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(54) Title: METHOD TO STOP THE ENGINE OF A VEHICLE

(57) Abstract: The present invention refers to a method to stop an engine of a vehicle, comprising the steps of monitoring a Human-Machine Interface (HMI) of the vehicle for reception of a command to stop the engine, verifying a motion state of the vehicle to be in stand-still or not, and stopping the engine, in case the vehicle is in stand-still motion state. For avoiding unintentional stopping of the engine an information or alert to the driver to take back control is send out, in case the vehicle is not in stand-still motion state.

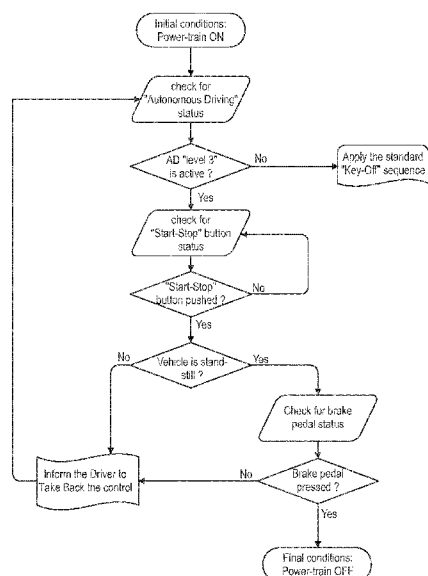


Fig. 2

Method to Stop the Engine of a Vehicle

The present invention refers to a method to stop an engine of a vehicle, comprising the steps of monitoring a Human-Machine Interface (HMI) of the vehicle for reception of a command to stop the engine, verifying a motion state of the vehicle to be in stand-still or not, and stopping the engine, in case the vehicle is in stand-still motion state.

The present invention also refers to a control unit for a vehicle for the execution of the above method.

Older cars use a “classical” mechanical key or ignition lock as HMI to start the ignition, to start the motor, to stop the motor or to cut-off the ignition. This is done by the driver by turning the key in at least two predetermined positions, “ignition on” and “starter on”. In some cases also a steering wheel lock is released or initiated or some consumers like the windshield wipers get power. Turning back the key leads to the stopping of the motor and to cut-off the ignition. Then the key can be released from the lock. These terms have been developed for most common vehicles having a combustion engine. However, these terms are also applied when talking about electrically driven vehicles or vehicles having other types of engines, including combinations of different types of engines. The latter are commonly referred to as hybrid vehicles.

More advanced state of the art vehicles have a “Start-Stop” push button as HMI, which the driver must push for starting or stopping the engine. As for this invention only the stopping of the engine is interesting, we have two possibilities: If the car is already at standstill or driving at very low speed, a simple short push of the driver will stop the motor. If the car is driving at higher speed, a short push is not enough. The driver or the passenger beside him has to push the button longer, normally some seconds to stop the motor. For example, some operator’s manuals of state of the art vehicles specify in respect to the Start-Stop push button, that the drive system can be switched off while the vehicle is in motion by pressing and holding the Start/Stop button for three seconds.

This is a safety feature for the case that the driver loses his consciousness and the person beside him will stop the ride. When switching off the ignition while driving, safety-

relevant functions are only available with limitations, or not at all. This could affect the power steering and the brake boosting effect. Both will need more power, will support only a limited time and have limited performances.

Common vehicles react directly on a respective interaction on the HMI and directly stop the engine when the driver presses the start-stop push button, even when the vehicle is in motion.

The described direct stopping of the engine after having received the stop command has the advantage to be simple, easy to understand and secured enough in case of manual driving as long as the driver is always “in the loop” and continuously checking the powertrain status. The driver can namely simply hear whether the engine is running or whether it has stopped running. He also can see its status by pictograms and/or the engine rev meter, e.g. in the dash board of the vehicle.

