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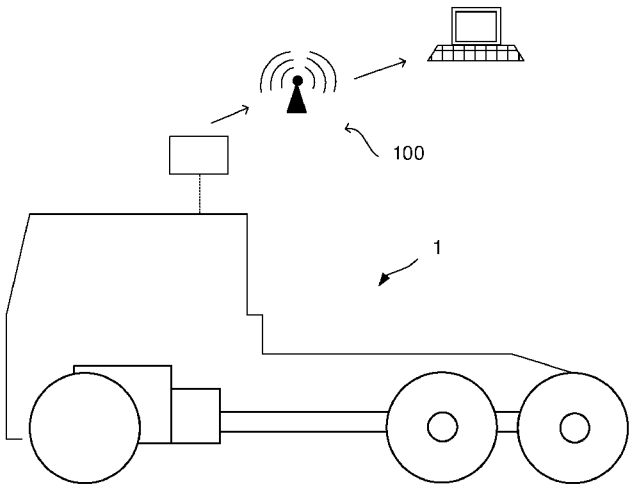

Fig. 1

(57) Abstract: The invention relates to a method for evaluating the operational performance of advanced driver assistant systems (200) associated with a vehicle (1). The method comprises the steps of logging (s101) driving performance data from at least one vehicle (1); categorizing (s102) the logged data into a set of driving situations; classifying (s103) the logged data based on which advanced driver assistant system (200) was activated; evaluating (s104) the operational performance of the advanced driver assistant systems (200) by comparing driving performance data with a first classification and a first categorization with driving performance data with a different second classification but the same first categorization; and providing (s105) a result of the evaluation. The invention also relates to a system (100), a computer program (P) and a computer program product.

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Method and system for evaluating the operational performance of advanced driver assistant systems associated with a vehicle

TECHNICAL FIELD

The present invention relates to a method for evaluating the operational performance of advanced driver assistant systems associated with a vehicle, a system for evaluating the operational performance of advanced driver assistant systems associated with a vehicle, a computer program and a computer program product according to the appended claims.

BACKGROUND

Vehicles of today commonly comprise various advanced driver assistant systems (ADAS) in order to aid the driver in challenging driving situations. Many of such systems are adapted to reduce the fuel consumption. Reducing the fuel consumption is of course of great interest for fleet owners and vehicle owners, specifically when it relates to heavy vehicles. Examples of advanced driver assistant systems which mainly focus on reducing the fuel consumption are so called driver coaching systems, cruise control systems with active prediction and adaptive cruise control systems. A driver coaching system is suitably configured to instruct the driver on how to improve the driving behaviour with respect to fuel consumption. A cruise control system with active prediction may be configured to control the vehicle speed in a fuel-efficient way based on the upcoming road topography, for example by lowering the vehicle speed before a downhill slope. An adaptive cruise control system may be configured to enable platooning or convoying to reduce the air drag and thereby reduce the fuel consumption. Even though studies have shown that advanced driver assistant systems save fuel, the overall performance of such systems is rarely discussed.

A fleet owner or vehicle owner may have several different requirements regarding the operation of the vehicle(s), wherein fuel efficiency might be one of

these requirements. Other requirements could for example relate to safety, time of travel, comfort or similar. In striving to reduce the fuel consumption by using a specific advanced driver assistant system, other requirements may be neglected. It would therefore be advantageous for the fleet owner/vehicle owner to know the overall performance of the various kinds of advanced driver assistant systems associated with each vehicle. Document JP2009128395 A discloses a driving simulation apparatus with a simulated driving assistance unit for handling objects in the travel environment. The simulation apparatus further comprises an evaluation means for evaluating the effect of the driving assistance unit.

SUMMARY OF THE INVENTION

Despite known solutions in the field, there is still a need to develop a method and a system for evaluating the operational performance of advanced driver assistant systems associated with a vehicle, such that the benefits of the different systems can be used as a basis for how to operate the vehicle.

An object of the present invention is to achieve an advantageous method for evaluating the operational performance of advanced driver assistant systems associated with a vehicle, which enables monitoring of an individual vehicle and the actual benefits of each advanced driver assistant system associated with that vehicle.

Another object of the present invention is to achieve an advantageous method for evaluating the operational performance of advanced driver assistant systems associated with a vehicle, which enables efficient transports complying with the relevant requirements of the vehicle owner.

An object of the present invention is to achieve an advantageous system for evaluating the operational performance of advanced driver assistant systems

associated with a vehicle, which enables monitoring of an individual vehicle and the actual benefits of each advanced driver assistant system associated with that vehicle.

Another object of the present invention is to achieve an advantageous system for evaluating the operational performance of advanced driver assistant systems associated with a vehicle, which enables efficient transports complying with the relevant requirements of the vehicle owner.

The herein mentioned objects are achieved by a method for evaluating the operational performance of advanced driver assistant systems associated with a vehicle, a system for evaluating the operational performance of advanced driver assistant systems associated with a vehicle, a computer program and a computer program product according to the independent claims.

According to an aspect of the present invention a method for evaluating the operational performance of advanced driver assistant systems associated with a vehicle is provided. The method comprises the steps of:
- logging driving performance data from at least one vehicle;
- categorizing the logged data into a set of driving situations;
- classifying the logged data based on which advanced driver assistant system was activated;
- evaluating the operational performance of the advanced driver assistant systems by comparing driving performance data with a first classification and a first categorization with driving performance data with a different second classification but the same first categorization; and
- providing a result of the evaluation.

The method step of classifying the logged data suitably comprises to classify the logged data as manual operation when no advanced driver assistant system was activated.

Lots of different advanced driver assistant systems exist with the purpose of aiding the driver in challenging driving situations. Most of these systems are adapted to reduce the fuel consumption and if a vehicle comprises more than one system it may be difficult to decide which system to use when. In some driving situations it may also be more efficient to operate the vehicle manually, without the use of an advanced driver assistant system. That is, in a specific driving situation, the driving performance data obtained with a first advanced driver assistant system may differ from the driving performance data obtained with a second advanced driver assistant system. In the same driving situation the driving performance data obtained with a third advanced driver assistant system may differ from the driving performance data obtained during manual operation. By logging driving performance data, categorizing it into a set of driving situations and classifying it based on if an advanced driver assistant system was used and if so, which system, the advanced driver assistant systems can be evaluated by comparing the driving performance data of the same driving situation category but with different classification. This way, each advanced driver assistant system is evaluated based on its actual performance in its actual environment and a more accurate comparison between the systems can be made. With the result of the evaluation it can be determined which advanced driver assistant system should be used in a certain driving situation, if any. Future transport missions may thereby be planned more efficiently.

