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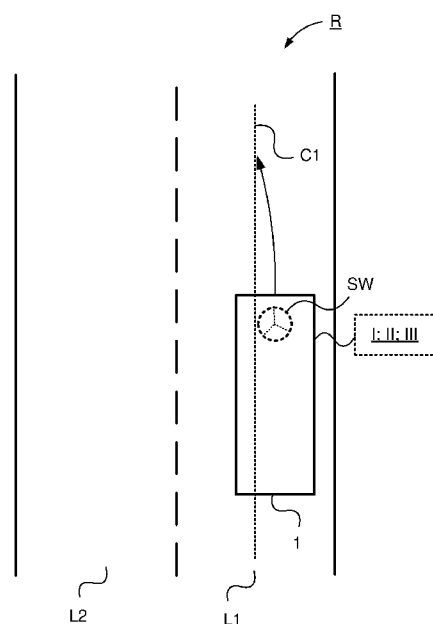


Fig. 2

(57) Abstract: The present invention relates to a method for facilitating steering of a vehicle by a driver of the vehicle during driving along a road. The method comprises the step of determining (330) a steering torque based upon current driving situation (310) so as to assist said driver during driving. The method further comprises the step of determining (320) a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel. The step of determining a steering torque based upon current driving situation so as to assist said driver comprises the step of considering (P, I, D, 332) the result of the thus determined driver steering wheel activity function. The method further comprises the step of providing (TQ) a thus determined steering torque. The present invention also relates to a system for facilitating steering of a vehicle during driving along a road. The present invention also relates to a vehicle. The present invention also relates to a computer program and a computer program product.

METHOD AND SYSTEM FOR FACILITATING STEERING OF A VEHICLE BY A DRIVER OF THE VEHICLE DURING DRIVING ALONG A ROAD

TECHNICAL FIELD

- 5 The invention relates to a method for facilitating steering of a vehicle by a driver of the vehicle during driving along a road. The invention also relates to a system for facilitating steering of a vehicle by a driver of the vehicle during driving along a road. The invention also relates to a vehicle. The invention in addition relates to a computer program and a computer program product.

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BACKGROUND ART

In order to facilitate steering during driving along a road systems for controlling the steering torque are utilized. Such systems include active steering systems.

- 15 In a lane keep assistance (LKA) system where a driver and a torque regulator together control the vehicle, the torque regulator normally handles the steering and positioning of the vehicle by the driver during driving along a road as a known or unknown error and is arranged to eliminate this possible fault. This means, that using fault-integration would counteract the driver, making the steering wheel be very stiff. Also using fault-prediction may induce a very high
20 change in steering torque which would make the regulator feel "nervous".

- US2010010712 discloses a method and device for improving driving comfort in a steering assistance system. An actuating torque is exerted on the steering system of the vehicle in order to cause the driver to make a change in the position of the steering wheel. The steering intervention by the actuating torque
25 is made significantly more comfortable by limiting the gradient of the actuating torque to a maximum value.

There is however a need for further increasing comfort for the driver when assisting the driver steering a vehicle during driving along a road.

OBJECTS OF THE INVENTION

- 5 An object of the present invention is to provide a method for facilitating steering of a vehicle by a driver of the vehicle during driving along a road which provides safe drive and improves comfort for the driver when assisting the driver steering the vehicle by means of providing a steering torque.

- 10 Another object of the present invention is to provide a system for facilitating steering of a vehicle by a driver of the vehicle during driving along a road which provides safe drive and improves comfort for the driver when assisting the driver steering the vehicle by means of providing a steering torque.

SUMMARY OF THE INVENTION

- 15 These and other objects, apparent from the following description, are achieved by a method, a system, a vehicle, a computer program and a computer program product, as set out in the appended independent claims. Preferred embodiments of the method and the system are defined in appended dependent claims.
- 20 Specifically an object of the invention is achieved by a method for facilitating steering of a vehicle by a driver of the vehicle during driving along a road. The method can comprise the step of determining a steering torque based upon current driving situation so as to assist said driver during driving. The method further comprises the step of determining a driver steering wheel activity
- 25 function reflecting if, and to what extent said driver is steering by means of said steering wheel. In other words a determination is made indicating how actively the driver is steering the vehicle. The step of determining a steering torque

- based upon current driving situation so as to assist said driver comprises the step of considering the result of the thus determined driver steering wheel activity function. The method further comprises the step of providing a thus determined steering torque. In other words, the assisting torque applied by the vehicle to keep the vehicle in the lane is made dependent on the determined activity of the driver. In particular a determined relative high steering activity by the driver results in that the lane keep assist system provides a relatively smaller amount of assist torque to keep the vehicle at a determined lateral position in the lane. On the other hand, a determined relative low steering activity by the driver results in that the lane keep assist system provides a relatively higher amount of assist torque to keep the vehicle at a determined lateral position in the lane. The lateral position in the lane that the system strives to maintain can be any suitable lateral position such as a centre position, but also another position that is determined to be desired to keep.
- 15 The method thus can comprise the step of determining said steering torque assisting said driver based upon the result of the thus determined driver steering wheel activity function.

- The current driving situation on which the steering torque is based for assisting the driver may be any suitable driving situation. The current driving situation on which the steering torque is based for assisting the driver may comprise any driving situation where assistance in following a certain trajectory in connection to the road such as following a lane of the road, following another vehicle travelling along the road, guidance to a road exit along the road, guidance to a stop along the road or the like. The current driving situation on which the steering torque is based for assisting the driver comprises according to an embodiment a driving situation where the position of the vehicle deviates from a desired position of the lane of the road along which the vehicle is travelling, wherein assisting the driver comprises providing steering torque so as to keep the vehicle essentially in the desired position of the lane. The

desired position may for example be a central position of the lane. This may comprise a so called lane keep assistance function.

According to an embodiment the method comprises the step of determining the driving situation.

- 5 The step of determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel comprises according to an embodiment determining if, and to what degree the driver keeps his hands on the steering wheel. Thus if the driver is not steering by means of the steering wheel involves according to an embodiment the driver
- 10 not keeping his hands on the steering wheel. To what degree the driver is steering by means of said steering wheel comprises according to an embodiment the driver holding the steering wheel very loosely, i.e. almost not keeping the hands on the wheel, to holding steadily on the wheel and degrees there between.
- 15 The step of determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel may comprise any suitable way of determining if, and to what extent said driver is steering by means of the steering wheel. The step of determining a driver steering wheel activity function reflecting if, and to what extent said driver is
- 20 steering by means of said steering wheel comprises according to an embodiment the step of measuring driver torque, i.e. the torque provided to the steering wheel by the driver, and determining when and for how long the driver torque is above or below certain levels.

- 25 The step of determining the steering torque for assisting the driver considering the result of the thus determined driver steering wheel activity function comprises adapting the steering torque considering the result of the thus determined driver steering wheel activity function. According to an embodiment the method comprises the step of adapting the steering torque for

assisting the driver considering the result of the thus determined driver steering wheel activity function.

By thus determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel and
5 determining the steering torque assisting the driver considering the result of the thus determined driver steering wheel activity function the comfort for the driver may be improved in that the assistance by means of the steering torque may be set to not influence the steering to a high extent if the driver holds steadily on the steering wheel and be more influential if the driver holds loosely
10 to the steering wheel or does not keep the hands on the steering wheel at all thus increasing the safety of driving the vehicle along the road. Thus, hereby precision lane correction may be obtained by providing a certain steering torque while the driver is not active with the steering wheel, thereby increasing safety, and good comfort for the driver steering the vehicle may be obtained
15 by providing less steering torque merely guiding the steering in a calm manner when the driver is active with the steering wheel.

