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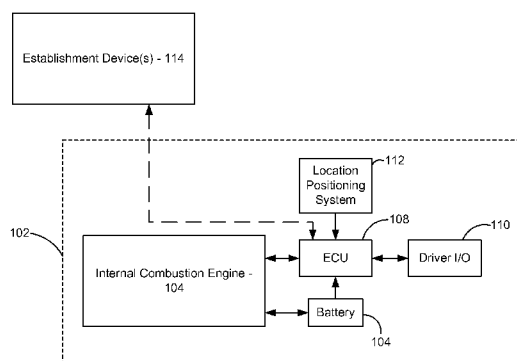


FIG. 1

(57) **Abstract:** Systems and methods for implementing a start-stop feature on a vehicle powered at least in part by an internal combustion engine are described. The method includes receiving, at an electronic control unit ("ECU") of the vehicle, an indication that the vehicle is in line at a drive-thru. The method further includes determining, by the ECU, a number of start-stop events anticipated during the drive-thru. The method includes determining, by the ECU, an approximate stop time for each of the number of start-stop events. The method further includes determining, by the ECU, that a battery of the vehicle has enough remaining charge to power a plurality of vehicle components during implementation of the start-stop feature. The method includes implementing, by the ECU, the start-stop feature in which the internal combustion engine is turned off for at least a portion of the time when the vehicle is stopped.

SMART AUTOMATIC ENGINE START-STOP SYSTEMS AND METHODS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 62/027,084, entitled “SMART AUTOMATIC ENGINE START-STOP SYSTEMS AND METHODS,” filed on July 21, 2014, which is herein incorporated by reference in its entirety and for all purposes.

TECHNICAL FIELD

[0002] The present invention relates generally to automatically stopping and starting an internal combustion engine of a vehicle.

BACKGROUND

[0003] Many vehicles are powered by internal combustion engines. The internal combustion engines burn fuel to power the car. Often, the internal combustion engines remain on in an idle operating state even when a vehicle is not moving (e.g., when a vehicle is stopped at a stop sign). In these situations, fuel is still consumed by the engines even though the vehicles are not moving. Some vehicles address this problem by employing a start-stop system that automatically shuts down and restarts the internal combustion engines under certain operating conditions in which the vehicle remains in idle for extended periods of time to reduce the amount of fuel consumed by the engines. For example, the engine may be shut off when the vehicle is stopped at a stop light, stopped a train crossing, or placed in park. However, in many stop-and-go situations or vehicle creep situations (e.g., as commonly experienced during heavy traffic), vehicles do not remain stopped long enough to effectively implement the start-stop feature. Additionally, during these stop-and-go situations, the repeated restarting of the engine may cause excess battery drain. Thus, the engine control units (ECUs) are configured to identify the stop-and-go and vehicle creep situations and to disable the start-stop system in the identified situations.

[0004] However, some stop-and-go situations that are appropriate for implementing the start-stop feature are misidentified by the ECUs as being inappropriate for the start-stop

system. For example, during certain drive-thru situations, the ECU of a car may classify the vehicle's behavior as ordinary traffic and override the start-stop system even though the start-stop system would reduce the amount of fuel consumed without overly draining the car's battery. The ECUs misidentify these situations occurs because the ECUs are not aware of the exact situation the car is in. Rather, the ECUs use algorithms to determine the situation the car is in and to determine whether or not to employ the start-stop system.

SUMMARY

[0005] One embodiment relates to a method for implementing a start-stop feature on a vehicle powered at least in part by an internal combustion engine. The method includes interpreting, at an electronic control unit (ECU) of the vehicle, an indication that the vehicle is in line at a drive-thru. The method further includes determining, by the ECU, a number of start-stop events anticipated during the drive-thru. The method includes determining, by the ECU, an approximate stop time for each of the number of start-stop events. The method further includes determining, by the ECU, that a battery of the vehicle has enough remaining charge to power a plurality of vehicle components during implementation of the start-stop feature. The method includes implementing, by the ECU, the start-stop feature in which the internal combustion engine is turned off for at least a portion of the time when the vehicle is stopped.

[0006] Another embodiment relates to an apparatus. The apparatus includes a driver input module structured to interpret driver input from a driver of a vehicle via driver controls. The apparatus further includes a communication module structured to send and receive data to and from an establishment device associated with an establishment operating a drive-thru. The apparatus includes a start-stop module in communication with the driver input module and the communication module. The start-stop module structured to implement a start-stop feature in which an internal combustion engine powering the vehicle is stopped during periods of expected extended idling while the vehicle is in a line at the drive-thru to conserve fuel.

[0007] A further embodiment relates to a system. The system includes an internal combustion engine that burns a fuel and powers a vehicle. The system further includes a battery that provides electrical power to at least one component of the system. The system includes a controller. The controller is structured to interpret an indication that the vehicle

is in line at a drive-thru. The controller is further structured to determine a number of start-stop events anticipated during the drive-thru and to determine an approximate stop time for each of the number of start-stop events. The controller is structured to determine that the battery has enough remaining charge to power a plurality of vehicle components during implementation of the start-stop feature. The controller is further structured to implement the start-stop feature in which the internal combustion engine is turned off for at least a portion of the time when the vehicle is stopped, wherein the start-stop feature is implemented based at least in part on determining that the battery has enough remaining charge.

