map among the plurality of torque upper limit maps to a second torque upper limit map among the plurality of torque upper limit maps on a basis of an update of the version of the application software installed in the portable terminal, and to use the second torque upper limit map for controlling the vehicle.