The logging, categorizing and the classification steps are suitably performed continuously. Alternatively, the logging, categorizing and the classification steps are performed with a predetermined interval. The evaluation step and the step of providing a result of the evaluation are suitably performed with a predetermined interval.

According to an aspect of the invention the logged data is categorized into a driving situation based on at least one of geographic location, road quality, road grade, road curvature and surrounding traffic. Such driving situation may for example be queueing, uphill driving, downhill driving, driving on curvy roads, driving on gravel roads, driving in an urban environment or highway driving. The

driving performance data may also be categorized into a driving situation relating to a specific geographic location or road segment. Information regarding driving situation, for example road map data, such as altitude, road grade, curvature and similar, may be available in the vehicle through navigation systems, sensors and/or cameras. Different driving situations require different ways of operating the vehicle. For example, a driver coaching system may result in a better overall performance when driving on small curvy roads while an adaptive cruise control system may be more efficient when driving on highways. Thus, by specifying the driving situation, a more accurate comparison can be made between different advanced driver assistant systems and/or between an advanced driver assistant system and manual operation. The inventive method thereby facilitates for a vehicle owner to determine which advanced driver assistant system to use when.

The operational performance of the advanced driver assistant systems may be evaluated by comparing logged driving performance data with a first classification and a first categorization with estimated driving performance data with a different second classification but the same first categorization. For example, the fuel consumption using a cruise control with active prediction may be logged for a certain driving situation and may then be compared with the estimated fuel consumption should a regular cruise control system have been used in the same driving situation. This way, when only one advanced driver assistant system of a vehicle has been used in a certain driving situation, the operational performance of that system in that driving situation can still be evaluated. The estimation may be based on logged data with respect to fuel consumption between two different advanced driver assistant systems over the same road segment. Furthermore, data involving the number of brake actions, active steering interventions and/or velocity changes mandated by an advanced driver assistant system can be utilized as a basis for estimation of how effective a corresponding system has been.

Driving performance data from more than one vehicle may be logged, categorized and classified. For example, driving performance data from all

vehicles in a vehicle fleet may be logged, categorized and classified. Alternatively, driving performance from a plurality of non-related vehicles may be logged, categorized and classified. This way, a greater basis of the evaluation is obtained. When driving performance data from a plurality of vehicles is logged, the logged driving performance data suitably comprises information regarding which vehicle it relates to. This way, the operational performance of each individual vehicle can be monitored.

The driving performance data in a certain driving situation varies depending on the type of vehicle, the weight/load of the vehicle, the tires of the vehicle etc. Thus, the operational performance of an advanced driver assistant system varies depending on the type of vehicle, the weight/load of the vehicle, the tires of the vehicle etc. The step of evaluating the operational performance of the advanced driver assistant systems thus suitably comprises to consider information regarding the vehicle from which the driving performance data is received. By considering vehicle characteristics, a more accurate evaluation can be achieved.

The step of evaluating the operational performance of the advanced driver assistant systems may comprise to calculate operational performance values for the advanced driver assistant systems. A calculated operational performance value is suitably calculated for an advanced driver assistant system in relation to another advanced driver assistant system. For example, to calculate an operational performance value may comprise to calculate a percentage of how much smaller the fuel consumption was when a certain advanced driver assistant system was used compared to when another advanced driver assistant system was used.

According to an aspect of the invention the advanced driver assistant systems are evaluated with respect to at least one of safety, fuel consumption, driving time, comfort and brake use. The advanced driver assistant systems are suitably evaluated with respect to fuel consumption and at least one of safety, driving

time, comfort and brake use. As previously mentioned most of the advanced driver assistant systems on the market are aiming to save fuel. There may, however, be more or other requirements which should be considered when planning transport missions. The different requirements may have different priority and it is of interest for a vehicle owner to make sure that the requirement with the highest priority is complied with first. Which advanced driver assistant systems that should be used in a certain driving situation does thus depend on the requirements of the vehicle owner. By evaluating the different advanced driver assistant systems with respect to a plurality of different factors, a better understanding of the benefits of the different advanced driver assistant systems is achieved and it enables the vehicle owner to achieve more efficient future transports which comply with the requirements of the vehicle owner. As an example, the driving performance data logged when an adaptive cruise control system was active in a certain driving situation shows that the fuel consumption decreased but also that the engine torque used to propel the vehicle decreased. This driving performance data may be compared with driving performance data obtained when another advanced driver assisting system was active in the same driving situation. Based on the provided result of the evaluation the vehicle owner can thereby choose the advanced driver assistant system which provides the best operational performance in terms of fuel consumption and/or engine torque, depending on the requirement of the vehicle owner. Evaluation with respect to safety may relate to personal safety of the operator of the vehicle or safety of the surrounding environment. Safety may relate to whether the vehicle is able to stay in the relevant lane, the ability to handle obstacles in the road etc. Evaluation with respect to comfort may relate to comfort of the driver and/or passengers in the vehicle. The advanced driver assistant systems may be evaluated with respect to sudden and/or significant changes of vehicle speed.

The driving performance data suitably comprises at least one of engine torque, instantaneous fuel consumption, active gear, braking action, vehicle speed and acceleration. The driving performance data may be available through the communication system of the vehicle, such as via a controller area network

(CAN) or similar. The driving performance data may be determined by means of sensors on the vehicle. The driving performance data is suitably determined continuously and accumulated values of the data is suitably calculated and logged in an analysis unit.

According to an aspect of the invention the method further comprises the step of:

- providing driving advice to the operator of a vehicle based on the provided result of the evaluation of the advanced driver assistant systems.

The evaluation of the relevant advanced driver assistant systems will clarify if an advanced driver assistant system is suitable in a certain driving situation, and if so, which system. The result of the evaluation may thus be used to instruct the operator of the vehicle (the driver). The driving advice may be of general nature, such as “always use adaptive cruise control over undulating road segments” or “always use cruise control when driving on highways”. The driving advice may alternatively or additionally be of more specific nature and may thus be provided when the vehicle is approaching a certain driving situation. Such a driving advice could be “you are approaching a curvy road segment, to improve fuel efficiency please activate the adaptive cruise control system and deactivate the driver coaching system”.

According to an aspect of the invention the method further comprises the step of:

- transferring the result of the evaluation to an off-board system.