According to an embodiment of the method the step of determining said steering torque assisting said driver considering the result of the thus determined driver steering wheel activity function comprises the step of
20 providing a relatively higher steering torque assisting said driver to a greater extent compensating for relatively lower driver steering wheel activity and providing a relatively lower steering torque assisting said driver to a minor extent compensating for a relatively higher driver steering wheel activity. Hereby safe drive and improved comfort for the driver is obtained in an efficient
25 way when assisting the driver steering the vehicle by means of providing a steering torque.

According to an embodiment the method comprises the step of providing said steering torque by means of a lane keep assistance function of said vehicle as part of said current driving situation.

According to an embodiment of the method the step of determining said steering torque considering the result of the thus determined driver steering wheel activity function comprises the step of adapting the steering torque by considering a difference between a desired yaw rate and the current yaw rate
5 by means of a regulator unit. Hereby an efficient way of adapting the steering torque is obtained.

According to an embodiment of the method the step of adapting the steering torque by considering a difference between a desired yaw rate and the current yaw rate by means of a regulator unit is performed by means of a PID-regulator
10 unit, wherein the step of considering the difference between a desired yaw rate and the current yaw rate comprises the step of adapting the influence of the P-, I- and D-functions respectively, of said PID-regulator unit. By using a PID-regulator adaption of the steering torque considering the result of the thus determined driver steering wheel activity function may be obtained in a simple
15 and efficient way.

Specifically an object of the invention is achieved by a system for facilitating steering of a vehicle by a driver of the vehicle during driving along a road. The system comprises means for determining a steering torque based upon current driving situation so as to assist said driver during driving. The system further
20 comprises means for determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel. The means for determining a steering torque based upon current driving situation so as to assist said driver comprises means for considering the result of the thus determined driver steering wheel activity function. The
25 system further comprises means for providing a thus determined steering torque.

According to an embodiment of the system the means for determining said steering torque assisting said driver considering the result of the thus determined driver steering wheel activity function comprises means for
30 providing a relatively higher steering torque assisting said driver to a greater

extent compensating for relatively lower driver steering wheel activity and means for providing a relatively lower steering torque assisting said driver to a minor extent compensating for a relatively higher driver steering wheel activity.

According to an embodiment the system comprises means for providing said steering torque by means of a lane keep assistance function of said vehicle as
5 part of said current driving situation.

According to an embodiment of the system the means for determining said steering torque considering the result of the thus determined driver steering wheel activity function comprises a regulator unit for adapting the steering
10 torque by considering a difference between a desired yaw rate and the current yaw rate.

According to an embodiment of the system the regulator unit for adapting the steering torque by considering a difference between a desired yaw rate and the current yaw rate comprises a PID-regulator unit arranged to adapt the
15 influence of the P-, I- and D-functions respectively, of said PID-regulator unit.

The system for facilitating steering of a vehicle by a driver of the vehicle during driving along a road is adapted to perform the methods as set out herein.

The system according to the invention has the advantages according to the corresponding method claims.

20 Specifically an object of the invention is achieved by a vehicle comprising a system according to the invention as set out herein.

Specifically an object of the invention is achieved by a computer program for facilitating steering of a vehicle by a driver of the vehicle during driving along a road, said computer program comprising program code which, when run on
25 an electronic control unit or another computer connected to the electronic control unit, causes the electronic control unit to perform methods as set out herein.

Specifically an object of the invention is achieved by a computer program product comprising a digital storage medium storing the computer program.

BRIEF DESCRIPTION OF THE DRAWINGS

- 5 For a better understanding of the present invention reference is made to the following detailed description when read in conjunction with the accompanying drawings, wherein like reference characters refer to like parts throughout the several views, and in which:

Fig. 1 schematically illustrates a side view of a vehicle according to the present
10 invention;

Fig. 2 schematically illustrates a plan view of the vehicle in fig. 1 driving along a road;

Fig. 3 schematically illustrates a block diagram of a system for facilitating steering of a vehicle by a driver of the vehicle during driving along a road
15 according to an embodiment of the present invention;

Fig. 4 schematically illustrates a block diagram of a system for facilitating steering of a vehicle by a driver of the vehicle during driving along a road according to an embodiment of the present invention;

Fig. 5 schematically illustrates a block diagram of a system for facilitating
20 steering of a vehicle by a driver of the vehicle during driving along a road according to an embodiment of the present invention;

Fig. 6 schematically illustrates a block diagram of a system for facilitating steering of a vehicle by a driver of the vehicle during driving along a road according to an embodiment of the present invention; and

25 Fig. 7 schematically illustrates a computer according to an embodiment of the present invention.

DETAILED DESCRIPTION

Hereinafter the term “link” refers to a communication link which may be a physical connector, such as an optoelectronic communication wire, or a non-physical connector such as a wireless connection, for example a radio or microwave link.

Fig. 1 schematically illustrates a side view of a vehicle 1 according to the present invention. The exemplified vehicle 1 is a heavy vehicle in the shape of a truck. The vehicle according to the present invention could be any suitable vehicle such as a bus or a car. The vehicle 1 comprises a system I for facilitating steering of a vehicle by a driver of the vehicle during driving along a road R.

Fig. 2 schematically illustrates a plan view of the vehicle 1 in fig. 1 driving along a road R. The road R has two lanes L1, L2 and the vehicle 1 is travelling in the right lane L1. The vehicle 1 comprises a steering wheel SW. The vehicle 1 comprises a system I for facilitating steering of a vehicle by a driver of the vehicle during driving along a road R.

The system I comprises a lane keep assistance function for providing a steering torque so as to assist in keeping the vehicle in the lane L1 along which the vehicle 1 is travelling. In fig. 2 the current driving situation of the vehicle 1 involves the vehicle 1 being displaced from the centre C1 of the lane L1 in that the vehicle is positioned more to the right side of the lane L1.

In order to keep the vehicle 1 in the centre C1 of the lane L1 a steering torque is provided such that the vehicle 1 when deviating from the centre is assisted towards the centre C1 of the lane L1. The position of the vehicle 1 in the lane L1 is determined by any suitable means comprising any suitable detection means such as camera unit, laser scanner unit and/or radar unit. According to an embodiment, in order to provide a basis for assisting in correcting such a

deviation, the current yaw rate and the desired yaw rate of the steering wheel in order to reposition the vehicle in a desired position of the lane L1, here the centre C1 of the lane L1, within a certain time/within a certain distance are compared so as to determine an error corresponding to the difference between
5 current yaw rate and desired yaw rate. The steering torque provided is based upon said error.

According to the invention the steering torque for assisting the driver is further based upon if, and to what extent the driver of the vehicle 1 is steering by means of the steering wheel of the vehicle. Therefor a driver steering wheel
10 activity function reflecting if, and to what extent said driver is steering by means of said steering wheel is determined.

A relatively higher steering torque assisting said driver to a greater extent is provided to compensate for relatively lower driver steering wheel activity and a relatively lower steering torque assisting said driver to a minor extent is
15 provided to compensate for a relatively higher driver steering wheel activity.

