Title of the Invention: Methods and systems for energy management in vehicles

INT CL: B60L 58/14 (2019.01) B60W 10/26 (2006.01) H02J 7/00 (2006.01)

Application No: 1706082.3
Date of Filing: 18.04.2017

Priority Data:
- 201741005401 (31) 15.02.2017 IN

Date of A Publication: 22.08.2018

Documents Cited:
- GB 2498817 A
- CN 103522909 B
- US 5793189 A
- US 20140176085 A1
- US 20100082198 A1

Field of Search:
As for published application 2559819 A viz:
INT CL B60L, B60W, H02J
Other: EPDOC, WPI
updated as appropriate

Inventor(s):
- Aravind Gorripati
- Jayanta Borah
- Allabakah Naikodi
- Mahesh Babu

Proprietor(s):
Mahindra Electric Mobility Limited
Plot No. 66 to 69 & 72 to 76,
Bommasandra Industrial Area, 4th Phase,
Jigani Link Road, Anekal Taluk, Bangalore 560099,
Karnataka, India

Agent and/or Address for Service:
Albright IP Limited
County House, Bayshill Road, CHELTENHAM,
Gloucestershire, GL50 3BA, United Kingdom
Vehicle enters idle state

Monitor the time spend in idle state

Is $T_1 > Th_1$?

If No, return to normal state

If Yes, initiate the first state

Has the wake-up trigger been detected?

If No, Is $T_2 > Th_2$?

Proceed to A

FIG. 2a
Initiate the second state

Has the wake-up trigger been detected?

Is T3 > Th3?

Initiate the third state

Has the exit trigger been detected?

Are the the voltages of the batteries in the operating range?

Shut down the vehicle

FIG. 2b
“Methods and systems for energy management in vehicles”

TECHNICAL FIELD

[001] Embodiments disclosed herein relate to energy management in vehicles, and more particularly to energy management in vehicles by managing power supplied to modules and systems present in the vehicle.

BACKGROUND

[002] Currently, due to a growing environmental consciousness in society, use of vehicles powered by alternative sources of energy has become popular. Examples of vehicles powered by alternative sources of energy are hybrid vehicles, electric vehicles, hydrogen powered vehicles, solar powered vehicles and so on. However, a limitation of such vehicles is that there is a limited amount of energy available for storage in the vehicle (typically in a battery present on-board the vehicle). The range of the vehicle is limited by the capacity and state of charge of the battery on board the vehicle. A short-range vehicle would require one or more stops during a trip to recharge, when it is used to travel long distances. Hence, the energy needs to be utilized efficiently to improve drivable range of the vehicle. Energy consumed during nonoperational period by the electrical and electronic systems/modules present in the vehicle impacts the drivable range of the vehicle during long idle conditions.

OBJECTS

[003] The principal object of this invention is to disclose methods and systems for energy management in vehicles by managing power supplied to
modules and systems present in the vehicle, based on the idle condition of the vehicle.

[004] Another object of the invention is to disclose methods and systems for energy management in vehicles by managing power supplied to modules and systems present in the vehicle by operating the vehicle in a plurality of levels, wherein the levels depend on the idle condition of the vehicle.

**STATEMENT OF INVENTION**

[005] In accordance with the first aspect of the present invention, there is provided a method of managing energy in a vehicle as set out by claim 1. Preferable or optional features are set out in claims 2 and 3.

[006] In accordance with the second aspect of the present invention, there is provided a system for managing energy in a vehicle as set out by claim 4. Preferable or optional features are set out in claims 5 and 6.

**BRIEF DESCRIPTION OF FIGURES**

[007] Embodiments herein are illustrated in the accompanying drawings, through out which like reference letters indicate corresponding parts in the various figures. The embodiments herein will be better understood from the following description with reference to the drawings, in which:

[008] FIG. 1 depicts a system in a vehicle for managing power supplied to modules and systems present in the vehicle, based on the idle condition of the vehicle, according to embodiments as disclosed herein; and

[009] FIGs. 2a and 2b are flowcharts depicting a process of managing power supplied to modules and systems present in the vehicle,
based on the idle condition of the vehicle, according to embodiments as disclosed herein.