The result of the evaluation is suitably transferred to an off-board system, such as a road side unit, a back office system, a server or the cloud. The result of the evaluation may thereby be presented to a fleet owner or vehicle owner, who can use the result for planning future transports.

According to an aspect of the invention the method further comprises the step of:

- automatically controlling a vehicle based on the result of the evaluation of the advanced driver assistant systems.

The result of the evaluation may be used to generate control signals which are transmitted to a vehicle control system for automatically controlling the vehicle. The result of the evaluation may be used as a basis for creating algorithms for controlling the vehicle. If the result of the evaluation is that an adaptive cruise control system lowers the fuel consumption with 2% in a certain driving situation compared to a general cruise control system, a control signal for activation of the adaptive cruise control system may be generated each time such driving situation is approaching.

According to an aspect of the invention a system for evaluating the operational performance of advanced driver assistant systems associated with a vehicle is provided. The system comprising an analysis unit arranged in communication with at least one vehicle. The analysis unit is adapted to log driving performance data from the at least one vehicle; to categorize the logged data into a set of driving situations; classify the logged data based on which advanced driver assistant system was activated; evaluate the operational performance of the advanced driver assistant systems by comparing driving performance data with a first classification and a first categorization with driving performance data with a different second classification but the same first categorization; and to provide a result of the evaluation.

The analysis unit is suitably adapted to classify the logged data as manual operation when no advanced driver assistant system was activated.

The analysis unit may be arranged on the vehicle or may be a vehicle external unit. The analysis unit may be arranged in wireless communication with the at least one vehicle. The analysis unit may be arranged in the external environment,

such as a commonly known roadside unit (RSU). The analysis unit constituting a roadside unit is thus suitably arranged in wireless communication with a plurality of vehicles irrespective of fleet or vehicle owner. The analysis unit is adapted to receive driving performance data from at least one vehicle. The analysis unit is suitably adapted to receive the driving performance data through a communication system of the vehicle, such as via a controller area network (CAN) or similar. The driving performance data may be determined by means of sensors/cameras on the vehicle. The analysis unit is suitably adapted to log, categorize and classify driving performance data from more than one vehicle. The analysis unit may be adapted to log driving performance data from all vehicles in a vehicle fleet. The analysis unit is suitably adapted to calculate an aggregated value of the driving performance data over a specific time period or distance and subsequently log the aggregated value. The analysis unit may thus be adapted to perform the evaluation of the operational performance of the advanced driver assistant systems based on aggregated data. The analysis unit may be a control unit, a computer, a vehicular cloud or a roadside cloud.

The analysis unit is suitably adapted to evaluate the operational performance of the advanced driver assistant systems by comparing driving performance data within the same category but with different classification. This way, differences in driving performance data obtained with different advanced driver assistant systems active in the same type of driving situation will be apparent. The evaluation thus clarifies the various benefits of each of the advanced driver assistant systems associated with a vehicle. The advanced driver assistant systems are thereby evaluated based on their actual performance in an advantageous way. The analysis unit may be adapted to evaluate all advanced driver assistant systems associated with a vehicle. The analysis unit may be adapted to evaluate an advanced driver assistant system by comparing driving performance data obtained with that system active, with driving performance data obtained with another system active and/or driving performance data obtained when operating the vehicle manually. The analysis unit may be adapted to evaluate the operational performance of the advanced driver

assistant systems by comparing logged driving performance data with a first classification and a first categorization with estimated driving performance data of a different second classification but the same first categorization. The analysis unit may thus be adapted to estimate driving performance data relating to a certain advanced driver assistant system.

The analysis unit is suitably adapted to evaluate the operational performance of the advanced driver assistant systems by considering information regarding the vehicle from which the driving performance data is received. By considering vehicle characteristics, a more accurate evaluation can be achieved.

The analysis unit may be adapted to evaluate the operational performance of the advanced driver assistant systems by calculating operational performance values for the advanced driver assistant systems. The analysis unit may be adapted to calculate operational performance values for the advanced driver assistant systems and provide this as a result of the evaluation. The analysis unit suitably calculates operational performance values for an advanced driver assistant system in relation to another advanced driver assistant system.

The analysis unit is suitably adapted to categorize the logged data into a driving situation based on geographic location, road quality, road grade, road curvature and/or surrounding traffic. The analysis unit may be adapted to categorize the logged data into driving situations, such as queueing, uphill driving, downhill driving, driving on curvy roads, driving on gravel roads, driving in an urban environment or highway driving. The analysis unit may also be adapted to categorize the driving performance data into a driving situation relating to a specific geographic location or road segment. The analysis unit is suitably adapted to receive information regarding the driving situation from the vehicle via navigation systems, sensors and/or cameras. Such information may be road map data, such as altitude, road grade, curvature and similar.

According to an aspect of the invention the analysis unit is adapted to evaluate the advanced driver assistant systems with respect to at least one of safety, fuel consumption, driving time, comfort and brake use. The analysis unit is suitably adapted to evaluate the advanced driver assistant systems with respect to fuel consumption and at least one of safety, driving time, comfort and brake use. The analysis unit may further be adapted to evaluate the advanced driver assistant systems with respect to sudden and/or significant changes of vehicle speed.

The analysis unit is suitably adapted to provide driving advice to the operator of the vehicle based on the result of the evaluation of the advanced driver assistant systems. The analysis unit may be adapted to provide the result of the evaluation as driving advice to the operator of the vehicle. The analysis unit is suitably adapted to provide driving advice relating to the advanced driver assistant systems based on the result of the evaluation. The analysis unit is adapted to evaluate the advanced driver assistant systems by performing a comparative analysis and the result of the evaluation will thus clarify if an advanced driver assistant system is suitable in a certain driving situation, and if so which system. The analysis unit may be adapted to provide general driving advice, such as "always use adaptive cruise control over undulating road segments" or "always use cruise control when driving on highways". The analysis unit may alternatively or additionally be adapted to provide specific driving advice when the vehicle is approaching a certain driving situation.

According to an aspect of the invention the analysis unit is adapted to transfer the result of the evaluation to an off-board system. The analysis unit is suitably adapted to transmit the result of the evaluation to an off-board system which displays the result to a vehicle owner, fleet owner or similar.

According to an aspect of the invention the analysis unit is adapted to automatically control a vehicle based on the result of the evaluation of the advanced driver assistant systems. The analysis unit may be adapted to generate control signals based on the result of the evaluation and to transmit

the control signals to a vehicle control system for automatically controlling the vehicle.