Thus, in the driving situation in fig. 2, the driver will receive less assistance if the driver holds steadily to the steering wheel when steering and will receive more assistance the looser the driver holds on to the steering wheel and the less steering activity that is detected. Hereby safe drive and improved comfort
20 for the driver is obtained in an efficient way when assisting the driver steering the vehicle by means of providing a steering torque.

The present invention is described in more detail with reference to fig. 3-7.

Fig. 3 schematically illustrates a block diagram of a system I for facilitating steering of a vehicle by a driver of the vehicle during driving along a road
25 according to an embodiment of the present invention.

The system I comprises an electronic control unit 100.

The system I comprises means 110 for determining a current driving situation as a basis for determining possible steering assist of the driver during driving.

- The current driving situation on which the steering torque is based for assisting the driver may be any suitable driving situation. The current driving situation on which the steering torque is based for assisting the driver may comprise any driving situation where assistance in following a certain trajectory in connection to the road such as following a lane of the road, following another vehicle travelling along the road, guidance to a road exit along the road, guidance to a stop along the road or the like. The current driving situation may be a driving situation where the vehicle is positioned with a certain displacement relative to a lane of the road along which the vehicle is travelling.
- 5
- 10 The means 110 for determining a current driving situation comprises according to an embodiment means for determining the position of the vehicle in the lane of the road along which the vehicle is travelling. The means for determining the position of the vehicle may comprise any suitable sensor unit for detecting the road and the lane of the road such as a camera unit, a laser scanner unit
- 15 and/or a radar unit. The means 110 for determining a current driving situation comprises according to an embodiment means for determining the speed of the vehicle. The means for determining the vehicle speed comprises according to an embodiment the speedometer of the vehicle. The vehicle speed may be determined continuously or intermittently during drive of the vehicle. The
- 20 means 110 for determining a current driving situation comprises means for determining the curvature of the road comprises according to an embodiment a Global Navigation satellite System, GNSS, e.g. a global positioning system, GPS, for continuously or intermittently determining the position of the vehicle and map data comprising information about the curvature of the road. The
- 25 means for determining the curvature of the road comprises according to an embodiment any suitable sensor unit such as one or more camera units for detecting road marks and/or crash barriers and/or side of the road so as to continuously or intermittently determining the curvature of the road in connection to the position of the vehicle.

The system I further comprises means 120 for determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel. The means 120 for determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel comprises according to an embodiment means for measuring driver torque, i.e. the torque provided to the steering wheel by the driver, and means for determining when and for how long the driver torque is above or below certain levels.

The system I comprises means 130 for determining a steering torque so as to assist said driver during driving.

The means 130 for determining a steering torque so as to assist said driver during driving comprises means 132 for determining a steering torque based upon current driving situation so as to assist said driver during driving.

The means 130 for determining a steering torque so as to assist said driver during driving comprises means 134 for considering the result of the thus determined driver steering wheel activity function.

The means 134 for determining said steering torque assisting said driver considering the result of the thus determined driver steering wheel activity function comprises means 134a for providing a relatively higher steering torque assisting said driver to a greater extent compensating for relatively lower driver steering wheel activity.

The means 134 for determining said steering torque assisting said driver considering the result of the thus determined driver steering wheel activity function comprises means 134b for providing a relatively lower steering torque assisting said driver to a minor extent compensating for a relatively higher driver steering wheel activity.

The system comprises means 140 for providing said steering torque by means of a lane keep assistance function of said vehicle as part of said current driving

situation. The means 110 and means 130 is according to an embodiment comprised in the means 140.

The means 134 for determining a steering torque considering the result of the thus determined driver steering wheel activity function comprises a regulator unit for adapting the steering torque based upon the current situation and if, and to what extent said driver is steering by means of said steering wheel. The means 130 for determining a steering torque so as to assist said driver during driving comprises said regulator unit.

The regulator unit may be any suitable regulator unit. The regulator unit may be a non-model based regulator unit such as a PID-regulator. An embodiment where the means 130 is constituted by a PID-regulator is described with reference to the fig. 5. The regulator unit may be any model based regulator unit such as a LQ-regulator unit. The regulator unit may also be denoted Controller.

The system I further comprises means 150 for providing a thus determined steering torque. The means 150 for providing a thus determined steering torque is arranged to provide the steering torque so as to assist the driving of the driver.

The electronic control unit 100 is operably connected to the means 110 for determining a current driving situation as a basis for determining possible steering assist of the driver during driving via a link 10. The electronic control unit 100 is via the link 10 arranged to receive a signal from said means 110 representing data for current driving situation.

The electronic control unit 100 is operably connected to the means 120 for determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel via a link 20. The electronic control unit 100 is via the link 20 arranged to receive a signal from said means 120 representing data for driver steering wheel activity function

reflecting if, and to what extent said driver is steering by means of said steering wheel.

The electronic control unit 100 is operably connected to the means 132 for determining a steering torque based upon current driving situation so as to assist said driver during driving via a link 32. The electronic control unit 100 is via the link 32 arranged to send a signal to said means 132 representing data for current driving situation.

The electronic control unit 100 is operably connected to the means 134 for determining said steering torque assisting said driver considering the result of the thus determined driver steering wheel activity function via a link 34. The electronic control unit 100 is via the link 34 arranged to send a signal to said means 134 representing data for driver steering wheel activity. The means 134 is arranged to process said data so as to provide relatively higher steering torque assisting said driver to a greater extent compensating for relatively lower driver steering wheel activity with the means 134a and providing a relatively lower steering torque assisting said driver to a minor extent compensating for a relatively higher driver steering wheel activity with the means 134b.

The electronic control unit 100 is operably connected to the means 130 for determining a steering torque so as to assist said driver during driving via a link 30. The electronic control unit 100 is via the link 30 arranged to receive a signal from said means 130 representing data for driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel.

The electronic control unit 100 is operably connected to the means 140 for providing said steering torque by means of a lane keep assistance function of said vehicle as part of said current driving situation via a link 40a. The electronic control unit 100 is via the link 40a arranged to send a signal to said means 140 representing data for current driving situation comprising data for

vehicle position relative to the centre of the lane of the road along which the vehicle is travelling.

The electronic control unit 100 is operably connected to the means 140 for providing said steering torque by means of a lane keep assistance function of said vehicle as part of said current driving situation via a link 40b. The
5 electronic control unit 100 is via the link 40b arranged to receive a signal from said means 140 representing data for steering torque so as to assist the driver keeping the lane position.

The electronic control unit 100 is operably connected to the means 150 for
10 providing a steering torque determined by the means 130 via a link 50a. The electronic control unit 100 is via the link 50a arranged to send a signal to said means 150 representing data for determined steering torque.

The electronic control unit 100 is operably connected to the means 150 for providing a steering torque determined by the means 130 via a link 50b. The
15 electronic control unit 100 is via the link 50b arranged to receive a signal from said means 150 representing data for steering torque so as to assist the driver driving. The electronic control unit 100 is arranged to provide control in accordance with said provided steering torque so as to assist the driver driving.

Fig. 4 schematically illustrates a block diagram of a system II for facilitating
20 steering of a vehicle by a driver of the vehicle during driving along a road according to an embodiment of the present invention.

The system II could be a subsystem to the system I. The system II may comprise parts of the system I. The system II could be a subsystem to the system III described with reference to fig. 5.

