(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
26 November 2015 (26.11.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/178843 A1

(51) International Patent Classification:
B60W 30/02 (2012.01) *B60W 30/14* (2006.01)
B60K 28/16 (2006.01) *B60W 40/072* (2012.01)
B60K 31/00 (2006.01)

(21) International Application Number:
PCT/SE2015/050573

(22) International Filing Date:
20 May 2015 (20.05.2015)

(25) Filing Language: Swedish

(26) Publication Language: English

(30) Priority Data:
1450600-0 21 May 2014 (21.05.2014) SE

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) Title: METHOD AND SYSTEM FOR THE ADAPTATION OF THE SPEED OF A VEHICLE WHEN TAKING A CURVE

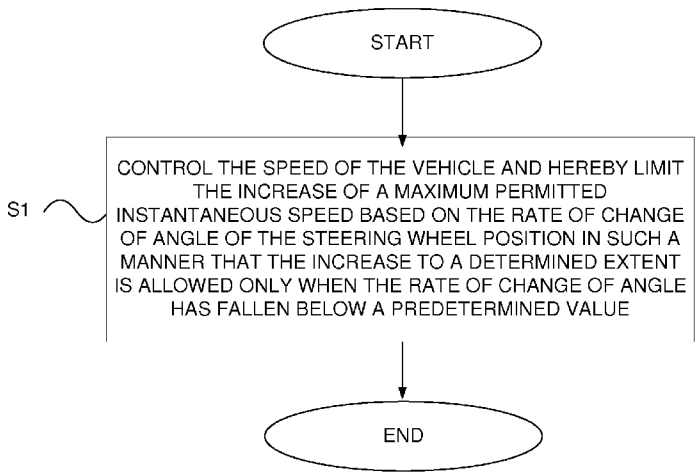


Fig. 3

(57) Abstract: The present invention relates to a method for the adaptation of the speed of a vehicle when taking a curve. The method comprises the step to control (S1) the speed of the vehicle and in this case limit the increase of a maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position in such a manner that the increase to a determined extent is allowed only when the rate of change of angle has fallen below a predetermined value. The present invention relates also to a system for the adaptation of the speed of a vehicle when taking a curve. The present invention relates also to a motor vehicle. The present invention relates also to a computer program and a computer program product.

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METHOD AND SYSTEM FOR THE ADAPTATION OF THE SPEED OF A VEHICLE WHEN TAKING A CURVE

TECHNICAL AREA

The invention relates to a method for the adaptation of the speed of a vehicle when taking a curve according to the introduction to claim 1. The invention relates to a system for the adaptation of the speed of a vehicle when taking a curve. The invention relates also to a motor vehicle. The invention relates also to a computer program and a computer program product.

BACKGROUND

During the driving of a heavy vehicle on a curvy and winding roadway it is necessary that the driver is attentive to the geometry of the road and adapts the speed in order to drive the vehicle in a safe manner. It may be difficult, due to the curvature of the roadway, for the driver to predict curves ahead and to take measures well in advance, for the safe driving of the vehicle.

DE10258167 and EP2492160 reveal methods to control the speed of the vehicle before a curve based on the shape of the curve and the position of the vehicle.

During the driving of the vehicle in a curve, the acceleration of the vehicle in the curve would be able to cause severe lateral accelerations with the consequence that the vehicle leaves the roadway or unintentionally moves over into a neighbouring lane. Consequently, should acceleration in the curve caused by the driver (through the driver pressing on the accelerator), or caused by the cruise-control system by the resumed previously set cruise-control speed in a curve (for example through an unintentional resumption of

the cruise-control system in a roundabout), the accelerating vehicle in the curve may cause an accident.

PURPOSE OF THE INVENTION

One purpose of the present invention is to achieve a method and a system for the adaptation of the speed of a vehicle in association with taking a curve that makes improved safety possible.

SUMMARY OF THE INVENTION

These and other purposes, which are made clear by the description below, are achieved by means of a method, a system, a motor vehicle, a computer program and a computer program product of the type described in the introduction, and that furthermore demonstrate the distinctive features specified in the characterising part of the attached independent patent claims. Preferred embodiments of the method and the system are defined in the attached non-independent claims.