[0008] These and other features, together with the organization and manner of operation thereof, will become apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

[0009] FIG. 1 is a block diagram of an automotive system according to an example embodiment.

[0010] FIG. 2 is a block diagram of an ECU according to an example embodiment.

[0011] FIG. 3 is a flow diagram of a method of implementing a start-stop feature via an ECU of an engine according to an example embodiment.

DETAILED DESCRIPTION

[0012] Referring to the figures generally, a smart start-stop system for a vehicle is described. The vehicle is powered by an internal combustion engine (e.g., a diesel engine, a gas engine, a hydrogen engine, etc.). An electronic control unit (ECU) controls the operation of the internal combustion engine. The ECU includes a start-stop feature that stops the internal combustion engine during periods of expected extended idling (e.g., while the vehicle is stopped at a stop light) to conserve fuel. The ECU can implement the start-stop feature based on predicting an extended idling period by monitoring the vehicle driving characteristics. Additionally, the ECU can implement the start-stop feature based at least in part on information or instructions received from another device indicating expected idling periods. The device may be a driver control device (e.g., a button or a

touchscreen display located within the vehicle's cabin) or third-party devices external to the vehicle (e.g., computing devices that transmit wireless signals). The indicated expected idling periods may relate to expected driving conditions expected as a result of the vehicle entering a drive-thru.

[0013] Referring to FIG. 1, FIG. 1 shows a block diagram of an automotive system 100 according to an exemplary embodiment. The system 100 includes a vehicle 102. The vehicle 102 is powered by an engine 104. The engine 104 is an internal combustion engine that burns a fuel (e.g., gasoline, diesel, etc.) to power the vehicle 102. In some arrangements, the vehicle 102 is a hybrid gas-electric vehicle. The vehicle 102 includes a battery 106. The battery 106 provides electrical power to the components (e.g., stereo system, navigation system, power windows, power locks, etc.) of the vehicle 102. The battery 106 also powers a starter motor that is used to start the engine 104. An alternator of the engine 104 recharges the battery 106 when the engine 104 is on. Additionally, the alternator may provide electrical power to the various components of the vehicle 102 when the engine 104 is on.

[0014] The operation of the engine 104 is controlled by an ECU 108. Accordingly, the ECU 108 includes a controller. Referring to FIG. 2, a block diagram of the ECU 108 is shown according to an example embodiment. As shown in FIG. 2, the ECU 108 includes a processing circuit 202 and memory 206. The processing circuit 202 includes a processor 204. The processor 204 may be implemented as a general-purpose processor, an application specific integrated circuit (ASIC), one or more field programmable gate arrays (FPGAs), a digital signal processor (DSP), a group of processing components, or other suitable electronic processing components. The memory 206 may be RAM, ROM, Flash Memory, hard disk storage, or the like. The memory 206 may store data and/or computer code for facilitating the various processes described herein. Thus, the memory 206 is communicably connected to the processing circuit 202 and provides computer code or instructions to the processor 204 executing the processes described in regard to the ECU 108 herein. Moreover, the memory 206 may be or include tangible, non-transient volatile memory or non-volatile memory. Accordingly, the memory 206 may include database components, object code components, script components, or any other type of information structure for supporting the various activities and information structures described herein. The ECU 108 may be a single device or a distributed device, and the functions of the ECU

108 may be performed by hardware and/or as computer instructions on a non-transient computer readable storage medium.

[0015] In certain embodiments, the ECU 108 includes one or more modules structured to functionally execute the operations of the ECU 108. The description herein including modules emphasizes the structural independence of the aspects of the ECU 108, and illustrates one grouping of operations and responsibilities of the ECU 108. Other groupings that execute similar overall operations are understood within the scope of the present application. The memory 206 is shown to include various modules for completing the activities described herein. More particularly, the memory 206 includes a battery charge determining module 208, a driver input module 210, a gear determining module 212, a brake pedal determining module 214, a communication module 216, and a start-stop module 218. The modules are configured to selectively implement a start-stop feature of the engine 104 as described in further detail below. Each of the modules are communicatively coupled to the each other. While various modules with particular functionality are shown in FIG. 2, it should be understood that the ECU 108 and memory 206 may include any number of modules for completing the functions described herein. For example, the activities of multiple modules may be combined as a single module, as additional modules with additional functionality may be included, etc. Further, it should be understood that the ECU 108 may further control other vehicle activity beyond the scope of the present disclosure. Although shown as being part of the memory 206, the modules may be implemented in hardware and/or as computer instructions on a non-transient computer readable storage medium, and modules may be distributed across various hardware or computer based components.