25 The system II comprises means 210 for determining a current driving situation as a basis for determining possible steering assist of the driver during driving. The current driving situation on which the steering torque is based for assisting the driver may be any suitable driving situation. The current driving situation

on which the steering torque is based for assisting the driver comprises may comprise any driving situation where assistance in following a certain trajectory in connection to the road such as following a lane of the road, following another vehicle travelling along the road, guidance to a road exit along the road, guidance to a stop along the road or the like. The current driving situation may be a driving situation where the vehicle is positioned with a certain displacement relative to a lane of the road along which the vehicle is travelling.

The system II further comprises means 220 for determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel.

The system II comprises means 230 for determining a steering torque so as to assist said driver during driving.

The means 230 for determining a steering torque so as to assist said driver during driving is operably connected to the means 210 for determining a current driving situation via a link 210a. The means 230 is arranged to receive a signal from the means 210 representing data for current driving situation.

The means 230 for determining a steering torque so as to assist said driver during driving is arranged to process the data of current driving situation from the means 210 as a basis for determining the steering torque for assisting the driver during driving.

The means 230 for determining a steering torque so as to assist said driver during driving is operably connected to the means 220 for determining a driver steering wheel activity function via a link 220a. The means 230 is arranged to receive a signal from the means 220 representing data for if, and to what extent said driver is steering by means of said steering wheel.

The means 230 for determining a steering torque so as to assist said driver during driving is arranged to process the data of extent of driver steering from the means 220 as a basis for determining the steering torque for assisting the

driver during driving. The means 230 for determining a steering torque so as to assist said driver during driving is arranged to adapt the steering torque for the current situation based upon the determined driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel so as to adapt the assisting the driver during driving under said current driving situation.

The means 230 for determining a steering torque considering the result of the thus determined driver steering wheel activity function comprises a regulator unit for adapting the steering torque based upon the current situation and if, and to what extent said driver is steering by means of said steering wheel.

The system II comprises means for providing a thus determined steering torque TQ for assisting the driving of the driver depending on the current driving situation and steering activity from the driver. The means for providing a thus determined steering torque is according to an embodiment comprised in the means 230 for determining a steering torque.

The means 230 for determining a steering torque is arranged to control the steering torque based upon current driving situation and steering activity from the driver.

The regulator unit may be any suitable regulator unit. The regulator unit may be a non-model based regulator unit such as a PID-regulator. An embodiment where the means 230 is constituted by a PID-regulator is described with reference to the fig. 5. The regulator unit may be any model based regulator unit such as a LQ-regulator unit. The regulator unit may also be denoted Controller.

Fig. 5 schematically illustrates a block diagram of a system III for facilitating steering of a vehicle by a driver of the vehicle during driving along a road according to an embodiment of the present invention.

According to an embodiment the system III constitutes a detailed embodiment of the system II described in connection to fig. 4.

The system II comprises means 310 for determining a current driving situation involving lane keeping of the vehicle as a basis for determining possible steering assist of the driver during driving.

The means 310 comprises means 312 for determining the position of the vehicle on the lane of the road along which the vehicle is driving. The means 312 for determining the position of the vehicle on the lane may comprise any suitable sensor unit such as a camera unit, a laser scanner unit and/or a radar unit.

The means 310 comprises means 314 for determining the current yaw rate. The means 314 for determining the current yaw rate comprises means for detecting the current yaw rate of the vehicle. The means 314 for detecting the current yaw rate comprises any suitable detector unit for detecting the yaw rate. The detector unit is configured to detect/measure the rotation in the x/y-plane. The detector unit is according to an embodiment a gyro configured to sense the rotation in the x/y-plane. The detection by means of said detector unit is according to an embodiment performed continuously.

The means 310 comprises means 316 for determining the desired yaw rate in order to reposition the vehicle in the centre of the lane within a certain time/within a certain distance. The means 316 for determining the desired yaw rate comprises any suitable calculation means. For a lane keep assistance function the desired yaw rate may be determined by determining, e.g. measuring, the curvature of the road. In a situation where the vehicle is following another vehicle the desired yaw rate may be determined based upon the driving of the leading vehicle which said vehicle is following.

The means 310 comprises means 318 for determining the difference between the current yaw rate and desired yaw rate so as to determine a possible error.

According to an embodiment, in order to provide a basis for assisting in correcting such a deviation, the current yaw rate and the and the desired yaw rate of the steering wheel in order to reposition the vehicle in the centre C1 of the lane L1 within a certain time/within a certain distance are compared so as to determine an error corresponding to the difference between current yaw rate and desired yaw rate. The steering torque provided is based upon said error.

The system II further comprises means 320 for determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel.

10 The system II comprises means 330 for determining a steering torque so as to assist said driver during driving. The means 330 for determining a steering torque so as to assist said driver during driving is constituted by a PID-regulator unit 330.

15 The PID-regulator unit 330 comprises a means P for providing a proportional function, means I for providing an integral function and means for providing a derivative function. The proportional function is also denoted P-function, the integral function is also denoted I-function and the derivative function is also denoted D-function.

20 The PID-regulator unit 330 comprises means 332 for determining a torque based upon the P-function, I-function and D-function.

The PID-regulator unit 330 for determining a steering torque so as to assist said driver during driving is operably connected to the means 310 for determining a current driving situation relating to lane keeping via a link 310a. The PID-regulator unit 330 is arranged to receive a signal from the means 310 representing data for error representing difference between current yaw rate and desired yaw rate.

The PID-regulator unit 330 for determining a steering torque so as to assist said driver during driving is arranged to process the data of current driving

situation from the means 310 as a basis for determining the steering torque for assisting the driver during driving.

The PID-regulator unit 330 is arranged to process the data for error representing difference between current yaw rate and desired yaw rate
5 arranged by means of the P-function of the means P for providing a proportional torque T_{Qp} , the I-function of the means I for providing an integral torque T_{Qi} and the D-function of the means D for providing a derivative torque T_{Qd} . The means 332 is arranged to determine the sum of the proportional torque T_{Qp} , integral torque T_{Qi} and derivative torque T_{Qd} .

10 The PID-regulator unit 330 for determining a steering torque so as to assist said driver during driving is operably connected to the means 320 for determining a driver steering wheel activity function via a link 320a. The PID-regulator unit 330 is arranged to receive a signal from the means 320 representing data for if, and to what extent said driver is steering by means of
15 said steering wheel.

The PID-regulator unit 330 for determining a steering torque so as to assist said driver during driving is arranged to process the data of extent of driver steering from the means 320 as a basis for determining the steering torque for assisting the driver during driving. The PID-regulator unit 330 for determining
20 a steering torque so as to assist said driver during driving is arranged to adapt the steering torque for the current situation based upon the determined driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel so as to adapt the assisting the driver during driving under said current driving situation.

25 If it is determined that the extent said driver is steering by means of the steering wheel corresponds to the driver holding loosely to the steering wheel or not at all for a certain time period the torque determined based upon the current driving situation by means of the PID-regulator unit 330 using the P-, I-, D-

functions will be the torque provided such that the driver is assisted during driving to a greater extent with a relatively higher steering torque.