According to the invention, the purposes are achieved with a method for the adaptation of the speed of a vehicle when taking a curve, comprising the step to limit the speed of the vehicle and in this case to limit the raising of a maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position in such a manner that the increase to a determined extent is allowed only when the rate of change of angle has fallen below a predetermined value. It is in this case avoided that the vehicle accelerates too much during an S-bend between a first curve and a second curve. The safety when driving along a winding road is in this case further improved. It is in this case avoided also that the driver is permitted to accelerate too strongly or to resume a previously preset cruise-control speed in a curve. As a consequence of this, safety while taking a curve is in this

case improved, whereby the risks of skidding or leaving the roadway in the curve are reduced. With such a solution, high safety when taking a curve can be achieved without map data or corresponding means to determine coming degrees of curvature along the route of the vehicle being required for adaptation of the speed when taking the curve.

According to one embodiment, the method comprises the step to permit raising the maximum permitted instantaneous speed only a specified time after the rate of change of angle has fallen below a predetermined value. It is in this case avoided that the vehicle accelerates too early after a first curve in order to avoid that the vehicle has sufficient time to accelerate too strongly at a subsequent second curve.

According to one embodiment of the method, the step to limit the raising of the maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position takes place only for a change of steering wheel position greater than a predetermined magnitude. Unnecessary limitation of the speed during small changes of steering wheel position is in this case avoided.

According to one embodiment, the method comprises the step to control the speed of the vehicle based on the steering wheel angle of the vehicle corresponding to a determined turning radius such that a predetermined lateral acceleration is not exceeded. It is in this case avoided that the driver is permitted to accelerate too strongly or to resume a previously preset cruise-control speed in a curve.

According to one embodiment of the method, the step of controlling the speed of the vehicle at the steering wheel position of the vehicle includes the step of determining a maximum permitted instantaneous speed based on the vehicle parameters: the said predetermined lateral acceleration, the said steering wheel angle, the effective wheelbase, the gear ratio of the steering, and, where appropriate, the understeer gradient of the vehicle. A more

correct determination of the relevant turning radius of the vehicle is in this way made possible, and thus a better basis for the control of the speed of the vehicle when driving the vehicle around a curve.

The embodiments of the system demonstrate corresponding advantages as corresponding embodiments of the method described above.

DESCRIPTION OF DRAWINGS

The present invention will be better understood with reference to the following detailed description read together with the attached drawings, where the same reference numbers refer to the same parts throughout the several views, and where:

Figure 1 illustrates schematically a motor vehicle according to one embodiment of the present invention;

Figure 2 illustrates schematically a system for the adaptation of the speed of a vehicle during taking a curve according to one embodiment of the present invention;

Figure 3 illustrates schematically a block diagram of a method for the adaptation of the speed of a vehicle during taking a curve according to one embodiment of the present invention; and

Figure 4 illustrates schematically a computer according to one embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

In this document, the term “link” refers to a communication link that may be a physical line, such as an opto-electronic communication line, or a non-

physical line, such as a wireless connection, for example a radio link or microwave link.

In this document, the term “effective wheelbase” refers to the virtual distance between the axles of the vehicle that most closely corresponds to a simplified representation of a two-axled vehicle. The term “effective wheelbase” involves a simplification of reality. For a two-axled truck, the effective wheelbase is equal to the wheelbase, i.e. the distance between the axles. For a vehicle that includes in addition to this a support axle in association with and at a distance from a rear driving axle, the effective wheelbase will be displaced to a location between the support axle and the driving axle, although not necessarily exactly halfway between them: the magnitude of the effective wheelbase depends on several factors such as the distribution of weight, whether the support axle is steered, etc. The purpose of the effective wheelbase is to be able to consider a vehicle with several axles as a two-axled vehicle, in order to simplify the calculation of dynamics according to the cycle model.

Figure 1 illustrates schematically a motor vehicle 1 according to one embodiment of the present invention. The vehicle 1 given as an example is constituted by a heavy vehicle in the form of a lorry. Alternatively, the vehicle may be constituted by any appropriate vehicle at all, such as a bus or a car. The vehicle includes a system I according to the present invention.

Figure 2 illustrates schematically a block diagram of a system I for the adaptation of the speed of a vehicle during taking a curve according to one embodiment of the present invention.

The system I comprises an electronic control unit 100.

The system I comprises means 110 to control the speed of the vehicle, and in this case limit the increase of a maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position in such a manner that the increase to a determined extent is allowed only when the

rate of change of angle has fallen below a predetermined value. The means 110 to limit the speed of the vehicle comprises consequently means to limit the raising of a maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position.

The means 110 to limit the speed of the vehicle and in this case to limit the raising of the maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position comprises means 112 to determine the rate of change of angle of the steering wheel position. The means 112 to determine the rate of change of angle of the steering wheel position comprises means for derivation, including possible filtration of the steering wheel angle.