When driving is partly automated, which is also referred to as Autonomous Driving (AD) level 2, the vehicle can perform e.g. tasks of automated parking, or automatic keeping the track or the distance, whereby accelerating and decelerating is done by driving support systems, but monitored by the driver. Also the function of an emergency stop can be automated. E.g. some high end vehicles offer functionalities like a so called “Emergency Assist”. This means that when the driver is not reacting on two or three inviting sound signals, by doing anything, the car starts a “minimum risk maneuver” to stop the car smoothly. The minimum risk maneuver is based on the assumption that the driver lost his consciousness. The system will control the longitudinal behavior of the vehicle only with the aim to decelerate the vehicle more or less slowly depending on the environmental situation. The vehicle will choose the right lane or the side-strip and stop smoothly. Such a behavior has already been introduced long time ago as “dead man's switch” or “dead man's handle” in the area of railroads. If the driver doesn't push a special button every minute, the train stops automatically.

When driving is further automated, i.e. Autonomous Driving from level 3 upwards without monitoring of the vehicle's behavior by the driver, the stop of the engine can even be more dangerous, because the stop of the motor also means a reduction of the power supplied to other systems of the autonomous vehicle like brakes or steering. Of course, as soon as the motor is detected as OFF, the automated function should give back the

control to the driver and even start a minimum risk maneuver in order to secure the vehicle, if the driver doesn't take back the control quickly.

On the other hand, it should be always possible for the driver or the passenger beside him to stop the engine in a panic situation like unintended acceleration or losing the brake function. Therefore all cars on the market have the overriding command that the motor really stops when the driver or someone else pushes the start/stop button long enough. It would be quite unusual and difficult to accept that the motor keeps running when the button is pushed longer.

In this context, the term "Standing-still" means really standing (velocity zero) or only moving with very low speed (velocity of a pedestrian, maximum 5 km/h). "In motion" means the normal driving/moving of the vehicle with a speed higher than the velocity of a pedestrian.

It is an object of the present invention to provide a solution for avoiding unintentional stopping of the engine while the vehicle is moving.

This object is achieved by the independent claims. Advantageous embodiments are given in the dependent claims.

In particular, the present invention provides a method to stop an engine of a vehicle, comprising the steps of monitoring a Human-Machine Interface (HMI) of the vehicle for reception of a command to stop the engine, verifying a motion state of the vehicle to be in stand-still or not, and stopping the engine, in case the vehicle is in stand-still motion state, and sending an information or alert to the driver to take back control, in case the vehicle is not in stand-still motion state.

The present invention also provides a control unit for a vehicle for the execution of the above method, whereby there is provided a logic circuit for detecting the status of moving or standing-still, and for detecting the command of the driver and there is provided an output function to send an information to the driver.

The basic idea of the invention is the decoupling of the command from the action of the system in the control unit. It is avoided to stop the motor even when an unintentional

driver “stop” request is detected. The motor is not immediately switched off. The driver is informed to do something, i.e. to act further or to react. He has to react or take back the control of the car. The motor keeps running and supplies the auxiliaries with power till a second command verifies the wish of the driver to stop. It is more important when the system is executing an automated driving. For the driver exists always the possibility to easily stop the engine in case of emergency or panic situation.

In any case, switch off of the engine while driving can be dangerous. In case of autonomous driving, autonomous systems may not know how to deal with this situation. Furthermore, a power off of the engine is typically connected to a deactivation of several auxiliary systems, which can be required for moving the vehicle. Still further, the power off can be dangerous for the engine itself, e.g. when the wheels continue to turn the engine. This refers to a combustion engine as well as an electric engine.

It should be noted that there are two general options for interacting with the driver of the vehicle: One option is a general warning for the driver to do something, i.e. to “act”, which can be given in “normal” driving status. The other option is to send an alert to the driver to take back control when the vehicle is in autonomous driving status.

In this context, the term human machine interface (HMI) can refer to different kinds of interface. The HMI can comprise a mechanical or an electrical key, a start/stop button or another electronic device, e.g. a smartphone, commanding by gestures or by speech. To “stop” the engine is synonymous for the terms: “power-off”, “switch off”, “turn off”, “cut off” and “key-off”. It should further be noted that the term “key-off” is more used in automobile context to design the fact to stop the engine(s) and auxiliaries, typically for “older” vehicles with a mechanical key. “Engine” is synonymously used for “motor”, “ignition” or “power-train”. “Standing-still” means really standing (velocity zero) or only moving with very low speed (velocity of a pedestrian, maximum 5 km/h). “In motion” means the normal driving/moving of the vehicle with a speed higher than the velocity of a pedestrian.