If it is determined that the extent said driver is steering by means of the steering wheel corresponds to the driver holding steadily to the steering wheel for a
5 certain time period the torque determined based upon the current driving situation by means of the PID-regulator unit 330 using the P-, I-, D-functions will be adapted by means of reducing the influence of the integral torque T_{Qi} provided by the I-function of the means I of the PID-regulator unit such that the driver is assisted during driving to a lesser extent with a relatively lower
10 steering torque.

The system III comprises means for providing a thus determined steering torque T_q for assisting the driving of the driver depending on the current driving situation and steering activity from the driver. The means for providing a thus determined steering torque is according to an embodiment comprised in the
15 PID-regulator unit 330 for determining a steering torque.

The PID-regulator unit 330 for determining a steering torque is arranged to control the steering torque based upon current driving situation and steering activity from the driver.

Fig. 6 schematically illustrates a block diagram of a system for facilitating
20 steering of a vehicle by a driver of the vehicle during driving along a road according to an embodiment of the present invention.

According to the embodiment the method for facilitating steering of a vehicle by a driver of the vehicle during driving along a road comprises a step S1. In this step a driver steering wheel activity function reflecting if, and to what extent
25 said driver is steering by means of said steering wheel is determined.

According to the embodiment the method for facilitating steering of a vehicle by a driver of the vehicle during driving along a road comprises a step S2. In

this step S2, the a steering torque is determined based upon current driving situation so as to assist said driver during driving.

The step S2 of determining a steering torque based upon current driving situation so as to assist said driver comprises a step S2a of considering the
5 result of the thus determined driver steering wheel activity function.

According to the embodiment the method for facilitating steering of a vehicle during driving along a road comprises a step S3. In this step a thus determined steering torque is provided. The steering torque is provided to assist the driver driving where the assistance is based upon the current driving situation such
10 as vehicle position in a lane and the driver steering activity, i.e. if and to what extent said driver is steering by means of said steering wheel corresponding to if and to what extent the driver is holding on to the steering wheel. Little or no steering from the driver by means of the steering wheel results in a higher degree of assistance by providing a relatively higher steering torque assisting
15 said driver to a greater extent and steering from the driver by means of steering wheel to a great extent results in a lower degree of assistance by providing a relatively lower steering torque assisting said driver to a minor extent.

With reference to figure 7, a diagram of an apparatus 500 is shown. The control unit 100 described with reference to fig. 3 may according to an embodiment
20 comprise apparatus 500. Apparatus 500 comprises a non-volatile memory 520, a data processing device 510 and a read/write memory 550. Non-volatile memory 520 has a first memory portion 530 wherein a computer program, such as an operating system, is stored for controlling the function of apparatus 500. Further, apparatus 500 comprises a bus controller, a serial communication
25 port, I/O-means, an A/D-converter, a time date entry and transmission unit, an event counter and an interrupt controller (not shown). Non-volatile memory 520 also has a second memory portion 540.

A computer program P is provided comprising routines for facilitating steering of a vehicle by a driver of the vehicle during driving along a road according to

an embodiment of the present invention. The program P comprises routines for determining a steering torque based upon current driving situation so as to assist said driver during driving. The program P comprises routines for determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel. The routines for determining a steering torque based upon current driving situation so as to assist said driver comprises routines for considering the result of the thus determined driver steering wheel activity function. The program P comprises routines for providing a thus determined steering torque. The routines for determining said steering torque assisting said driver considering the result of the thus determined driver steering wheel activity function comprises routines for providing a relatively higher steering torque assisting said driver to a greater extent compensating for relatively lower driver steering wheel activity and routines for providing a relatively lower steering torque assisting said driver to a minor extent compensating for a relatively higher driver steering wheel activity. The program P comprises routines for providing said steering wheel torque by means of a lane keep assistance function of said vehicle as part of said current driving situation. The routines for determining said steering wheel torque considering the result of the thus determined driver steering wheel activity function comprises routines for adapting the steering torque by considering a difference between a desired yaw rate and the current yaw rate by means of a regulator unit. The routines for adapting the steering torque by considering a difference between a desired yaw rate and the current yaw rate by means of a regulator unit is performed by means of a PID-regulator unit, wherein the routines for considering the difference between a desired yaw rate and the current yaw rate comprises routines for adapting the influence of the P-, I- and D-functions respectively, of said PID-regulator unit. The computer program P may be stored in an executable manner or in a compressed condition in a separate memory 560 and/or in read/write memory 550.

When it is stated that data processing device 510 performs a certain function it should be understood that data processing device 510 performs a certain

part of the program which is stored in separate memory 560, or a certain part of the program which is stored in read/write memory 550.

- Data processing device 510 may communicate with a data communications port 599 by means of a data bus 515. Non-volatile memory 520 is adapted for communication with data processing device 510 via a data bus 512. Separate memory 560 is adapted for communication with data processing device 510 via a data bus 511. Read/write memory 550 is adapted for communication with data processing device 510 via a data bus 514. To the data communications port 599 e.g. the links connected to the control units 100 may be connected.
- 10 When data is received on data port 599 it is temporarily stored in second memory portion 540. When the received input data has been temporarily stored, data processing device 510 is set up to perform execution of code in a manner described above. The signals received on data port 599 can be used by apparatus 500 for determining a steering torque based upon current driving
- 15 situation so as to assist said driver during driving. The signals received on data port 599 can be used by apparatus 500 for determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel. The signals used for determining a steering torque based upon current driving situation so as to assist said driver are considering
- 20 the result of the thus determined driver steering wheel activity function. The signals received on data port 599 can be used by apparatus 500 for providing a thus determined steering torque. The signals used for determining said steering torque assisting said driver considering the result of the thus determined driver steering wheel activity function are used for providing a
- 25 relatively higher steering torque assisting said driver to a greater extent compensating for relatively lower driver steering wheel activity and for providing a relatively lower steering torque assisting said driver to a minor extent compensating for a relatively higher driver steering wheel activity. The signals received on data port 599 can be used by apparatus 500 for providing
- 30 said steering wheel torque by means of a lane keep assistance function of said

vehicle as part of said current driving situation. The signals used for determining said steering wheel torque considering the result of the thus determined driver steering wheel activity function are used for adapting the steering torque by considering a difference between a desired yaw rate and
5 the current yaw rate by means of a regulator unit. . The signals used for adapting the steering torque by considering a difference between a desired yaw rate and the current yaw rate by means of a regulator unit is performed by means of a PID-regulator unit, wherein the routines for considering the difference between a desired yaw rate and the current yaw rate comprises
10 routines for adapting the influence of the P-, I- and D-functions respectively, of said PID-regulator unit.

Parts of the methods described herein can be performed by apparatus 500 by means of data processing device 510 running the program stored in separate memory 560 or read/write memory 550. When apparatus 500 runs the
15 program, parts of the methods described herein are executed.

The foregoing description of the preferred embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to
20 practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated.