The means 112 to determine rate of change of angle of the steering wheel position comprises means 112a to determine the magnitude of the steering wheel position. The system I comprises in this case means 112a to determine the magnitude of the steering wheel position: the magnitude of the steering wheel position is determined by, for example, steering wheel angle sensors.

The means 110 to limit the raising of the maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position comprises means 114 to limit the increase only for steering wheel positions that lie above a certain magnitude.

The system I comprises means 120 to permit raising the maximum permitted instantaneous speed only a specified time after the rate of change of angle has fallen below a predetermined value. The means 120 to permit raising the maximum permitted instantaneous speed only a specified time after the rate of change of angle has fallen below a predetermined value comprises means to determine the time from the rate of change of angle having fallen below the predetermined value and during the predetermined time, and the time from the rate of change of angle having fallen below the predetermined

value, and until the rate of change of angle again achieves or exceeds the predetermined value.

The system I comprises means 140 to control the speed of the vehicle based on the steering wheel angle of the vehicle corresponding to a determined turning radius, such that a predetermined lateral acceleration is not exceeded.

The means to control the speed of the vehicle includes means 140a to determine a maximum permitted instantaneous speed based on the vehicle parameters: the said predetermined lateral acceleration, the said steering wheel angle, the effective wheelbase, the gear ratio of the steering, and, where appropriate, the understeer gradient of the vehicle.

The means 140a to determine a maximum permitted instantaneous speed comprises means 141 to determine a maximum permitted lateral acceleration a_{lat}. The means 141 to determine a maximum permitted lateral acceleration comprises the determination of a predetermined maximum permitted lateral acceleration, which is based on normal conditions with respect to properties of the vehicle such as the length of the vehicle, the width of the vehicle, the composition of the vehicle train, the centre of gravity of the vehicle, and the axle pressure of the vehicle, and/or properties of the surroundings such as the effective width of the traffic lane, frictional properties of the roadway, visibility conditions and camber properties of the roadway. The predetermined maximum permitted lateral acceleration is, according to one embodiment, of the magnitude of 2 m/s^2. The maximum permitted lateral acceleration is in this case constituted by a predetermined maximum permitted lateral acceleration. According to one alternative or supplementary variant, the electronic control unit 100 includes stored data of the maximum permitted lateral acceleration.

The means 140a to determine a maximum permitted instantaneous speed means 142 to determine the steering wheel angle δ. The means 142 to

determine the steering wheel angle is arranged for the continuous determination of steering wheel angle. The means 142 to determine the steering wheel angle comprises sensor means in the form of steering wheel angle sensors to determine the position of the steering wheel that corresponds to a certain steering wheel angle.

The means 140a to determine a maximum permitted instantaneous speed comprises means 143 to determine the effective wheelbase *L*. The means 143 to determine the effective wheelbase includes the determination of properties of the vehicle including the distance between wheel axles, the number of wheel axles, the presence of a bogie where relevant, and possibly also the presence of a support axle and the position of the support axle, i.e. whether the support wheels on the support axle are caused to interact with the roadway or are elevated such that the support wheels are not in contact with the roadway. The effective wheelbase is estimated based on, among other things, the axle separation, the bogie distance, the number of axles, the distribution of weight, whether the support axle is elevated, etc. According to one alternative or supplementary variant, the electronic control unit 100 includes stored data of the effective wheelbase.

The means 140a to determine a maximum permitted instantaneous speed comprises means 144 to determine the gear ratio of the steering i_L. The means 144 to determine the gear ratio of the steering includes, according to one variant, stored data for the gear ratio, which is normally known. The means to determine the gear ratio of the steering comprises sensor means to determine the gear ratio of the steering by measuring the input and the output rates of change of steering wheel angle. According to one alternative or supplementary variant, the electronic control unit 100 includes stored data of the gear ratio of the steering.

The means 140a to determine a maximum permitted instantaneous speed comprises means 145 to determine the understeer gradient K_{us} of the vehicle. The means 145 to determine the understeer gradient of the vehicle

comprises sensor means to determine the understeer gradient of the vehicle, and calculation models in which the understeer gradient is determined based on, among other things, the steering wheel angle, effective wheelbase, speed of the vehicle, input and output rates of change of steering wheel angle, speed of gearing, and degree of curvature of the roadway. According to one alternative or supplementary variant, the electronic control unit 100 includes stored data of the understeer gradient of the vehicle.