[0016] Certain operations of the ECU 108 described herein include operations to interpret and/or to determine one or more parameters. Interpreting or determining, as utilized herein, includes receiving values by any method known in the art, including at least receiving values from a datalink or network communication, receiving an electronic signal (e.g. a voltage, frequency, current, or PWM signal) indicative of the value, receiving a computer generated parameter indicative of the value, reading the value from a memory location on a non-transient computer readable storage medium, receiving the value as a run-time parameter by any means known in the art, and/or by receiving a value

by which the interpreted parameter can be calculated, and/or by referencing a default value that is interpreted to be the parameter value.

[0017] Referring again to FIG. 1, the ECU 108 receives driver input via a driver input/output (I/O) 110. The driver I/O may include, for example, driver controls such as a transmission selector, a brake pedal, an accelerator pedal, a clutch pedal, a steering wheel, turn signal indicators, an engine start/stop button or switch, and the like. In some arrangements, the ECU 108 presents various information about the engine 104 and the vehicle 102 to the driver and passengers of the vehicle 102 via display devices of the driver I/O 110. In further arrangements, the vehicle 102 includes a location positioning system 112 that provides vehicle 102 location information to the ECU 108. The location positioning system 112 may include, for example, a GPS receiver. The ECU 108 includes a data transceiver and can send and receive data to and from establishment devices 114. In some arrangements, the data transceiver is a wireless data transceiver, such as a Bluetooth®, WiFi®, or cellular data transceiver. The establishment devices 114 are devices capable of transmitting data to the ECU 108 from a location external to the vehicle 102 (e.g., via a wireless data transmission protocol).

[0018] The ECU 108 includes a smart start-stop feature that stops the internal combustion engine 104 during periods of expected extended idling (e.g., while the vehicle is stopped at a stop light) to conserve fuel. The ECU 108 can implement the start-stop feature based on predicting an extended idling by the engine 104 period by monitoring the vehicle 102 driving characteristics. Generally, the ECU 108 is programmed not to implement the start-stop feature during detected creep or short stop-and-go situations, such as those experienced during heavy traffic. During these situations, although the vehicle 102 may stop for short periods of time, the short duration of the stops and the frequency of the stops may cause excess battery drain due to the repeated restarting of the engine 104. Accordingly, the ECU 108 is programmed to identify these situations and to not implement the start-stop feature during these identified situations. However, as described in further detail below, the ECU 108 can implement the start-stop feature during situations that may be initially identified as the short stop-and-go or creep situations in response to receiving information that indicates successive and extended expected idling periods (e.g., that may be experienced as the vehicle 102 waits in line at a drive-thru). The information

is received from another device (e.g., driver control 110, GPS receiver 112, establishment devices 114, etc.).

[0019] Referring to FIG. 3, a flow diagram of a method 300 of implementing a start-stop feature via an ECU (e.g., ECU 108) of an engine (e.g., engine 104) is shown according to an exemplary embodiment. The engine provides power to a vehicle (e.g., vehicle 102). Method 300 begins when a drive-thru indication is received (302). The drive-thru indication is received by the ECU. The drive-thru indication informs the ECU that the vehicle has entered a drive-thru of an establishment (e.g., a bank, a restaurant, a pharmacy, a coffee shop, etc.).

[0020] In some arrangements, the drive-thru indication is received from a driver input. For example, the driver of the vehicle may indicate that the vehicle has entered the drive-thru by pressing a button or interacting with a touchscreen display of the vehicle. Alternatively, the driver may interact with a smartphone application on the driver's smartphone connected to the ECU 108 via the vehicle's infotainment system.

[0021] In other arrangements, the drive-thru indication is received from a device associated with the establishment operating the drive-thru. For example, the vehicle or ECU may be equipped with a wireless data receiver or transceiver (e.g., Bluetooth, WiFi, RFID, etc.) that receives a wireless signal broadcast by a computing device associated with the establishment when the vehicle enters the drive-thru. The computing device may include any of at least one beacon emitter (e.g., a Bluetooth Low Energy beacon, an iBeacon, etc.), at least one RFID tag (e.g., embedded in the pavement or a wall adjacent to the drive-thru), a wireless network router/hub broadcasting a drive-thru specific SSID, or a combination thereof. The ECU picks up the signal broadcast by the computing device and determines that the car is within the broadcast radius of the computing device. If the computing device is associated with a drive-thru of an establishment, the ECU determines the location of the vehicle as being in the drive-thru area. The association may be determined by referencing a device ID received via the wireless transmission to a database of known device IDs associated with drive-thru locations or based on a drive-thru indication contained within the received wireless transmission.

[0022] In further arrangements, the drive-thru indication is self-generated by the ECU. For example, the ECU may be programmed with the specific locations (e.g., coordinates)

of drive-thru locations of various establishments. As the vehicle is driven, the ECU receives vehicle location information from a locations sensor of the vehicle (e.g., GPS receiver 112). If the vehicle's location matches the location of a drive-thru location, the ECU determines that the vehicle's location as being in the drive-thru.