CLAIMS

1. A method for facilitating steering of a vehicle (1) by a driver of the vehicle comprising a lane keep assist system during driving along a road (R), comprising the step (S2) of determining a steering torque based upon current
5 driving situation so as to assist said driver during driving, wherein said lane keep assist system is configured to apply a steering torque to keep the vehicle at a determined lateral position in a lane, **characterized by** the step (S1) of determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel; wherein the step
10 (S2) of determining a steering torque based upon current driving situation so as to assist said driver comprises the step (S2a) of considering the result of the thus determined driver steering wheel activity function; the method further comprising the step (S3) of providing a thus determined steering torque.
2. A method according to claim 1, wherein the step of determining said
15 steering torque assisting said driver considering the result of the thus determined driver steering wheel activity function comprises the step of providing a relatively higher steering torque assisting said driver to a greater extent compensating for relatively lower driver steering wheel activity and providing a relatively lower steering torque assisting said driver to a minor
20 extent compensating for a relatively higher driver steering wheel activity.
3. A method according to claim 1 or 2, wherein the determined lateral position is the centre of the lane.
4. A method according to any of claims 1-3, wherein the step of determining
25 said steering torque considering the result of the thus determined driver steering wheel activity function comprises the step of adapting the steering torque by considering a difference between a desired yaw rate and the current yaw rate by means of a regulator unit.
5. A method according to claim 4, wherein the step of adapting the steering torque by considering a difference between a desired yaw rate and the current

yaw rate by means of a regulator unit is performed by means of a PID-regulator unit, wherein the step of considering the difference between a desired yaw rate and the current yaw rate comprises the step of adapting the influence of the P-, I- and D-functions respectively, of said PID-regulator unit.

- 5 6. A system (I; II; III) for facilitating steering of a vehicle (1) by a driver of the vehicle during driving along a road (R), comprising means (130; 230; 330) for determining a steering torque based upon current driving situation so as to assist said driver during driving, wherein said lane keep assist system is configured to apply a steering torque to keep the vehicle at a determined lateral position in a lane **characterized by** means (120; 220; 320) for determining a driver steering wheel activity function reflecting if, and to what extent said driver is steering by means of said steering wheel; wherein the means (130; 230; 330) for determining a steering torque based upon current driving situation so as to assist said driver comprises means (134; P, I, D, 332) for considering the result of the thus determined driver steering wheel activity function; the system further comprising means for providing a thus determined steering torque.

7. A system according to claim 6, wherein the means (134; P, I, D, 332) for determining said steering torque assisting said driver considering the result of the thus determined driver steering wheel activity function comprises means (134a) for providing a relatively higher steering torque assisting said driver to a greater extent compensating for relatively lower driver steering wheel activity and means (134b) for providing a relatively lower steering torque assisting said driver to a minor extent compensating for a relatively higher driver steering wheel activity.

- 25 8. A system according to claim 6 or 7, wherein the determined lateral position is the centre of the lane.

9. A system according to any of claims 6-8, wherein the means (130; 230; 330) for determining said steering torque considering the result of the thus determined driver steering wheel activity function comprises a regulator unit

for adapting the steering torque by considering a difference between a desired yaw rate and the current yaw rate.

10. A system according to claim 9, wherein the regulator unit for adapting the steering torque by considering a difference between a desired yaw rate and
5 the current yaw rate comprises a PID-regulator unit arranged to adapt the influence of the P-, I- and D-functions respectively, of said PID-regulator unit.

11. A vehicle (1) comprising a system (I) according to any of claims 6-10.

12. A computer program (P) for facilitating steering of a vehicle by a driver of the vehicle during driving along a road, said computer program (P) comprising
10 program code which, when run on an electronic control unit (100) or another computer (500) connected to the electronic control unit (100), causes the electronic control unit to perform the steps according to claim 1-5.

13. A computer program product comprising a digital storage medium storing the computer program according to claim 14.

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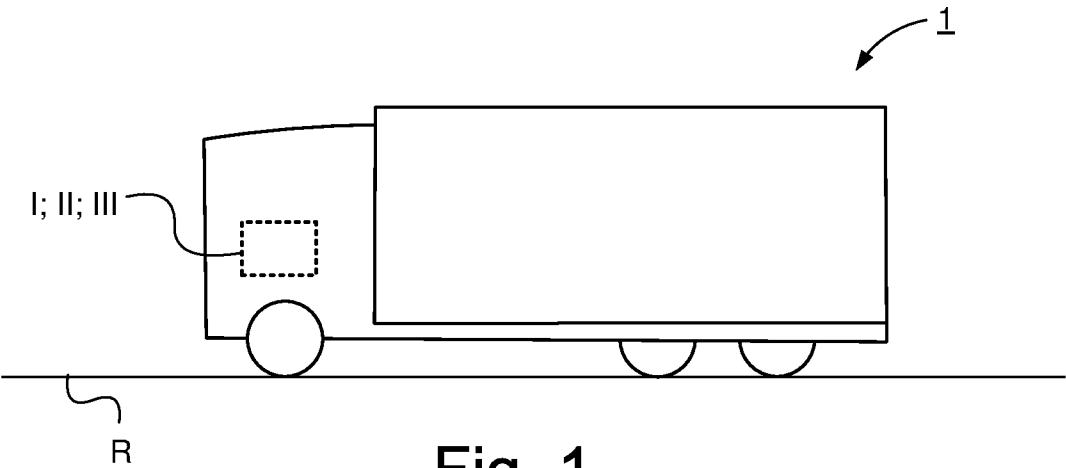