**DETAILED DESCRIPTION**

[0010] The embodiments herein and the various features and advantageous details thereof are explained more fully with reference to the non-limiting embodiments that are illustrated in the accompanying drawings and detailed in the following description. Descriptions of well-known components and processing techniques are omitted so as to not unnecessarily obscure the embodiments herein. The examples used herein are intended merely to facilitate an understanding of ways in which the embodiments herein may be practiced and to further enable those of skill in the art to practice the embodiments herein. Accordingly, the examples should not be construed as limiting the scope of the embodiments herein.

[0011] The embodiments herein disclose methods and systems for energy management in vehicles by managing power supplied to modules and systems present in the vehicle, based on the idle condition of the vehicle. Referring now to the drawings, and more particularly to FIGS. 1 through 2, where similar reference characters denote corresponding features consistently throughout the figures, there are shown preferred embodiments.

[0012] The vehicle as referred to herein can be a vehicle with limited on-board energy. Examples of the vehicle can be but not limited to a vehicle powered by electricity, hydrogen, solar energy or any other form of energy, where the vehicle utilizes the energy stored in energy storage systems present in the vehicle (such as batteries, super capacitors, rechargeable traction batteries, electric double-layer capacitors or flywheel energy storage, and so on).

[0013] FIG. 1 depicts a system in a vehicle for managing power supplied to modules and systems present in the vehicle, based on the idle
condition of the vehicle. The system 100, as depicted, comprises of a control unit (CU) 101, at least one battery 102, a converter 103, a plurality of relays 104, and 105, a plurality of loads 106a, 106b, 106c, and an auxiliary battery 107. The loads may be at least one of low voltage loads 106a, 106c and high voltage loads 106b. Examples of the low voltage loads 106a, 106c can be BCM (Body Controller Module), TPMS (Tyre Pressure Monitoring System), infotainment systems, and so on. Examples of the high voltage loads 106b can be chargers, auxiliary inverters, HVAC (Heating Ventilation Air Conditioning) systems, motor controllers, and so on. The CU 101 can be connected to various systems and modules present in the vehicle, such as the gearbox, engine status, door status, charge ports, door lock/unlock status, HVAC (Heating, Ventilation and Air Conditioning), and so on. The CU 101 can detect when the vehicle enters idle mode, by monitoring the vehicle systems such as the gearbox, engine, and so on. The converter 103 can continuously provide the loads connected with energy, as required.

[0014] The CU 101 can initiate a first state, on detecting that the vehicle has been in idle state for a first time period (T1) greater than a first pre-defined threshold (Th1). Idle state as disclosed herein can be at least one of all the doors of the vehicle being closed, key is in OFF position, the vehicle not being plugged in for charging, remote functions such as door lock/unlock, HVAC (Heating, Ventilation and Air Conditioning) being OFF, and so on. In the first state, the CU 101 can provide low power commands to all electrical loads 106b, 106c present in the vehicle. If a load 106 present in the vehicle does not have a low power node (such as loads 106a), the CU 101 can put the loads 106a into sleep mode by cutting power supply to the electrical loads 106a using the relay 104. The CU 101 can instruct the loads 106a which have to enter into sleep mode, to save data such as current state, relevant parameters, and so on. In the first state, the CU 101 can check for at least one wake-up trigger. Examples of the wake-up trigger can be at least
one of at least one door of the vehicle being opened, a load being plugged into at least one charging port present in the vehicle, a charger being plugged into the vehicle, a key of the vehicle is moved to an ON position, at least one door of the vehicle being locked/unlocked (either physically or remotely), the HVAC system being turned ON, and so on. On detecting at least one wake-up trigger, the CU 101 can exit the first state and return to normal state.