Further objects, advantages and novel features of the present invention will become apparent to one skilled in the art from the following details, and also by putting the invention into practice. Whereas the invention is described below, it should be noted that it is not restricted to the specific details described. Specialists having access to the teachings herein will recognise further applications, modifications and incorporations within other fields, which are within the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

For fuller understanding of the present invention and further objects and advantages of it, the detailed description set out below should be read together with the accompanying drawings, in which the same reference notations denote similar items in the various diagrams, and in which:

Figure 1 schematically illustrates a vehicle according to an embodiment of the invention;

Figure 2 schematically illustrates a system for evaluating the operational performance of advanced driver assistant systems associated with a vehicle according to an embodiment of the invention;

Figure 3 schematically illustrates a flow chart for a method for evaluating the operational performance of advanced driver assistant systems associated with a vehicle; and

Figure 4 schematically illustrates a control unit or computer according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

The term "link" refers herein to a communication link which may be a physical connection such as an opto-electronic communication line, or a non-physical connection such as a wireless connection, e.g. a radio link or microwave link.

Figure 1 schematically shows a side view of a vehicle 1 comprising a number of advanced driver assistant systems. Connected to the vehicle 1 is a system for evaluating the operational performance of advanced driver assistant systems associated with a vehicle 100 according to an embodiment of the invention. Some parts of the system 100 may be arranged on the vehicle 1 and other parts may be vehicle external. The system 100 is further described in relation to Figure 2. The vehicle 1 may be a heavy vehicle, e.g. a truck or a bus. The vehicle 1 may alternatively be a passenger car. The vehicle may be a hybrid vehicle, an electrical vehicle or a vehicle driven by a combustion engine. The vehicle may be manually operated, remotely operated or autonomously operated.

Figure 2 shows a system for evaluating the operational performance of advanced driver assistant systems associated with a vehicle 100 according to an embodiment of the invention. The vehicle 1 is suitably configured as described in Figure 1. The system 100 comprises an analysis unit 110 arranged in communication with at least one vehicle 1. The analysis unit 110 is adapted to log driving performance data from the least one vehicle 1; to categorize the logged data into a set of driving situations; classify the logged data based on which advanced driver assistant system 200 was activated; evaluate the operational performance of the advanced driver assistant systems 200 by comparing driving performance data with a first classification and a first categorization with driving performance data with a different second classification but the same first categorization; and to provide a result of the evaluation. The analysis unit 110 is suitably adapted to classify the logged data as manual operation when no advanced driver assistant system 200 was activated.

The analysis unit 110 may be arranged on the at least one vehicle 1 or may be a vehicle external unit. The analysis unit 110 may be arranged in the external environment, such as a commonly known roadside unit (RSU). In this case, the analysis unit 110 is arranged in wireless communication with a plurality of vehicles 1 irrespective of fleet or vehicle owner. The analysis unit 110 may be a control unit, a computer, a vehicular cloud or a roadside cloud.

The analysis unit 110 is arranged in communication with a number of advanced driver assistant systems 200 of the at least one vehicle 1. The advanced driver assistant systems 200 may comprise an adaptive cruise control system, a lane keep assisting system, a driver coaching system, a cruise control system with active prediction or similar. Each advanced driver assistant system 200 is adapted to transmit signals to the analysis unit 110 indicating that it is active or inactive. The signals from the advanced driver assistant systems 200 are transmitted via link L200 to the analysis unit 110. The analysis unit 110 is further arranged in communication with sensors and cameras 210 of the at least one vehicle 1. The sensors and cameras 210 are suitably adapted to transmit signals comprising driving performance data to the analysis unit 110 via link L210. Driving performance data may be such as engine torque, instantaneous fuel consumption, active gear, braking actions, vehicle speed, acceleration and similar information from speed regulating means of the at least one vehicle 1. The analysis unit 110 is also arranged in communication with a vehicle control unit 220. The vehicle control unit 220 is adapted to transmit road map data to the analysis unit 110 via link L220. The road map data, such as altitude, road grade, curvature etc. is used by the analysis unit 110 to categorize the logged driving performance data into a suitable driving situation. The information from the advanced driver assistant systems 200, the driving performance data from the sensors and cameras 210 and the road map data from the vehicle control unit 220 may be transmitted to the analysis unit 110 via an on-board electrical system of the at least one vehicle 1, such as a CAN. The analysis unit 110 may

thus be arranged in communication with an on-board electrical system of the at least one vehicle 1. A computer 120 may be connected to the control unit 110.

This figure has been described such that the analysis unit 110 is arranged in communication with one vehicle 1. It is to be understood that when the analysis unit 110 is arranged in communication with a plurality of vehicles 1, for example a fleet of vehicles 1, and thus is adapted to log driving performance data from a plurality of vehicles 1, the analysis unit 110 is arranged in communication with advanced driver assistant systems 200, sensors and cameras 210 and vehicle control units 220 relating to all these vehicles 1.

The analysis unit 110 may further be arranged in communication with a display unit 230 in at least one vehicle 1. The analysis unit 110 is suitably adapted to transmit driving advice based on the result of the evaluation via link L230 to the display unit 230. This way, the operator of the vehicle 1 is advised regarding which advanced driver assistant system 200 to use when, depending on the result of the evaluation.

The analysis unit 110 may also be arranged in communication with an off-board system 240. The off-board system 240 may be a road side unit, a back office system, a server or the cloud. The analysis unit 110 is suitably adapted to transmit the result of the evaluation to the off-board system 240 via link L240. This way, a vehicle owner/fleet owner may receive the result of the evaluation and can plan future transport missions more efficiently.

The analysis unit 110 may also be arranged in communication with a vehicle control system 250. The analysis unit 110 is suitably adapted to generate control signals and transmit these to the vehicle control system 250 via link L250. The vehicle control system 250 is thus adapted to automatically control the vehicle 1 based on the result of the evaluation.