Fig. 1

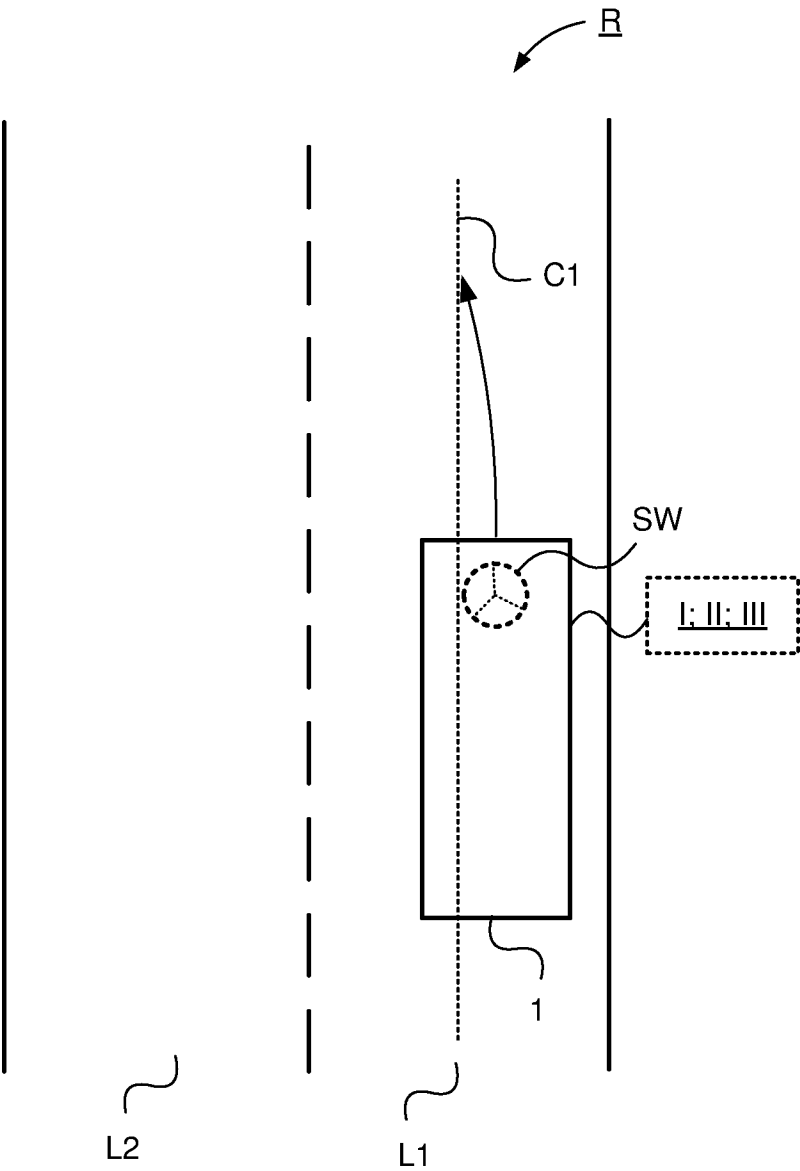


Fig. 2

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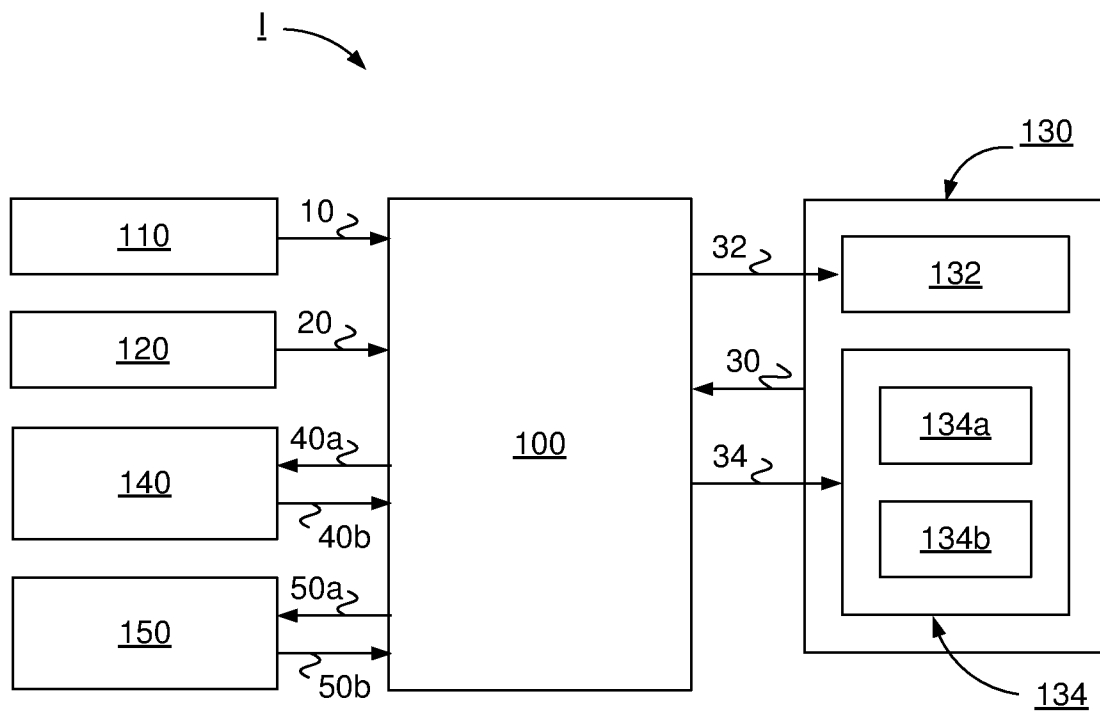


Fig. 3

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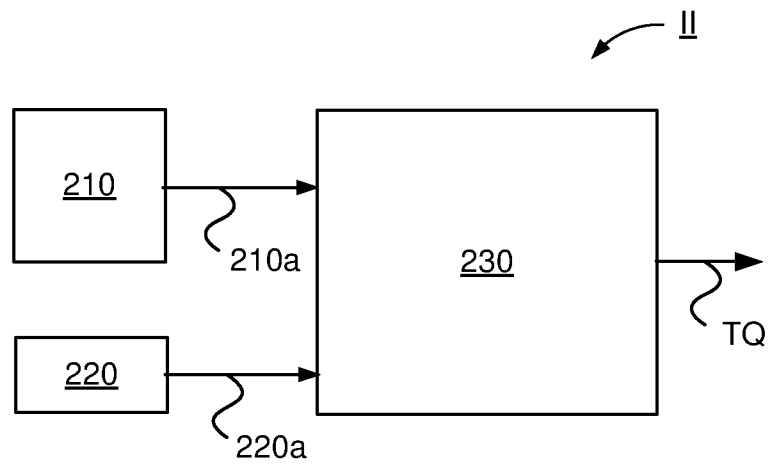