[0023] A number of start-stop events anticipated during the drive-thru is determined (302). The number of start-stop events generally corresponds to the number of other vehicles ahead of the vehicle in line for the drive-thru (e.g., the number of other vehicles between the vehicle and the drive-thru window of the establishment; the "number of other vehicles"). In some arrangements, the number of other vehicles is wirelessly transmitted from the establishment computing devices to the ECU. In such arrangements, the information transmitted with the indication may include the number of other vehicles or the number of other vehicles is determined based on the identifier of the establishment computing device. For example, the drive-thru may have a series of successive RFID tags or wireless transmitters embedded within the pavement of the drive-thru, and each unique tag or transmitter indicates that the car is in the drive-thru and the car is at a designated position number (e.g., three cars away from the window). In other arrangements, the driver provides the number of start-stop events by visually counting the number of other vehicles and inputting the number of other vehicles into the ECU (e.g., by interacting with the touchscreen display). In still further arrangements, the ECU self-determines the number of start-stop events. For example, the ECU may determine the distance between the vehicle and the drive-thru window based on vehicle location information received from the location sensor. The distance is used to estimate the number of other vehicles by dividing the distance by an average vehicle length.

[0024] An approximate stop time for each start-stop event is determined (306). The average stop time for each start-stop event varies by the type of drive-thru and from vehicle to vehicle. For example, a stop time associated with a customer ordering a single coffee from a coffee house drive-thru will likely be significantly less than a stop time associated with a customer ordering ten coffees. The approximate stop time for each start-stop event is later used by the ECU in determining the amount of battery needed by the vehicle while the engine is turned off. The approximate stop time can be provided by the establishment itself (e.g., as a wireless data transmission along with the drive-thru indication at 302), by the driver (e.g., by interacting with the touchscreen display), or by

the ECU (e.g., by accessing a database of standard stop times associated with a given drive-thru). In arrangements where the ECU self-estimates the stop time, the stop time may be adjusted up or down based at least in part on a time of day, a day of the week, the current weather, an indicated volume of customers, or a combination thereof.

[0025] The battery requirement for the stop time is determined (308). If the engine of the vehicle is to be turned off during stops in the drive-thru line, the battery (e.g., battery 106) of the vehicle is relied on to electrical power to the components of the vehicle. Additionally, the battery will be used to start the engine when the vehicle is ready to be moved between successive start-stop events and after the final start-stop event. The amount of battery power needed varies based on the situation. The longer the vehicle's engine is off, the more electrical power the battery will need to provide to the components of the vehicle. Accordingly, the amount of battery power is calculated based at least in part on the approximate stop time (as calculated in 306), the anticipated number of start-stop events (i.e., the number of times the batter will need to power the starter motor to restart the engine), and the active features of the vehicle (e.g., A/C, navigation screen, radio, entertainment system, ECU power draw, power windows, power locks, etc.). Other external factors, such as the weather conditions (e.g., temperature and humidity) and age of the battery, can be factored into battery requirement calculation. In some arrangements, a factor of safety is used in the calculation to ensure account for other variables, such as the driver turning on the A/C unit after the initial calculation is completed or the drive-thru taking an abnormally long time to pass through.

[0026] The determined battery requirement is compared with battery information (310). The ECU determines a current capacity of the battery by measuring a current voltage and/or amount of amps being discharged from the battery and comparing the measurements with historical battery information. The current battery capacity is compared to the calculated battery requirements (as calculated in 308). If the current battery capacity exceeds the estimated battery requirement, there is enough battery power to implement the start-stop feature. Based on the comparison, it is determined whether there is enough battery charge to implement the start-stop feature for the drive thru (312). If there is not enough battery charge to implement the start-stop feature, method 300 ends.

[0027] If there is enough battery charge to implement the start-stop feature, the start-stop feature is implemented (314). Accordingly, the engine is turned off when the vehicle

comes to a stop in the drive-thru line and is turned on when the vehicle is ready to move up to the next position in the drive-thru line or is ready to exit the drive-thru (e.g., when the driver takes his foot off the brake pedal). The start-stop feature may be implemented for only the number of start-stop events predicted at 304, for as long as the vehicle remains within the drive-thru area (e.g., as determined by received wireless signals from establishment computing devices, as determined by the GPS coordinates of the vehicle, etc.), or until the remaining charge of the battery falls below a threshold level. The decision to implement the start-stop feature is not an all-or-nothing decision. For example, if there are three start-stop events predicted (in 304), but the battery only has enough capacity (as calculated in 310) to perform two start-stop events, the ECU may control the engine to turn off at two of the start-stop events and remain on for the potential third start-stop event. In such a situation, the order of the turning off of the engine and leaving the engine in idle may be chose to optimize battery charge or to minimize fuel consumption.

[0028] In the above-described systems and methods, other characteristics of the vehicle may be analyzed by the ECU 108 in determining whether to implement the start-stop feature. For example, the ECU 108 may determine the pedal position (e.g., accelerator pedal position, brake pedal position, clutch pedal, etc.), the gear the vehicle is in (e.g., drive, park, neutral, reverse, first gear, second gear, third gear, etc.), climate control system activity, and other operational parameters. Accordingly, the decision to implement or not to implement the start-stop system may be based at least in part on the determined battery charge, the determined brake pedal position, the determined accelerator pedal position, the determined clutch pedal position, the determined gear the vehicle is in, a determined status of the climate control system, and any other operational parameter.