Future cars can be equipped with advanced HMIs, like electronic devices, smartphones, which are either handheld or mounted e.g. in the steering wheel, command systems, which receive the commands of the driver by clicking, whipping, gesturing or spoken words, or others.

According to a modified embodiment of the invention the method returns to the step of monitoring the HMI of the vehicle after the step of stopping the engine or sending an information or alert to the driver to take back control, the method comprises an additional step of evaluating a reception of an emergency signal to stop the vehicle, and the method comprises an additional step of switching of the engine in case of reception of the emergency signal.

According to a modified embodiment of the invention the method comprises an additional step of performing a minimum risk maneuver to stop the vehicle. The system will control the longitudinal behavior of the vehicle only with the aim to decelerate the vehicle more or less slowly depending on e.g. an environmental situation. The vehicle will choose the right lane or the side-strip and stop smoothly. Such a behavior has already been introduced long time ago as “dead man's switch” or “dead man's handle” in the area of railroads and is based on the assumption that the driver lost his consciousness or is not capable of driving the vehicle for any other reason.

According to a modified embodiment of the invention the step of sending an information or alert to the driver to take back control, in case the vehicle is not in stand-still motion state comprises sending a warning that the engine will stop if the driver keeps insisting in or repeats the stopping command via HMI, e.g. like pushing a button repeatedly or pushing a button longer, turning a key, pressing the brake pedal, sending a command or speaking.. Sending a command can also be done by pressing, clicking, whipping a field on a screen, for example, when an interactive screen or a smartphone is provided. Sending can also be done by moving hands or arms, if the vehicle is provided with a command system by gestures. Speaking is the way to give commands if the vehicle his provided with a command system by speaking. If the driver is not reacting the system recognizes that the Stop command was given non-intentional and continues the ride.

According to a modified embodiment of the invention the step of evaluating a reception of an emergency signal to stop the vehicle comprises monitoring a repeated reception of a command to stop the engine, a reception of a prolonged command to stop the engine, reception of a signal indicating a key turning, reception of a brake pedal pushing, reception of a command or reception of a spoken command.

According to a modified embodiment of the invention the method comprises verifying an autonomous driving state of the vehicle, and in case the vehicle is not in autonomous driving state, perform a regular “power-off” procedure to stop the engine of the vehicle.

According to a modified embodiment of the invention the method comprises an additional step of performing a Give Back process of control of the vehicle to a driver prior to performing a regular “power-off” procedure to stop the engine of the vehicle.

According to a modified embodiment of the invention the step of sending an information or alert to the driver comprises sending an information to take back control of the vehicle.

If the driver wishes to continue the AD mode after he has got an alert that the system initiates a Give Back process, he has to react accordingly. If he doesn't react, the system initiates a Minimum Risk Maneuver to smoothly stop the vehicle.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter. Individual features disclosed in the embodiments can constitute alone or in combination an aspect of the present invention. Features of the different embodiments can be carried over from one embodiment to another embodiment.

As stated before, all HMIs can be used in connection with the invention, but for the following detailed description of preferred embodiments the “Start-Stop” push button is chosen. The reason for this is that a classical mechanical key as HMI doesn't seem appropriate for a vehicle equipped with an autonomous driving function. Indeed, on a vehicle with such mechanical key interface, it will be quite unusual and difficult to accept by the driver, to allow to keep the engine ON when the key is turned OFF. In other words, in case of a vehicle operating in AD mode the situation could occur that the driver has for whatever reason switched the classical key to the OFF position (and perhaps even removes the key from the lock), but the motor continues to run. This situation would strike the driver as rather strange or “unnatural”.

In the drawings:

Fig. 1 shows a flow chart of an inventive sequence for a “normal” vehicle”

Fig. 2 shows a flow chart of an inventive sequence for an autonomous vehicle

Fig. 3 shows another sequence for an autonomous vehicle.