Figure 3 schematically shows a flow chart of a method for evaluating the operational performance of advanced driver assistant systems 200 associated with a vehicle 1 according to an embodiment of the invention. The method comprises the steps of logging s101 driving performance data from at least one vehicle 1; categorizing s102 the logged data into a set of driving situations; classifying s103 the logged data based on which advanced driver assistant system was activated; evaluating s104 the operational performance of the advanced driver assistant systems by comparing driving performance data with a first classification and a first categorization with driving performance data with a different second classification but the same first categorization; and providing s105 a result of the evaluation. The method is suitably performed by a system for evaluating the operational performance of advanced driver assistant systems associated with a vehicle 100 as described in Figure 2. By logging driving performance data, categorizing it into a set of driving situations and classifying it based on if an advanced driver assistant system 200 was used and if so, which system 200, the advanced driver assistant systems 200 can be evaluated by comparing the driving performance data of the same driving situation category but with different classification. This way, each advanced driver assistant system 200 is evaluated based on its actual performance in its actual environment and a more accurate comparison between the systems 200 can be made. With the result of the evaluation it can be determined which advanced driver assistant system 200 should be used in a certain driving situation. Future transport missions may thereby be planned more efficiently.

The step of classifying s103 the logged data suitably comprises to classify the logged data as manual operation when no advanced driver assistant system 200 was activated. This way, the operational performance of the various advanced driver assistant systems 200 can be evaluated compared to manual operation of the vehicle 1.

The steps of logging s101, categorizing s102 and classifying s103 may be performed continuously or with a predetermined interval. The step of evaluating

s104 and the step of providing s105 a result of the evaluation are suitably performed with a predetermined interval.

The step of categorizing s101 the driving performance data into a set of driving situations suitably comprises to categorise the driving performance data based on at least one of geographic location, road quality, road grade, road curvature and surrounding traffic. A driving situation may for example be queueing, uphill driving, downhill driving, driving on curvy roads, driving on gravel roads, driving in an urban environment or highway driving. The driving performance data may also be categorized into a driving situation relating to a specific geographic location or road segment.

The step of evaluating s104 the operational performance of the advanced driver assistant systems 200 may comprise to compare logged driving performance data with a first classification and a first categorization with estimated driving performance data with a different second classification but the same first categorization. This way, when only one advanced driver assistant system 200 of the at least one vehicle 1 has been used in a certain driving situation, the operational performance of that system 200 in that driving situation can still be evaluated.

The method may comprise to log, categorise and classify driving performance data from more than one vehicle 1. For example, driving performance data from all vehicles 1 in a vehicle fleet may be logged, categorized and classified. Alternatively, driving performance from a plurality of non-related vehicles 1 may be logged, categorized and classified. This way, a greater basis of the evaluation is obtained. When driving performance data from a plurality of vehicles is logged, the logged driving performance data suitably comprises information regarding which vehicle 1 it relates to. This way, the performance of each vehicle 1 can be monitored.

The driving performance data in a certain driving situation varies depending on the type of vehicle 1, the weight/load of the vehicle 1, the tires of the vehicle 1 etc. Thus, the operational performance of an advanced driver assistant system varies depending on the type of vehicle 1, the weight/load of the vehicle 1, the tires of the vehicle 1 etc. The step of evaluating s104 the operational performance of the advanced driver assistant systems 200 thus suitably comprises to consider information regarding the vehicle 1 from which the driving performance data is received. By considering vehicle characteristics, a more accurate evaluation can be achieved.

The operational performance of the advanced driver assistant systems 200 may be evaluated with respect to at least one of safety, fuel consumption, driving time, comfort and brake use. The advanced driver assistant systems 200 are suitably evaluated with respect to fuel consumption and at least one of safety, driving time, comfort and brake use. Which advanced driver assistant systems 200 that should be used in a certain driving situation depends on the requirements of the vehicle owner. By evaluating the different advanced driver assistant systems 200 with respect to a plurality of different factors, a better understanding of the different advanced driver assistant systems 200 is achieved and it enables the vehicle owner to achieve more efficient future transports. Evaluation with respect to safety may relate to personal safety of the operator of the vehicle or safety of the surrounding environment. Safety may relate to whether the vehicle is able to stay in the relevant lane, the ability to handle obstacles in the road etc. Evaluation with respect to comfort may relate to comfort of the driver and/or passengers in the vehicle. The advanced driver assistant systems 200 may be evaluated with respect to sudden and/or significant changes of vehicle speed.

The step of evaluating s104 the operational performance of the advanced driver assistant systems 200 may comprise to calculate operational performance values for the advanced driver assistant systems 200. A calculated operational performance value is suitably calculated for an advanced driver assistant system

200 in relation to another advanced driver assistant system 200 or in relation to manual operation. For example, to calculate an operational performance value may comprise to calculate a percentage of how much smaller the fuel consumption was when a certain advanced driver assistant system 200 was used compared to when another advanced driver assistant system 200 was used. The result of the evaluation thus suitably comprises operational performance values for the advanced driver assistant systems 200.

The method may further comprise the step of providing driving advice to the operator of a vehicle 1 based on the provided result of the evaluation of the advanced driver assistant systems 200. The step of providing s105 a result of the evaluation may comprise to provide a result of the evaluation in the form of driving advice to the operator of the vehicle 1. The driving advice is suitably presented on a display unit 230 arranged in the vehicle 1. The evaluation of the advanced driver assistant systems 200 will clarify if an advanced driver assistant system 200 is suitable in a certain driving situation, and if so which system. The result of the evaluation may thus be used to instruct the operator of the vehicle 1. The driving advice may be of general nature or the driving advice may be of more specific nature. The driving advice suitably relates to the usage or non-usage of advanced driver assistant systems 200.

The method may further comprise the step of transferring the result of the evaluation to an off-board system 240. The step of providing s105 a result of the evaluation may comprise to provide the result to an off-board system 240. The result of the evaluation may thereby be presented to a fleet owner or vehicle owner, who can use the result for planning future transport missions.

The method may further comprise the step of automatically controlling a vehicle based on the result of the evaluation of the advanced driver assistant systems 200. The step of providing s105 a result of the evaluation may comprise to provide the result of the evaluation in the form of control signals to a vehicle control system 250. The result of the evaluation may be used as a basis for

creating algorithms for controlling the vehicle 1. If the result of the evaluation is that an adaptive cruise control system lowers the fuel consumption with 2% in a certain driving situation compared to a general cruise control system, a control signal for activation of the adaptive cruise control system is suitably generated each time such driving situation is approaching.

Figure 4 schematically illustrates a device 500. The control unit 110 or computer 120 described with reference to Figure 2 may in a version comprise the device 500. The term "link" refers herein to a communication link which may be a physical connection such as an optoelectronic communication line, or a non-physical connection such as a wireless connection, e.g. a radio link or microwave link. The device 500 comprises a non-volatile memory 520, a data processing unit 510 and a read/write memory 550. The non-volatile memory 520 has a first memory element 530 in which a computer program, e.g. an operating system, is stored for controlling the function of the device 500. The device 500 further comprises a bus controller, a serial communication port, I/O means, an A/D converter, a time and date input and transfer unit, an event counter and an interruption controller (not depicted). The non-volatile memory 520 has also a second memory element 540.