[0029] The above described systems and methods are not limited to drive-thru retailers and establishments. The systems and methods can be applied to virtually any situation in which a vehicle comes to a stop for a period of time and the ECU 108 is unable to determine on its own that the situation is appropriate for employing the start-stop feature. For example, the same or similar principles and methods can be modified and applied to school or daycare pick-up and drop-off circles, toll booths, emissions facilities, drive-in diners, police checkpoints and the like.

[0030] As utilized herein, the terms “approximately,” “about,” “substantially,” and similar terms are intended to have a broad meaning in harmony with the common and

accepted usage by those of ordinary skill in the art to which the subject matter of this disclosure pertains. It should be understood by those of skill in the art who review this disclosure that these terms are intended to allow a description of certain features described and claimed without restricting the scope of these features to the precise numerical ranges provided. Accordingly, these terms should be interpreted as indicating that insubstantial or inconsequential modifications or alterations of the subject matter described and claimed are considered to be within the scope of the invention as recited in the appended claims.

[0031] It should be noted that the term “exemplary” as used herein to describe various embodiments is intended to indicate that such embodiments are possible examples, representations, and/or illustrations of possible embodiments (and such term is not intended to connote that such embodiments are necessarily extraordinary or superlative examples).

[0032] The terms “coupled,” “connected,” and the like as used herein mean the joining of two members directly or indirectly to one another. Such joining may be stationary (e.g., permanent) or moveable (e.g., removable or releasable). Such joining may be achieved with the two members or the two members and any additional intermediate members being integrally formed as a single unitary body with one another or with the two members or the two members and any additional intermediate members being attached to one another.

[0033] References herein to the positions of elements (e.g., “top,” “bottom,” “above,” “below,” etc.) are merely used to describe the orientation of various elements in the FIGURES. It should be noted that the orientation of various elements may differ according to other exemplary embodiments, and that such variations are intended to be encompassed by the present disclosure.

[0034] Example and non-limiting module implementation elements include sensors providing any value determined herein, sensors providing any value that is a precursor to a value determined herein, datalink and/or network hardware including communication chips, oscillating crystals, communication links, cables, twisted pair wiring, coaxial wiring, shielded wiring, transmitters, receivers, and/or transceivers, logic circuits, hard-wired logic circuits, reconfigurable logic circuits in a particular non-transient state configured according to the module specification, any actuator including at least an electrical, hydraulic, or pneumatic actuator, a solenoid, an op-amp, analog control

elements (springs, filters, integrators, adders, dividers, gain elements), and/or digital control elements.

[0035] It is important to note that the construction and arrangement of the various exemplary embodiments are illustrative only. Although only a few embodiments have been described in detail in this disclosure, those skilled in the art who review this disclosure will readily appreciate that many modifications are possible (e.g., variations in sizes, dimensions, structures, shapes and proportions of the various elements, values of parameters, mounting arrangements, use of materials, colors, orientations, etc.) without materially departing from the novel teachings and advantages of the subject matter described herein. For example, elements shown as integrally formed may be constructed of multiple parts or elements, the position of elements may be reversed or otherwise varied, and the nature or number of discrete elements or positions may be altered or varied. The order or sequence of any process or method steps may be varied or re-sequenced according to alternative embodiments. Other substitutions, modifications, changes and omissions may also be made in the design, operating conditions and arrangement of the various exemplary embodiments without departing from the scope of the present invention.

WHAT IS CLAIMED IS:

1. A method comprising:
 - interpreting, at an electronic control unit (“ECU”) of a vehicle, an indication that the vehicle is in line at a drive-thru;
 - determining, by the ECU, a number of start-stop events anticipated during the drive-thru;
 - determining, by the ECU, an approximate stop time for each of the number of start-stop events;
 - determining, by the ECU, that a battery of the vehicle has enough remaining charge to power a plurality of vehicle components during implementation of the start-stop feature; and
 - implementing, by the ECU, a start-stop feature in which an internal combustion engine powering the vehicle is turned off for at least a portion of the time when the vehicle is stopped, wherein the start-stop feature is implemented based at least in part on determining that the battery has enough remaining charge.
2. The method of claim 1, wherein interpreting the indication includes receiving the indication from a computing device associated with an establishment operating the drive-thru.
3. The method of claim 2, wherein the computing device is a beacon emitter, an RFID tag, a wireless network router, or a wireless network hub.
4. The method of claim 1, wherein the number of start-stop events anticipated during the drive-thru corresponds to the number of other vehicles ahead of the vehicle in line at the drive-thru.
5. The method of claim 4, wherein determining the number of start-stop events anticipated during the drive-thru includes receiving, by the ECU, an indication of the number of start-stop events from a computing device associated with an establishment operating the drive-thru.