Figure 1 shows an inventive process running in a control unit of a “normal” vehicle. This means that the status of autonomy is on Autonomous Driving (AD) level 0, according to which only the driver steers and accelerates the vehicle, AD level 1, according to which some assistance systems assist the driver like Adaptive Cruise Control (ACC), or AD level 2, according to which partly automated parking, automatic keeping the track or the distance or others are performed. In all cases, driving is always performed under control or surveillance of the driver.

The first step is to check whether the power-train is in the status ON. The second step is the check for the status of the “Start-Stop” button. If the “Start-Stop” button is not pushed there is no need to react for the system. If the “Start-Stop” button is pushed, the system checks whether the vehicle is moving or is standing-still. If it is moving, the system checks for confirmed driver’s intention to stop the engine, for instance, whether the “Start-Stop” button is pressed longer than three seconds or pressed repeatedly. If the driver’s intention is confirmed, the engine will be stopped. If the driver’s intention is not confirmed, the system sends an information to the driver to confirm his intention to stop. If the vehicle is standing-still, the system recognizes the wish of the driver to shut down the motor and stops the motor.

Fig. 2 shows a flow chart of an inventive sequence for an autonomous vehicle on level 3 (highly automated). This embodiment can also be used in level 4 (fully automated) or level 5 (no driver necessary) vehicles.

The first step is to check whether the power-train is in the status ON. The second step is the check for the “Autonomous Driving” status. An AD “level 3” function is considered active when it has been selected and activated by the driver, so that the longitudinal and lateral behavior is in charge by the system. If the driver overrides temporally either longitudinal or lateral control, then the AD “level 3” function is still considered active. If the system has already initiated a Give Back process (for the driver to take back the control), but neither the driver has yet fully taken the control back, nor the system has

yet finished its automatic Minimum Risk Maneuver (that consists in immobilizing the vehicle in a secure way), then the AD “level 3” function is still considered active.

If the AD “level 3” is not activated, the system applies a standard “Key-Off” sequence. This means that the standard sequence described in Fig. 1 will be applied. The engine will not be switched off immediately, if the vehicle is moving at high speed. The driver will be asked to confirm his wish (a longer push on the “Start-Stop” button, a repeated push or any other safety confirmation). If the AD “level 3” is activated, the system checks the “Start-Stop” button status continuously. If the “Start-Stop” button is not pushed there is no need to react for the system and the ride is continued. If the “Start-Stop” button is pushed, the system checks whether the vehicle is moving or is standing-still. If it is moving, the system sends out an information to the driver and asks him to take back the control, because it has recognized a contradiction and waits for a new/second command by checking the “Autonomous Driving” status again. If the vehicle is standing-still, the status of the brake pedal is checked. If the brake pedal is pressed, there is no more risk to shut down the engine and deactivate AD “level 3” function, as the vehicle is stopped and immobilized by the driver. The system shuts down the motor. If the brake pedal is not pressed, the control unit sends out the information to the driver to take back the control and again waits for a new command of the driver by checking the status of the “Autonomous Driving” again. The information to the driver to take back the control is a message or alert that asks the driver to apply a defined process to take back the control (this process is specific to level 3 function, and supposed to be well known by the driver). It can be realized, for example, by a double action such as hands on the steering wheel on one hand and a specific push or pedal press on the other hand.

It is supposed that the “Start-Stop” button can be pressed, accidentally or not, at any moment, so when the vehicle is at stand still or not. In addition, it should be made clear that the loop from the “Inform the driver to Take Back control” block to the “Check for “Autonomous Driving” status” block is there because if the push on the “Start-Stop” button is intentional (and not accidentally) and the driver really wants to stop the engine, the engine is stopped. So at the step “Inform the Driver to Take Back the control” the push will be ignored as long as the driver has not taken control back (meaning by deactivating the AD function). Or the vehicle becomes stand-still when the driver presses the brake pedal.

Fig. 3 shows a flow chart of another inventive sequence for an autonomous vehicle on level 3 (highly automated). This embodiment can also be used in level 4 (fully automated) or level 5 (no driver necessary) vehicles.