Fig. 4

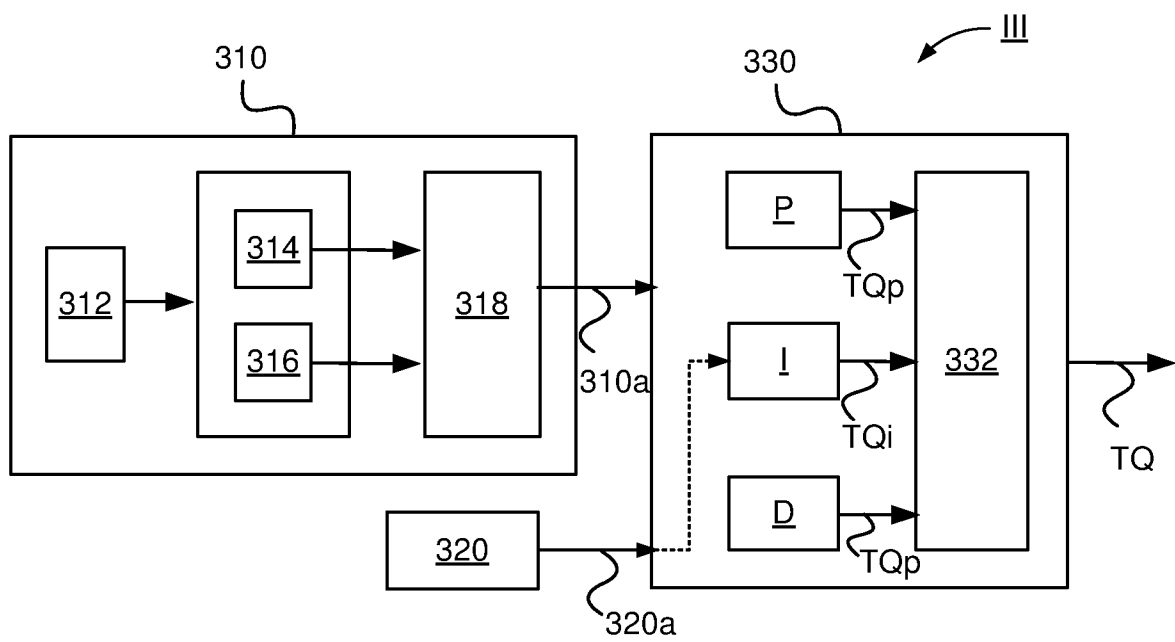


Fig. 5

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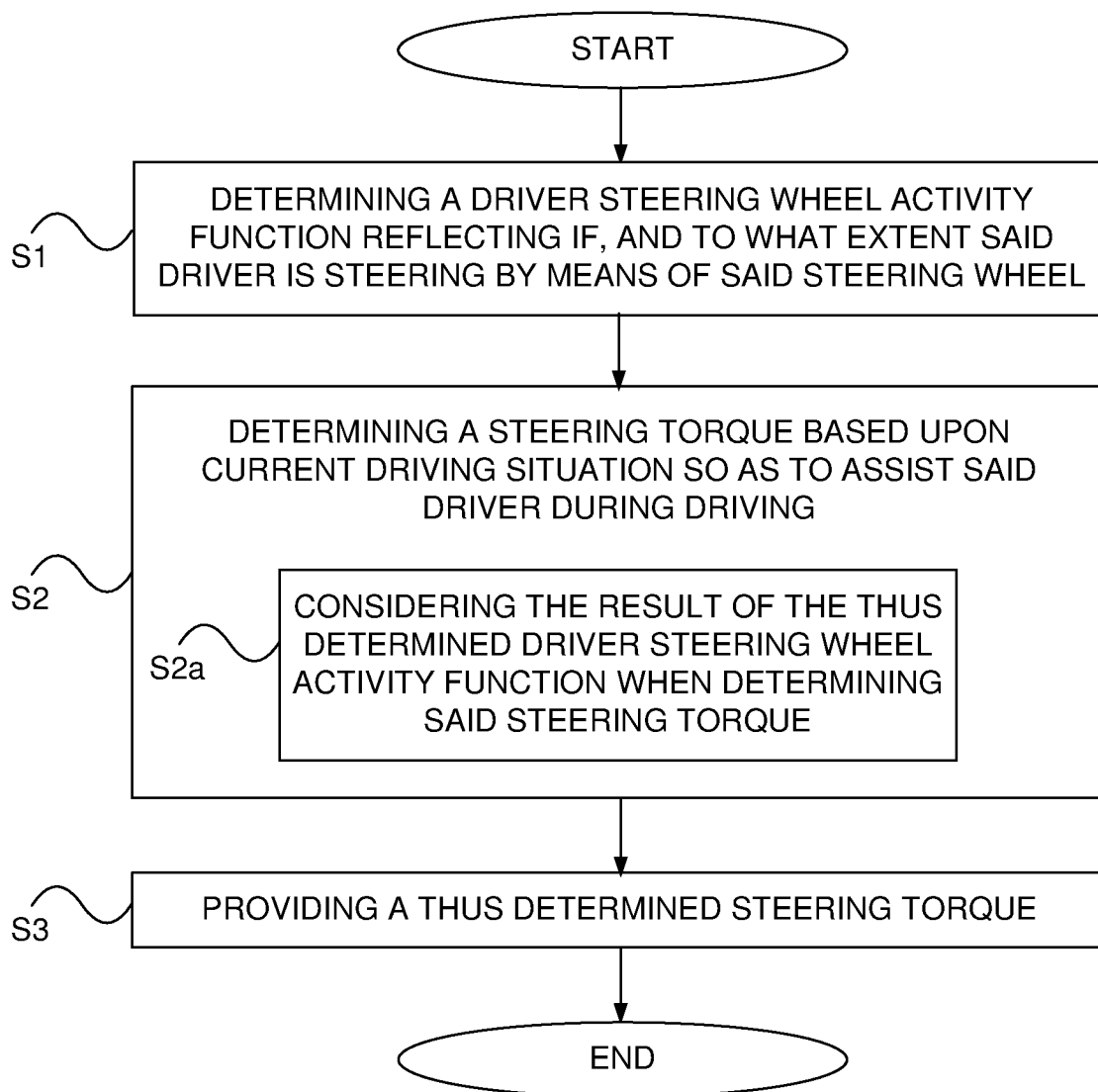


Fig. 6

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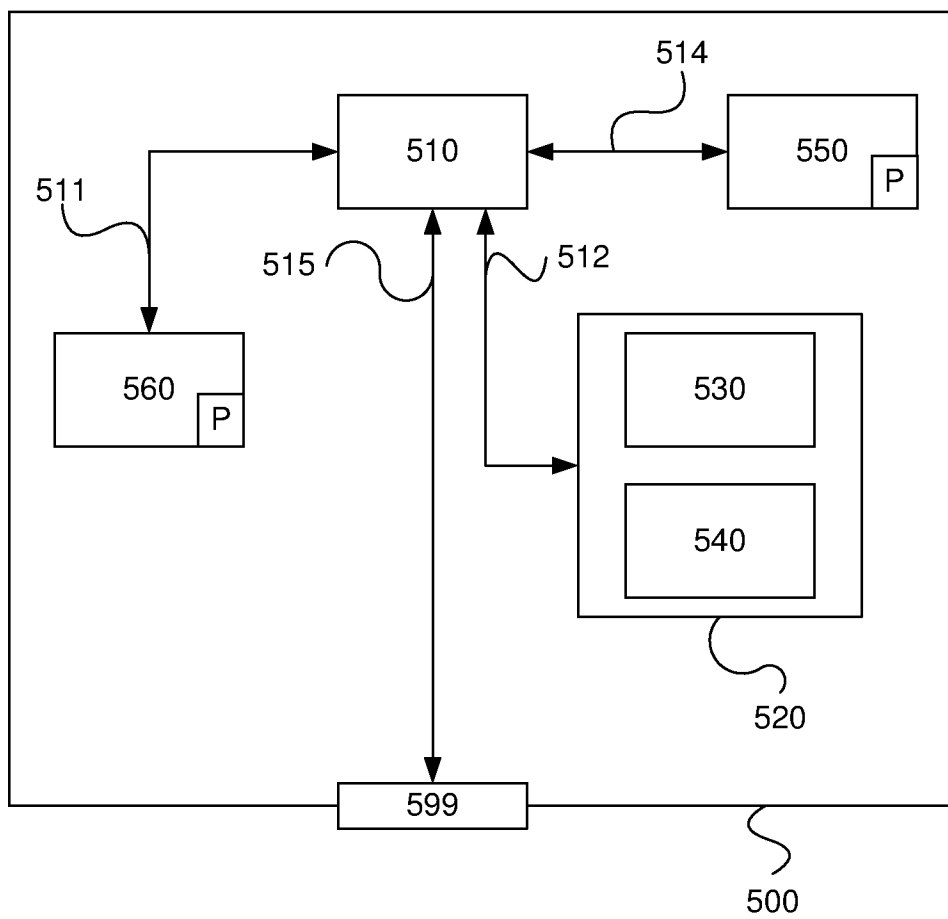


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/050302

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, B62D

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

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X	US 20160001811 A1 (ENDO MASAYA ET AL), 7 January 2016 (2016-01-07); paragraphs [0024]-[0043]; figures 3-4	1-2, 6-7, 11-13
Y	--	
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Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
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"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

16-05-2017

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/050302

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	US 20080255729 A1 (ICHINOSE MASANORI ET AL), 16 October 2008 (2008-10-16); paragraphs [0037]-[0038]; figure 4 --	1-13
A	US 20150274203 A1 (TAKEDA YUYA), 1 October 2015 (2015-10-01); paragraphs [0080]-[0082]; figures 2, 13-14 --	1-13
A	WO 2013187825 A1 (SCANIA CV AB ET AL), 19 December 2013 (2013-12-19); page 15, line 21 - page 16, line 4; figure 6 -- -----	1-13

Continuation of: second sheet

International Patent Classification (IPC)

B60W 30/12 (2006.01)

B62D 1/28 (2006.01)

B62D 5/04 (2006.01)

B62D 15/02 (2006.01)

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