There is provided a computer program P which comprises routines for a method for evaluating the operational performance of advanced driver assistant systems 200 associated with a vehicle 1 according to the invention. The computer program P comprises routines for logging driving performance data from at least one vehicle 1. The computer program P comprises routines for categorizing the logged data into a set of driving situations. The computer program P comprises routines for classifying the logged data based on which advanced driver assistant system 200 was activated. The computer program P comprises routines for evaluating the operational performance of the advanced driver assistant systems 200 by comparing driving performance data with a first classification and a first categorization with driving performance data with a different second classification but the same first categorization. The computer

program P comprises routines for providing a result of the evaluation. The computer program P comprises routines for providing driving advice based on the result of the evaluation. The computer program P comprises routines for transferring the result of the evaluation to an off-board system 240. The computer program P comprises routines for automatically controlling a vehicle based on the result of the evaluation of the advanced driver assistant systems 200. The program P may be stored in an executable form or in a compressed form in a memory 560 and/or in a read/write memory 550.

Where the data processing unit 510 is described as performing a certain function, it means that the data processing unit 510 effects a certain part of the program stored in the memory 560 or a certain part of the program stored in the read/write memory 550.

The data processing device 510 can communicate with a data port 599 via a data bus 515. The non-volatile memory 520 is intended for communication with the data processing unit 510 via a data bus 512. The separate memory 560 is intended to communicate with the data processing unit 510 via a data bus 511. The read/write memory 550 is adapted to communicating with the data processing unit 510 via a data bus 514.

When data are received on the data port 599, they are stored temporarily in the second memory element 540. When input data received have been temporarily stored, the data processing unit 510 is prepared to effect code execution as described above.

Parts of the methods herein described may be effected by the device 500 by means of the data processing unit 510 which runs the program stored in the memory 560 or the read/write memory 550. When the device 500 runs the program, methods herein described are executed.

The foregoing description of the preferred embodiments of the present invention is provided for illustrative and descriptive purposes. It is not intended to be exhaustive or to restrict the invention to the variants described. Many modifications and variations will obviously be apparent to one skilled in the art. The embodiments have been chosen and described in order best to explain the principles of the invention and its practical applications and hence make it possible for specialists to understand the invention for various embodiments and with the various modifications appropriate to the intended use.

Claims

1. A method for evaluating the operational performance of advanced driver assistant systems (200) associated with a vehicle (1), **characterized by** the steps of:

- logging (s101) driving performance data from at least one vehicle (1);
- categorizing (s102) the logged data into a set of driving situations;
- classifying (s103) the logged data based on which advanced driver assistant system (200) was activated;
- evaluating (s104) the operational performance of the advanced driver assistant systems (200) by comparing driving performance data with a first classification and a first categorization with driving performance data with a different second classification but the same first categorization; and
- providing (s105) a result of the evaluation.

2. The method according to claim 1, **wherein** the step of classifying (s103) the logged data further comprises to, when no advanced driver assistant system (200) was activated, classify the logged data as manual operation.

3. The method according to claim 1 or 2, **wherein** the logged data is categorized into a driving situation based on geographic location, road quality, road grade, road curvature and/or surrounding traffic.

4. The method according to any of the preceding claims, **wherein** the advanced driver assistant systems (200) are evaluated with respect to at least one of safety, fuel consumption, driving time, comfort and/or brake use.

5. The method according to any of the preceding claims, **wherein** the driving performance data comprises at least one of engine torque, instantaneous fuel consumption, active gear, braking action, vehicle speed and acceleration.

6. The method according to any of the preceding claims, **wherein** it further comprises the step of:

- providing driving advice to the operator of a vehicle (1) based on the result of the evaluation of the advanced driver assistant systems (200).

7. The method according to any of the preceding claims, **wherein** it further comprises the step of:
- transferring the result of the evaluation to an off-board system (240).

8. The method according to any of the preceding claims, **wherein** it further comprises the step of:
- automatically controlling a vehicle (1) based on the result of the evaluation of the advanced driver assistant systems (200).

9. A system for evaluating the operational performance of advanced driver assistant systems associated with a vehicle (100), the system (100) comprising an analysis unit (110) arranged in communication with at least one vehicle (1), **characterized in that** the analysis unit (110) is adapted to log driving performance data from the least one vehicle (1); to categorize the logged data into a set of driving situations; classify the logged data based on which advanced driver assistant system (200) was activated; evaluate the operational performance of the advanced driver assistant systems (200) by comparing driving performance data with a first classification and a first categorization with driving performance data with a different second classification but the same first categorization; and to provide a result of the evaluation.

10. The system according to claim 9, **wherein** the analysis unit (110) is adapted to classify the logged data as manual operation when no advanced driver assistant system (200) was activated.

11. The system according to claim 9 or 10, **wherein** the analysis unit (110) is adapted to categorize the logged data into a driving situation based on geographic location, road quality, road grade, road curvature and/or surrounding traffic.

12. The system according to any of claims 9-11, **wherein** the analysis unit (110) is adapted to evaluate the advanced driver assistant systems (200) with respect to at least one of safety, fuel consumption, driving time, comfort and brake use.

13. The system according to any of claims 9-12, **wherein** the driving performance data comprises at least one of engine torque, instantaneous fuel consumption, active gear, braking action, vehicle speed and acceleration.

14. The system according to any of claims 9-13, **wherein** the analysis unit (110) is adapted to provide driving advice to the operator of the vehicle based on the result of the evaluation of the advanced driver assistant systems (200).

15. The system according to any of claims 9-14, **wherein** the analysis unit (110) is adapted to transfer the result of the evaluation to an off-board system (240).

16. The system according to any of claims 9-15, **wherein** the analysis unit (110) is adapted to automatically control a vehicle (1) based on the result of the evaluation of the advanced driver assistant systems (200).

17. The system according to any of claims 9-16, **wherein** the analysis unit (110) is arranged in a vehicle (1) or in the external environment.

18. A computer program (P), wherein said computer program comprises program code for causing an electronic control unit (110; 500) or a computer (120; 500) connected to the electronic control unit (110; 500) to perform the steps according to any of the claims 1-8.