The first step is to check whether the power-train is in the status ON. The second step is the check for the "Autonomous Driving" status. If the AD "level 3" is not activated, the system applies the standard "Key-Off" sequence of Fig. 1. If the AD "level 3" is activated, the system checks the "Start-Stop" button status. If the "Start-Stop" button is not pushed there is no need to react for the system. If the "Start-Stop" button is pushed, the system checks for a repeated sequence on the "Start-Stop" button. If there is a repeated pressing of the "Start-Stop" the system recognizes the wish or command of the driver and alerts him that the system initiates a Give Back process and/or initiates a minimum risk maneuver to stop the vehicle if the driver doesn't react accordingly. For executing the minimum risk maneuver the motor should keep running for the time that is needed to automatically put the vehicle into a safe state. After standing still the motor can be switched off.

If there is no repeated pressing sequence of the "Start-Stop" button the system checks whether the vehicle is moving or is standing-still. If it is moving, the system sends out an information to the driver and asks him to take back the control, because it has recognized a contradiction and waits for a new/second command by checking the "Autonomous Driving" status again. If the vehicle is standing-still, the status of the brake pedal is checked. If the brake pedal is pressed the system recognizes the wish of the driver to shut down the motor and stops the motor. If the brake pedal is not pressed, the control unit sends out the information to the driver to take back the control and again waits for a new command of the driver by checking the status of the "autonomous Driving" again.

This embodiment has advantages for some situations, namely if a failure in the gearbox, or in the power-train occurs or if an unexpected acceleration starts. Then it may happen that the driver gets panic. Instead of stopping the AD function by the usual deactivation process, it may happen that he tries to stop the engine by pressing the "Start-Stop" button. If this action is repeated in such a way the system recognizes that it cannot be a non-intentional or accidental sequence. For example, but not limited to, if the button is pushed and released 2 or 3 times in less than 5 seconds. A permanent longer pressing,

e.g. more than 5 seconds, may have the same result that the system recognizes a “real” stopping request.

Patent claims

1. Method to stop an engine of a vehicle, comprising the steps of monitoring a Human-Machine Interface (HMI) of the vehicle for reception of a command to stop the engine, verifying a motion state of the vehicle to be in stand-still or not, and stopping the engine, in case the vehicle is in stand-still motion state, and sending an information or alert to the driver to take back control, in case the vehicle is not in stand-still motion state.
2. Method according to claim 1, characterized in that the method comprises an additional step of evaluating a reception of an emergency signal to stop the vehicle, and the method comprises an additional step of switching of the engine in case of reception of the emergency signal.
3. Method according to claim 2, characterized in that the method comprises an additional step of performing a minimum risk maneuver to stop the vehicle.
4. Method according to any of previous claims 2 or 3, characterized in that the step of sending an information or alert to the driver to take back control, in case the vehicle is not in stand-still motion state comprises sending a warning that the engine will stop if the driver keeps insisting in or repeats the stopping command via HMI, e.g. like pushing a button repeatedly or pushing a button longer, turning a key, pressing the brake pedal, sending a command or speaking.
5. Method according to previous claim 4, characterized in that the step of evaluating a reception of an emergency signal to stop the vehicle comprises monitoring a repeated reception of a command to stop the engine, a reception of a prolonged command to stop the engine, reception of a signal

indicating a key turning, reception of a brake pedal pushing, reception of a command or reception of a spoken command.

6. Method according to any previous claim, characterized in that the method comprises verifying an autonomous driving state of the vehicle, and in case the vehicle is not in autonomous driving state, perform a regular “power-off” procedure to stop the engine of the vehicle.
7. Control unit for a vehicle for the execution of a method according to one of the preceding claims, characterized in that there is provided a logic circuit for detecting the status of moving or standing-still, and for detecting the command of the driver and there is provided an output function to send an information to the driver.