6. The method of claim 1, further comprising determining a gear of the vehicle, wherein the start-stop feature is implemented based at least in part on the determined gear of the vehicle.
7. The method of claim 1, further comprising determining a brake pedal position of the vehicle, wherein the start-stop feature is implemented based at least in part on the determined brake pedal position of the vehicle.
8. The method of claim 1, wherein the internal combustion engine is a diesel internal combustion engine.
9. An apparatus comprising:
 - a driver input module structured to interpret driver input from a driver of a vehicle via driver controls;
 - a communication module structured to send and receive data to and from an establishment device associated with an establishment operating a drive-thru;
 - a start-stop module in communication with the driver input module and the communication module, the start-stop module structured to implement a start-stop feature in which an internal combustion engine powering the vehicle is stopped during periods of expected extended idling while the vehicle is in a line at the drive-thru to conserve fuel.
10. The apparatus of claim 9, further comprising a battery charge determining module structured to determine a charge of a battery of the vehicle, the battery structured to provide electrical power to components of the vehicle.
11. The apparatus of claim 10, wherein the start-stop module is structured to implement the start-stop feature based at least in part on a determination that the battery has enough remaining charge.
12. The apparatus of claim 9, wherein the start-stop module is structured to determine that the vehicle is in the line at the drive-through based on a communication from the establishment received at the communication module.

13. The apparatus of claim 9, further comprising a gear determining module structured to determine a current gear selection of a transmission of the vehicle, wherein the start-stop module is structured to implement the start-stop feature based at least in part on the current gear selection.

14. The apparatus of claim 9, further comprising a brake pedal position determining module structured to determine a position of a brake pedal of the vehicle, wherein the start-stop module is structured to implement the start-stop feature based at least in part on the position of the brake pedal.

15. The apparatus of claim 9, wherein the internal combustion engine is a diesel internal combustion engine.

16. A system comprising:

an internal combustion engine that burns a fuel and powers a vehicle;

a battery that provides electrical power to at least one component of the system;

and

a controller structured to:

interpret an indication that the vehicle is in line at a drive-thru;

determine a number of start-stop events anticipated during the drive-thru;

determine an approximate stop time for each of the number of start-stop

events;

determine that the battery has enough remaining charge to power a plurality of vehicle components during implementation of the start-stop feature; and

implement the start-stop feature in which the internal combustion engine is turned off for at least a portion of the time when the vehicle is stopped, wherein the start-stop feature is implemented based at least in part on determining that the battery has enough remaining charge.

17. The system of claim 16, wherein the controller is structured to interpret the indication after receiving the indication from a computing device associated with an establishment operating the drive-thru.

18. The system of claim 17, wherein the computing device is a beacon emitter, an RFID tag, a wireless network router, or a wireless network hub.
19. The system of claim 16, wherein the number of start-stop events anticipated during the drive-thru corresponds to the number of other vehicles ahead of the vehicle in line at the drive-thru.
20. The system of claim 20, wherein the controller is structured to determine the number of start-stop events anticipated during the drive-thru includes by interpreting an indication of the number of start-stop events received from a computing device associated with an establishment operating the drive-thru.
21. The system of claim 16, wherein the controller is structured to determine a gear of the vehicle, and wherein the start-stop feature is implemented based at least in part on the determined gear of the vehicle.
22. The system of claim 16, wherein the controller is structured to determine a brake pedal position of the vehicle, wherein the start-stop feature is implemented based at least in part on the determined brake pedal position of the vehicle.