19. A computer program product comprising a program code stored on a computer-readable medium for performing the method steps according to any of claims 1-8, when said computer program is run on an electronic control unit

(110; 500) or a computer (120; 500) connected to the electronic control unit (110; 500).

5

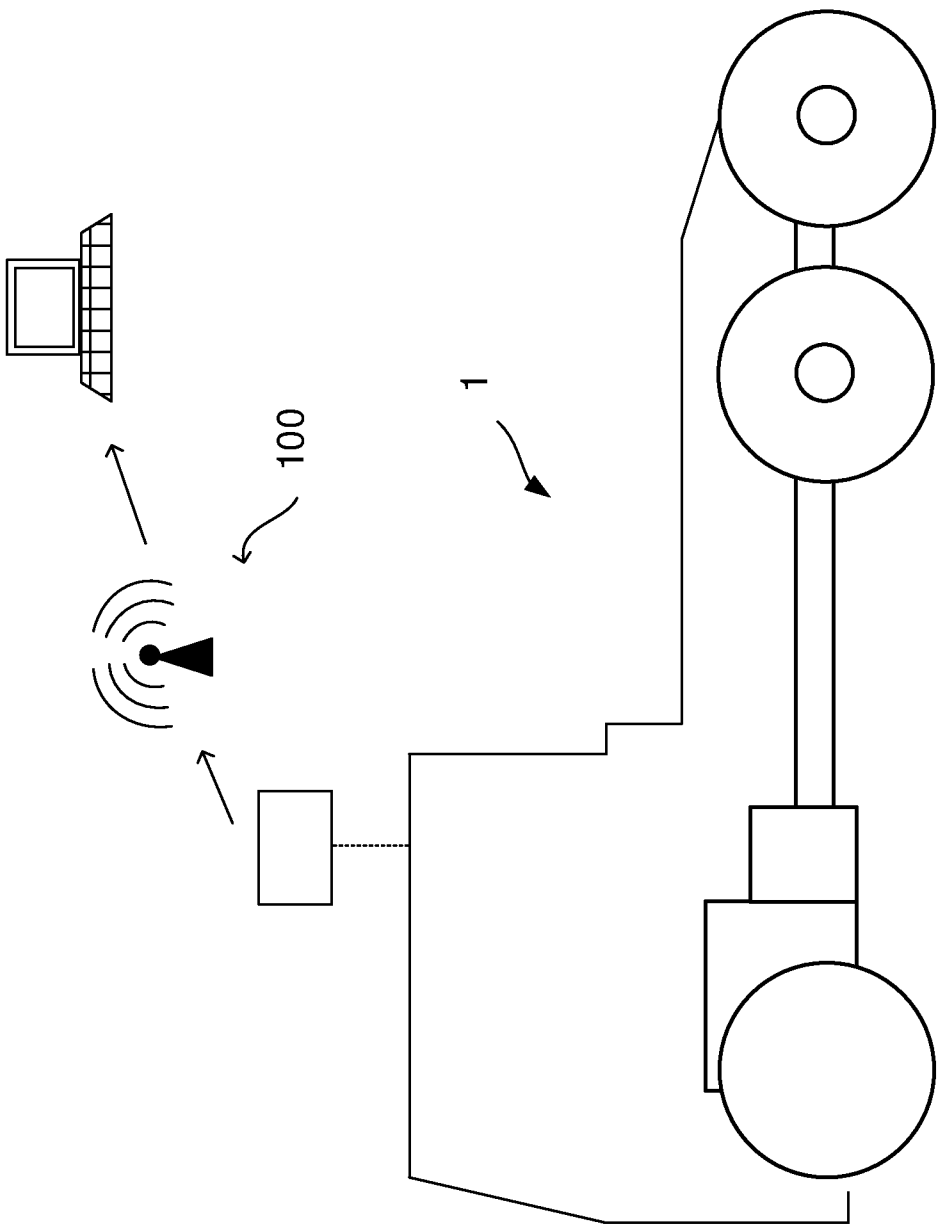
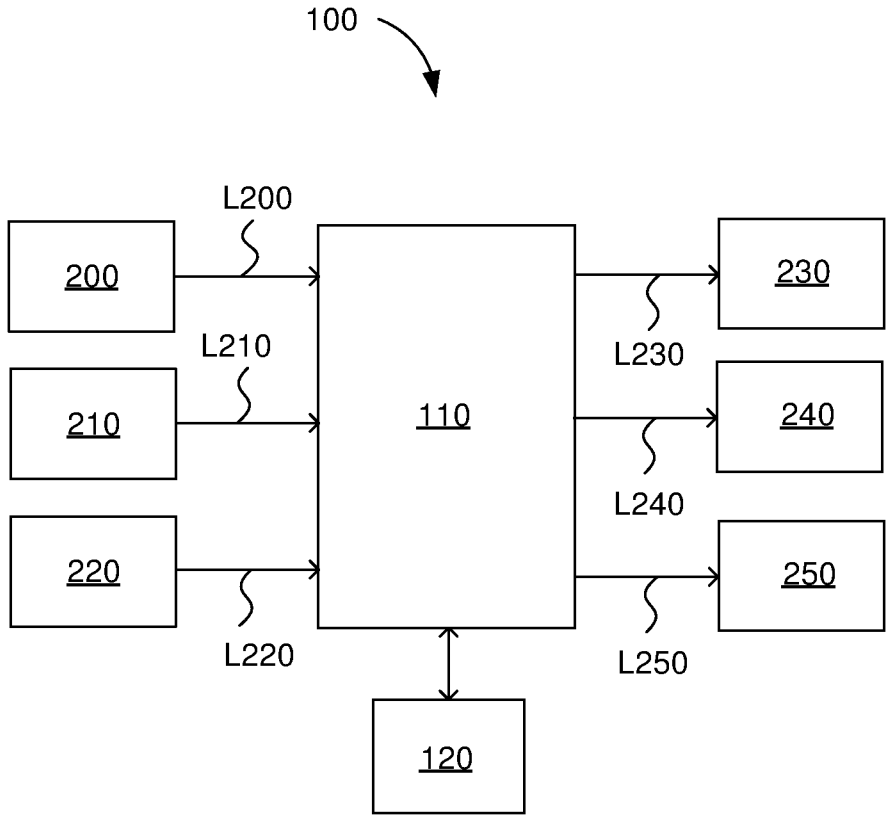