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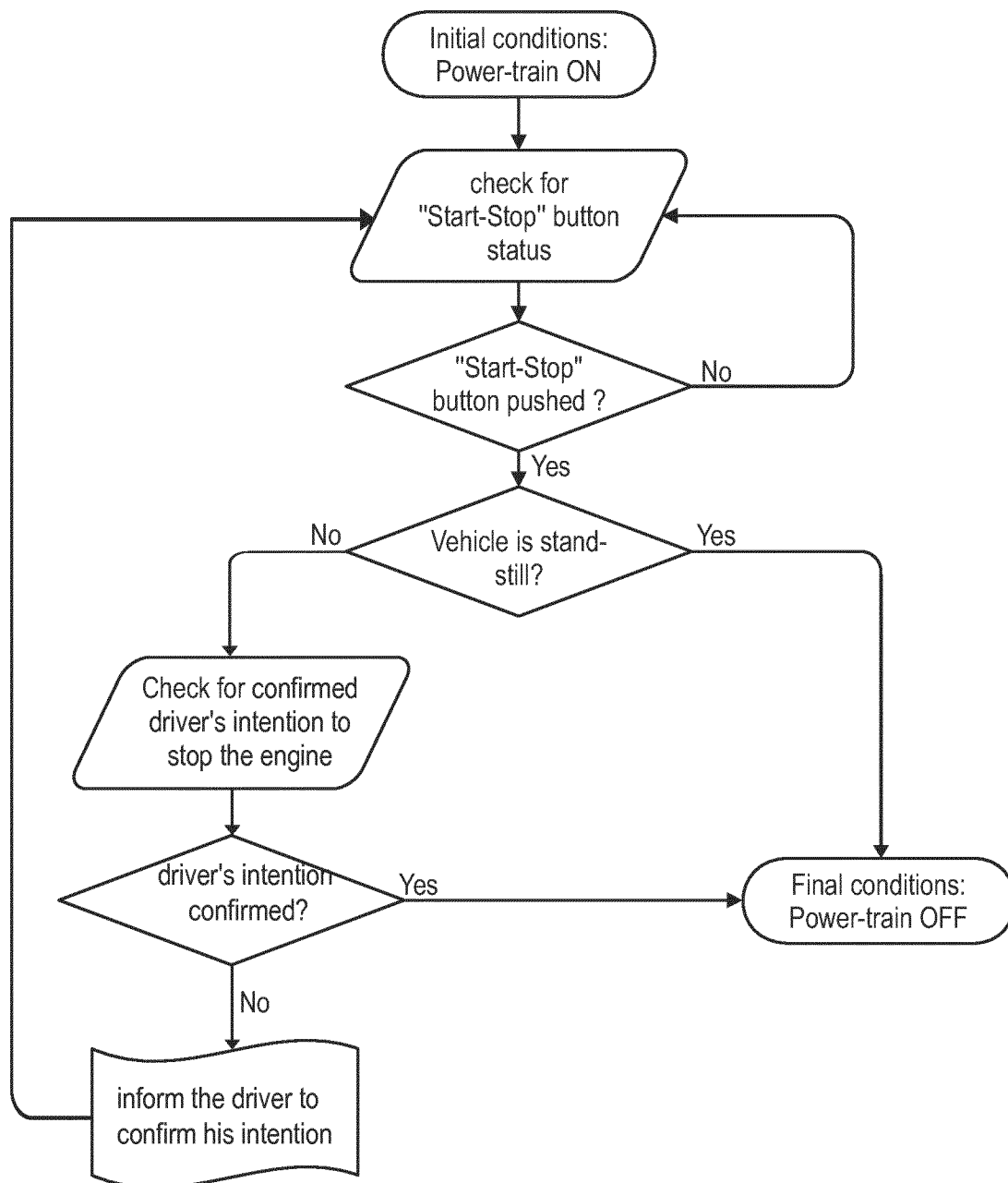