100 ↗

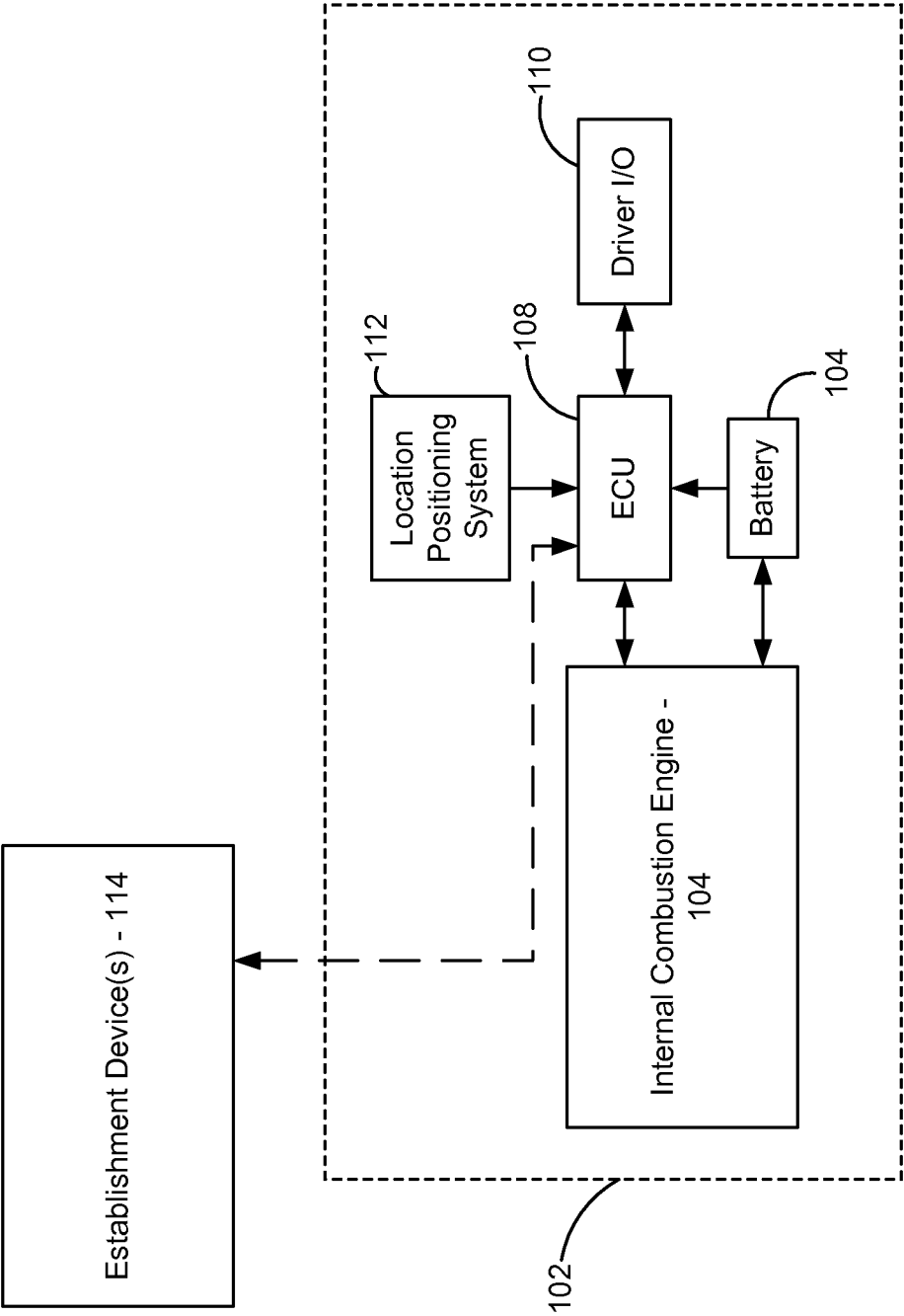


FIG. 1

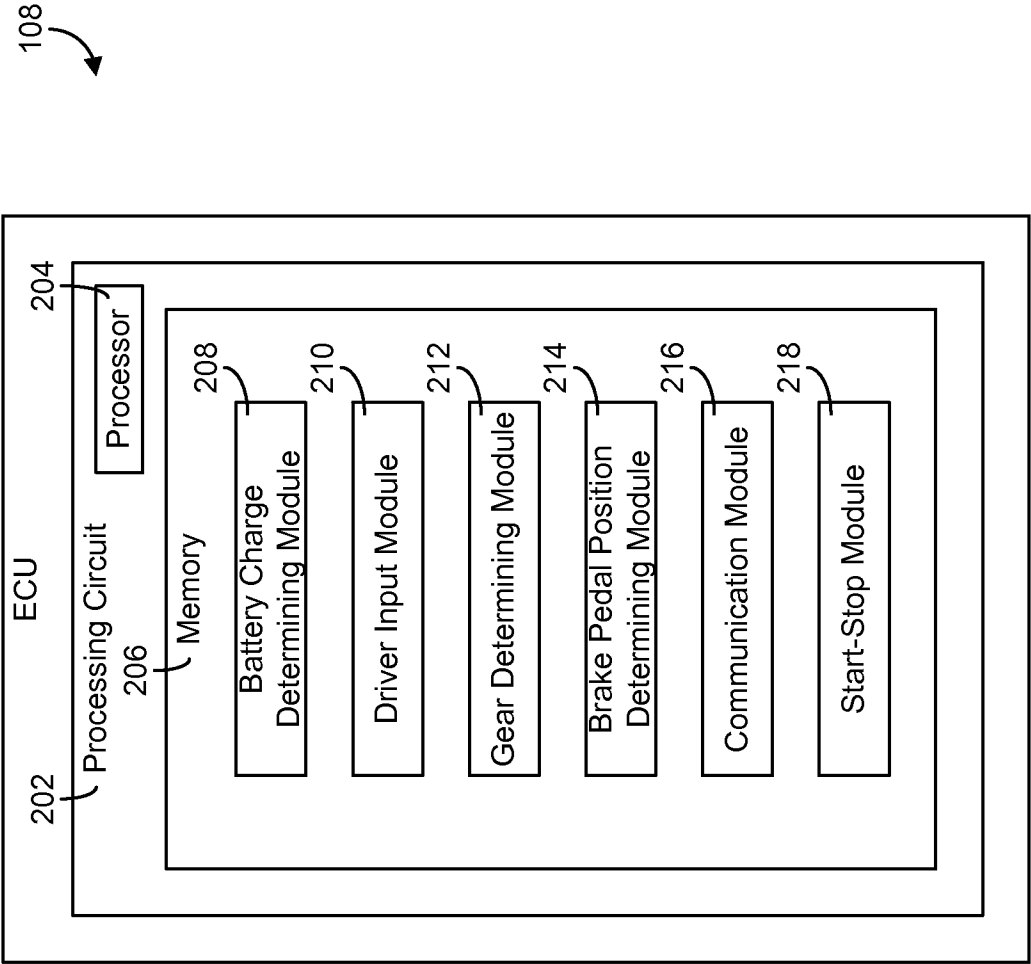


FIG. 2

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300

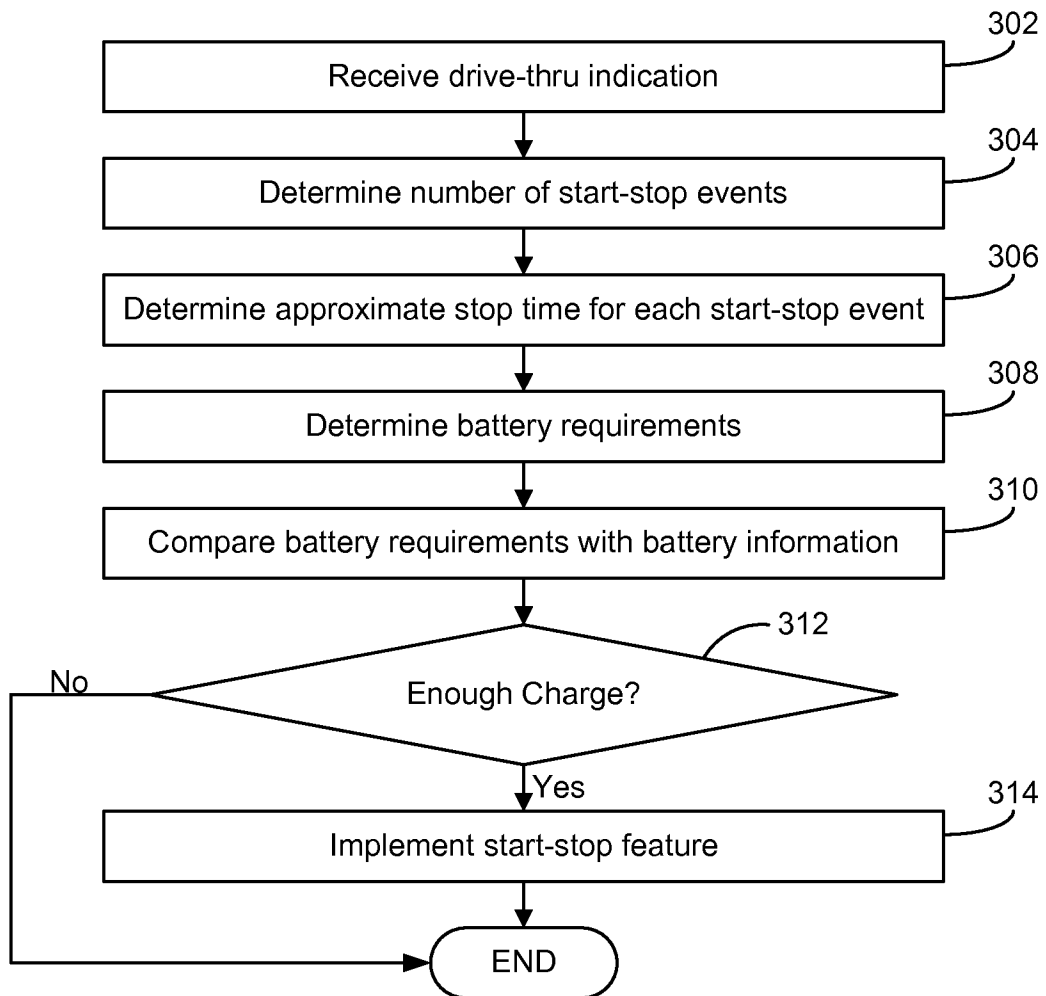


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US15/41109

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F02D 41/08, 45/00 (2015.01)

CPC - F02D 41/0025, 43/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) Classification(s): F02D 45/00, 17/00, 17/04, 13/00, 41/08 (2015.01)

CPC Classification(s): F02D 2200/0611, 41/0025, 41/0027, 2200/0612

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, Other Countries (INPADOC), RU, AT, CH, TH, BR, PH), ProQuest, IEEE/IEEEExplore, IP.com; ; Keywords: idle, start-stop, drive-through, pause, waiting, toll, fast food, bank, teller, charge, ahead, gear, brake, fuel, conserve, power, control, wireless, anticipate, estimate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ----- Y	US 2012/0095670 A1 (PIGGOTT, A), April 19, 2012; Paragraphs [0004], [0005], [0018], [0019], [0022], [0025], [0032].	1,16 ----- 2-15, 17-22
Y	US 2008/0313052 A1 (OTTO, J et al.), December 18, 2008; Paragraphs [0006]-[0008], [0076].	2-5, 9-15, 17-20
Y	US 2011/0166745 A1 (TIWARI, A et al.), July 07, 2011; Paragraphs [0005], [0019], [0044].	6-8, 13-15, 21, 22
A	US 2013/0271276 A1 (DENSO CORPORATION), October 17, 2013; Entire Document.	1-22

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

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