Fig. 1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L230
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L240
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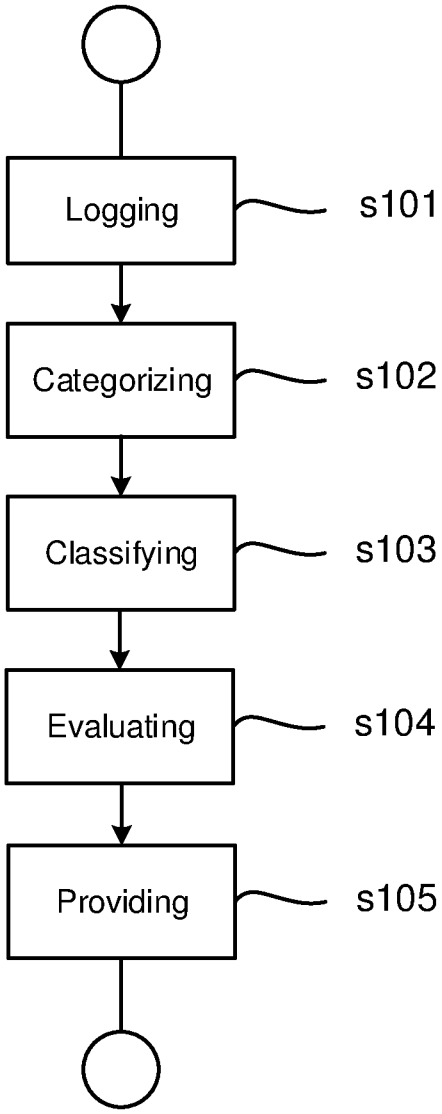
L250
120

Fig. 2


Logging
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Categorizing
s102
Classifying
s103
Evaluating
s104
Providing
s105

Fig. 3

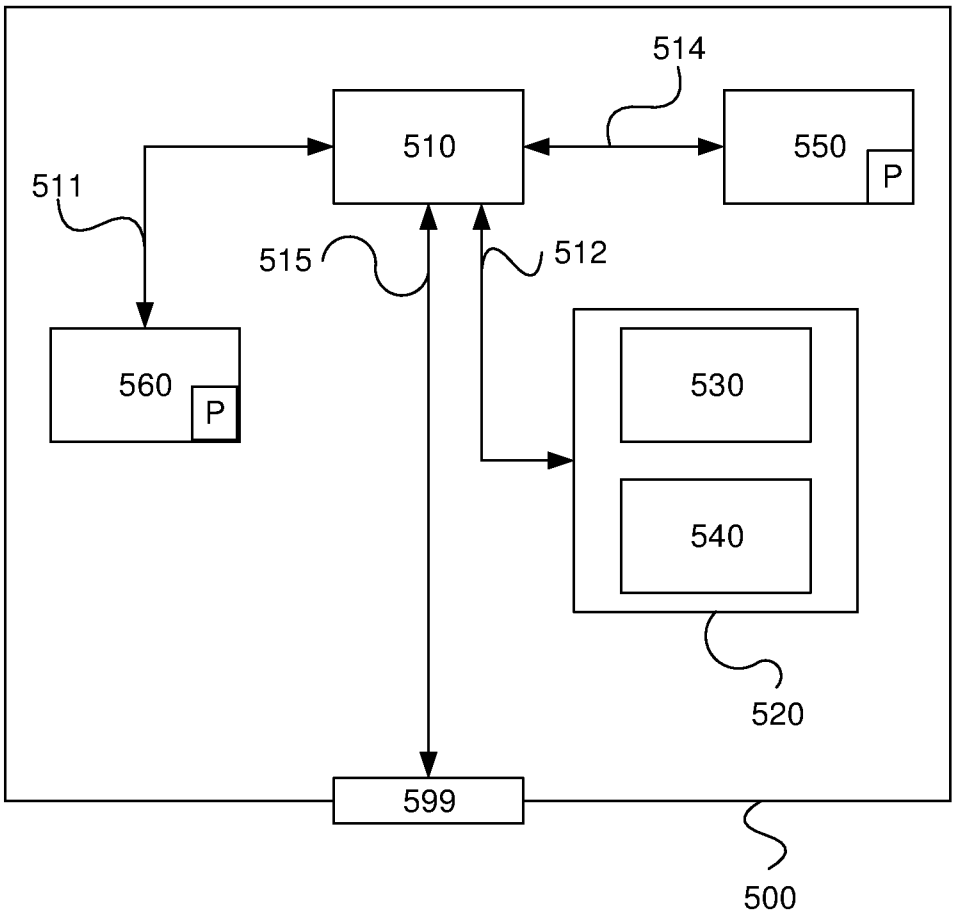

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/050512

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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: B60W, G09B

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 102010063792 A1 (BAYERISCHE MOTOREN WERKE AG), 21 June 2012 (2012-06-21); paragraphs [0010]-[0022], [0039]-[0042]; figure 2	1-19
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A	US 20160121904 A1 (HSIANG ET AL), 5 May 2016 (2016-05-05); paragraphs [0033], [0037]-[0038], [0049]-[0053]; figures 1-2	1-19
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A	DE 10358498 A1 (DAIMLER CHRYSLER AG), 7 July 2005 (2005-07-07); paragraphs [0011]-[0014], [0040]-[0053]	1-19
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17-08-2017	17-08-2017

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/050512

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20120022764 A1 (TANG ZHIJUN ET AL), 26 January 2012 (2012-01-26); paragraphs [0025]-[0033]; figure 2 --	1-19
A	DE 102011055495 A1 (CONTINENTAL TEVES AG & CO OHG), 23 May 2013 (2013-05-23); paragraphs [0019]-[0020] --	1-19
A	US 20130302756 A1 (TAKEUCHI SHOJIRO ET AL), 14 November 2013 (2013-11-14); claim 1 --	1-19

International application No.
PCT/SE2017/050512

Continuation of: second sheet

International Patent Classification (IPC)

B60W 50/00 (2006.01)
B60W 30/18 (2012.01)
B60W 40/04 (2006.01)
B60W 40/06 (2012.01)
B60W 50/08 (2012.01)
G09B 19/16 (2006.01)

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				DE	102015118565	A1	04/05/2016
DE	10358498	A1	07/07/2005	NONE			
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				EP	2595848	A1	29/05/2013
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				CN	103221665	B	03/06/2015
				EP	2643575	A1	02/10/2013
				JP	5375805	B2	25/12/2013
				JP	2012113631	A	14/06/2012
				US	8753123	B2	17/06/2014
				WO	2012070229	A1	31/05/2012