Fig. 1

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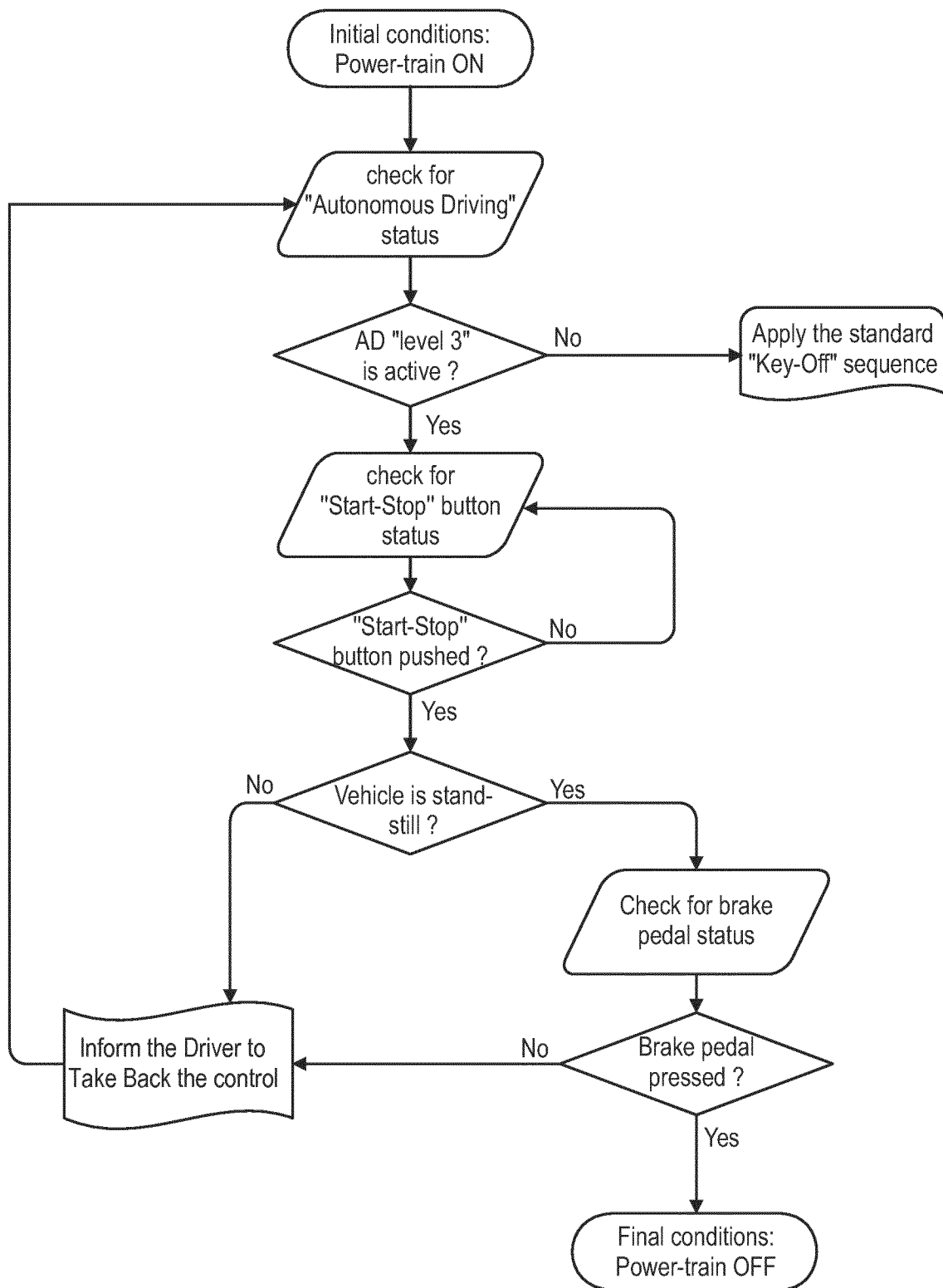