[0015] If the CU 101 detects that the vehicle has been in an idle state for a second time period (T2) greater than a second pre-defined threshold (Th2), the CU 101 can initiate a second state. Here, Th1<T2. In the second state, the CU 101 can disable the converter 103. In the second state, the CU 101 can check for at least one wake-up trigger. On detecting at least one wake-up trigger, the CU 101 can exit the second state and return to normal state.

[0016] If the CU 101 detects that the vehicle has been in an idle state for a third time period (T3) greater than a third pre-defined threshold (Th3), the CU 101 can initiate a third state. Here, Th1<T3 and Th2<T3. In the third state, the CU 101 can disconnect all the loads 106 from the battery 102 using a relay 105. In the third state, the CU 101 can check for at least one exit trigger. Examples of the exit trigger can be at least one of a manual wake-up switch operation, a charger being plugged into the vehicle, and so on. On detecting at least one exit trigger, the CU 101 can check the battery 102 and the auxiliary battery 107 for the voltage and available capacity. If the voltages of the battery 102 and the auxiliary battery 107 are in the operating range, the CU 102 can exit the third state and return to normal state.

[0017] FIGs. 2a and 2b are flowcharts depicting a process of managing power supplied to modules and systems present in the vehicle, based on the idle condition of the vehicle. On detecting that the vehicle has entered (201) an idle state, the CU 101 monitors (202) the time for which the vehicle is in idle state. The CU 101 checks (203) if T1>Th1. If T1>Th1, the
CU 101 initiates (204) the first state. In the first state, the CU 101 checks (205) for the wake-up trigger. On detecting the wake-up trigger, the CU 101 returns (206) to normal state by exiting the first state. If the CU 101 has not detected the wake-up trigger, the CU 101 checks (207) if T2 > Th2. If T2 > Th2, the CU 101 initiates (208) the second state. In the second state, the CU 101 checks (209) for the wake-up trigger. On detecting the wake-up trigger, the CU 101 returns (206) to normal state by exiting the second state. If the CU 101 has not detected the wake-up trigger, the CU 101 checks (210) if T2 > Th2. If T2 > Th2, the CU 101 initiates (211) the third state. In the third state, the CU 101 checks (212) for the exit trigger. On detecting the exit trigger, the CU 101 checks (213) the battery 102 and the auxiliary battery 107 for the voltage and available capacity. If the voltages of the battery 102 and the auxiliary battery 107 are in the operating range, the CU 102 returns (206) to normal state by exiting the third stage. If the voltages of the battery 102 and the auxiliary battery 107 are in the operating range, the CU 102 shuts (214) down the vehicle. The various actions in method 200 may be performed in the order presented, in a different order or simultaneously. Further, in some embodiments, some actions listed in FIGs. 2a and 2b may be omitted.

[0018] The embodiment disclosed herein describes methods and systems for managing the power supplied to modules and systems present in the vehicle, based on the idle condition of the vehicle. Therefore, it is understood that the scope of the protection is extended to such a program and in addition to a computer readable means having a message therein, such computer readable storage means contain program code means for implementation of one or more steps of the method, when the program runs on a server or mobile device or any suitable programmable device. The method is implemented in a preferred embodiment through or together with a software program written in e.g. Very high speed integrated circuit
Hardware Description Language (VHDL) another programming language, or implemented by one or more VHDL or several software modules being executed on at least one hardware device. The hardware device can be any kind of portable device that can be programmed. The device may also include means which could be e.g. hardware means like e.g. an ASIC, or a combination of hardware and software means, e.g. an ASIC and an FPGA, or at least one microprocessor and at least one memory with software modules located therein. The method embodiments described herein could be implemented partly in hardware and partly in software. Alternatively, the invention may be implemented on different hardware devices, e.g. using a plurality of CPUs.