Fig. 2

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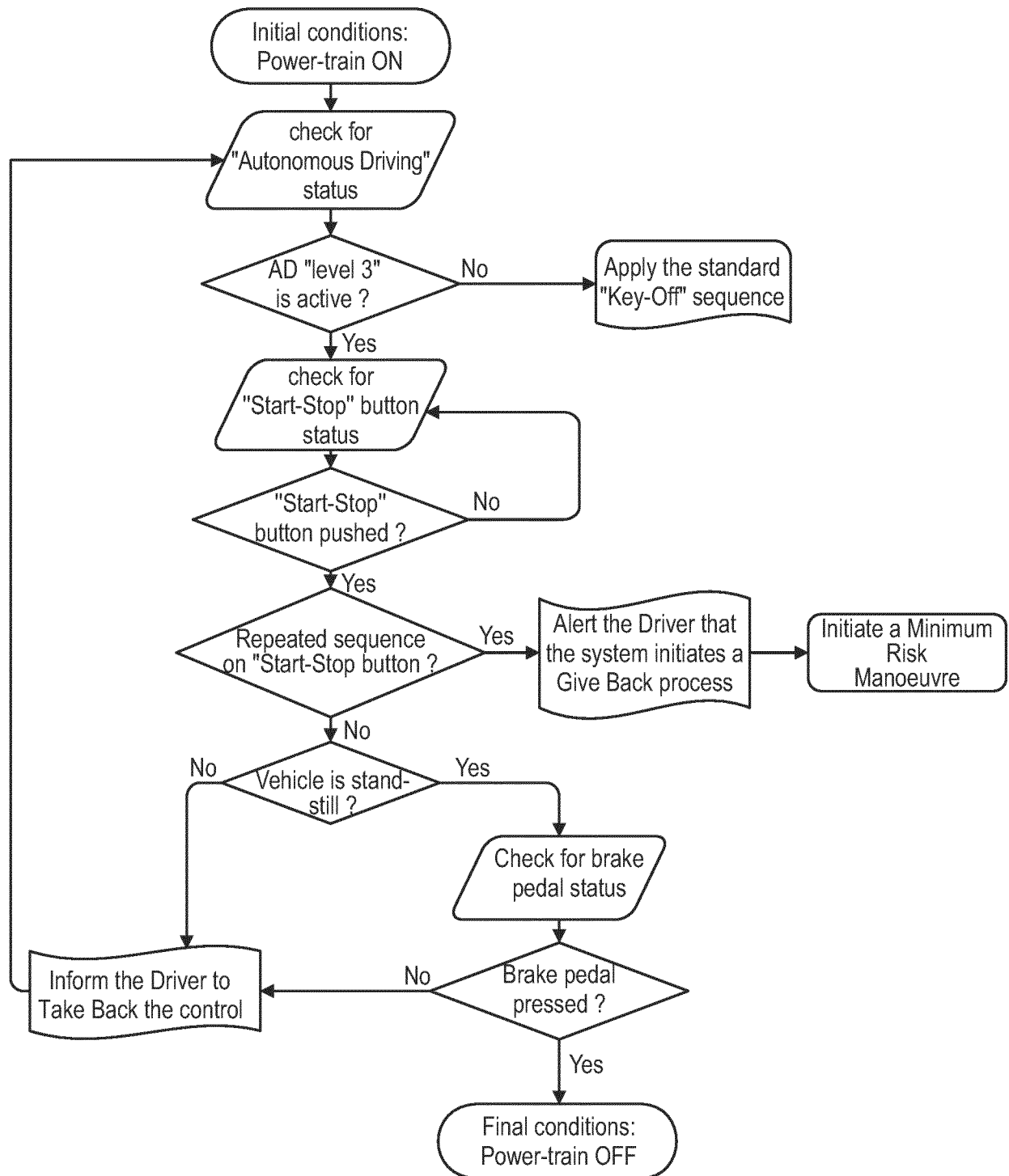


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/081843

A. CLASSIFICATION OF SUBJECT MATTER

INV. F02N11/08

ADD. F02D41/04 F02D17/04

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)

F02N F02D

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 574 706 A2 (KEIHIN CORP [JP]) 14 September 2005 (2005-09-14)	1
Y	paragraph [0065] - paragraph [0077]; figures 1-5	2-7
X	US 2016/023652 A1 (SOO BRIAN THOMAS [US] ET AL) 28 January 2016 (2016-01-28)	1
Y	paragraph [0034] - paragraph [0036]; figures 1-2	2-7
X	CN 104 791 112 B (SAIC MOTOR CORP LTD) 1 February 2017 (2017-02-01)	1
Y	paragraph [0038] - paragraph [0047]; figures 1-3	2-7
X	JP 2013 068216 A (DENSO CORP) 18 April 2013 (2013-04-18)	1
Y	paragraph [0011] - paragraph [0014]; figures 1-8	2-7



Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2018/081843

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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