[0019] The foregoing description of the specific embodiments will so fully reveal the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of preferred embodiments, those skilled in the art will recognize that the embodiments herein can be practiced with modification within the spirit and scope of the embodiments as described herein.
STATEMENT OF CLAIMS

We claim:

1. A method for managing energy in a vehicle, the method comprising

   initiating a first state by a Control Unit (CU) (101), on the CU (101) detecting that the vehicle has been in an idle state for a first time period (T1) greater than a first pre-defined threshold (Th1), wherein initiating the first state comprises at least one of:
   - providing low power commands to at least one load (106b, 106c) present in the vehicle by the CU (101), and
   - putting at least one load (106a) into sleep mode by the CU (101) by cutting power supply to the at least one load (106a) using a first relay (104);

   exiting the first state and returning to normal state by the CU (101) on detecting at least one wake-up trigger;

   initiating a second state by the CU (101), on the vehicle being in the first state, the CU (101) not detecting at least one wake-up trigger and that the vehicle has been in the idle state for a second time period (T2) greater than a second pre-defined threshold (Th2), where the first pre-defined threshold (Th1) is less than the second time period (T2), wherein initiating the second state comprises disabling a converter (103) by the CU (101);

   exiting the second state and returning to normal state by the CU (101) on detecting at least one wake-up trigger;

   initiating a third state by the CU (101), on the vehicle being in the second state, the CU (101) not detecting at least one wake-up trigger and that the vehicle has been in the idle state for a third time period (T3) greater than a third pre-defined threshold (Th3), where the second pre-defined threshold (Th2) is less than the third time period (T3), wherein initiating the third state comprises
disconnecting all loads from a battery (102) using a second relay (105) by the CU (101); and

exiting the third state and returning to normal state by the CU (101) on detecting at least one exit trigger.

2. The method, as claimed in claim 1, wherein the wake-up trigger comprises at least one of at least one door of the vehicle being opened, a load being plugged into at least one charging port present in the vehicle, a charger being plugged into the vehicle, a key of the vehicle is moved to an ON position, at least one door of the vehicle being locked or unlocked, and the HVAC system being turned ON.

3. The method, as claimed in claim 1, wherein the exit trigger comprises at least one of a manual wake-up switch operation, and a charger being plugged into the vehicle.

4. A system (100) for managing energy in a vehicle, the system configured for

   initiating a first state by a Control Unit (CU) (101), on the CU (101) detecting that the vehicle has been in an idle state for a first time period (T1) greater than a first pre-defined threshold (Th1), wherein the CU (101) is configured for initiating the first state by at least one of:

   providing low power commands to at least one load (106) present in the vehicle; and

   putting at least one load (106) into sleep mode by cutting power supply to the at least one load (106) using a first relay (104);
exiting the first state and returning to normal state by the CU (101) on detecting at least one wake-up trigger;

initiating a second state by the CU (101), on the vehicle being in the first state, the CU (101) not detecting at least one wake-up trigger and that the vehicle has been in the idle state for a second time period (T2) greater than a second pre-defined threshold (Th2), where the first pre-defined threshold (Th1) is less than the second time period (T2), wherein the CU (101) is configured for initiating the second state by disabling a converter;

exiting the second state and returning to normal state by the CU (101) on detecting at least one wake-up trigger;

initiating a third state by the CU (101), on the vehicle being in the second state, the CU (101) not detecting at least one wake-up trigger and that the vehicle has been in the idle state for a third time period (T3) greater than a third pre-defined threshold (Th3), where the second pre-defined threshold (Th2) is less than the third time period (T3), wherein the CU (101) is configured for initiating the third state by disconnecting all loads from a battery using a second relay; and

exiting the third state and returning to normal state by the CU (101) on detecting at least one exit trigger.

5. The system, as claimed in claim 4, wherein the wake-up trigger comprises at least one of at least one door of the vehicle being opened, a load being plugged into at least one charging port present in the vehicle, a charger being plugged into the vehicle, a key of the vehicle is moved to an ON position, at least one door of the vehicle being locked or unlocked, and the HVAC system being turned ON.
6. The system, as claimed in claim 4, wherein the exit trigger comprises at least one of a manual wake-up switch operation, and a charger plugged into the vehicle.