The means 140a to determine a maximum permitted instantaneous speed based on the vehicle parameters: the predetermined lateral acceleration, the steering wheel angle, the effective wheelbase, the gear ratio of the steering, and, where appropriate, the understeer gradient of the vehicle, is arranged to determine the maximum permitted instantaneous speed through the equation:

$$v_{lim} = \sqrt{\frac{a_{lat} L}{\frac{\delta}{i_L} - a_{lat} K_{us}}}$$

where

a_{lat} = the desired maximum absolute lateral acceleration, i.e. the maximum permitted lateral acceleration

L = effective wheelbase

δ = steering wheel angle

i_L = the gear ratio of the steering

K_{us} = the understeer gradient of the vehicle.

The system I comprises means 130 to determine continuously the speed of the vehicle. The means 130 to determine continuously the speed of the vehicle includes, according to one variant, speed measurement means.

The electronic control unit 100 is connected such that it exchanges signals over a link 12 with the means 112 to determine the rate of change of angle of the steering wheel position. The electronic control unit 100 is arranged to receive over the link 12 a signal from the means 112 that represents rate of change of angle data for the rate of change of angle of the steering wheel position including data for the magnitude of the steering wheel position from the means 112a.

The electronic control unit 100 is connected such that it exchanges signals over a link 14 with the means 114 to limit the instantaneous increase of the maximum permitted instantaneous speed only when the magnitude of the steering wheel position lies above a predetermined magnitude. The electronic control unit 100 is arranged to receive over the link 14 a signal from the means 114 representing limitation data in order to limit the increase only when the steering wheel position lies above a predetermined magnitude.

The electronic control unit 100 is connected through a link 20a to the means 120 to permit increase of the maximum permitted instantaneous speed only a specified time after the rate of change of angle has fallen below a predetermined value. The electronic control unit 100 is arranged to transmit over the link 20a a signal to the means 120 that represents rate of change of angle data for the rate of change of angle of the steering wheel position including data for the magnitude of the steering wheel position.

The electronic control unit 100 is connected such that it exchanges signals through a link 20b with the means 120 to permit increase of the maximum permitted instantaneous speed only a specified time after the rate of change of angle has fallen below a predetermined value. The electronic control unit 100 is arranged to receive over the link 20b a signal from the means 120 that represents time data for the time during which the rate of change of angle lies below, with a certain magnitude of the steering wheel position, a predetermined value.

The electronic control unit 100 is connected through a link 10a such that it exchanges signals with the means 110 to control the speed of the vehicle and in this case limit the increase of a maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position in such a manner that the increase to a determined extent is allowed only when the rate of change of angle has fallen below a predetermined value. The electronic control unit 100 is arranged to transmit over the link 10a a signal to the means 110 that represents rate of change of angle data for the rate of change of angle of the steering wheel position including data for the magnitude of the steering wheel position and the time of such a rate of change of angle.

The electronic control unit 100 is connected through a link 10b such that it exchanges signals with the means 110 to control the speed of the vehicle and in this case limit the increase of a maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position in such a manner that the increase to a determined extent is allowed only when the rate of change of angle has fallen below a predetermined value. The electronic control unit 100 is arranged to receive over the link 10b a signal from the means 110 that represents limiting data for the limitation of the rate of change of angle based on rate of change of angle data.

The electronic control unit 100 is connected such that it exchanges signals over a link 30 with the means 130 to determine continuously the speed of the vehicle. The electronic control unit 100 is arranged to receive over the link 30 a signal from the means 130 to determine continuously the speed of the vehicle representing speed data for the current speed of the vehicle.

The electronic control unit 100 is connected through a link 40a such that it exchanges signals with the means 140 to control the speed of the vehicle based on the steering wheel angle of the vehicle corresponding to a determined turning radius, such that a predetermined lateral acceleration is not exceeded. The electronic control unit 100 is arranged to transmit through

the link 40a a signal to the means 140 representing control data for the control of the speed of the vehicle.

The electronic control unit 100 is connected through a link 40b such that it exchanges signals with the means 140 to control the speed of the vehicle based on the steering wheel angle of the vehicle corresponding to a determined turning radius, such that a predetermined lateral acceleration is not exceeded. The electronic control unit 100 is arranged to receive over the link 40b a signal from the means 140 that represents steering wheel angle data corresponding to a determined turning radius of the vehicle.

The electronic control unit 100 is connected through a link 40 such that it exchanges signals with the means 140a to determine a maximum permitted instantaneous speed based on the vehicle parameters: the said predetermined lateral acceleration, the said steering wheel angle, the effective wheelbase, the gear ratio of the steering, and, where appropriate, the understeer gradient of the vehicle. The electronic control unit 100 is arranged to receive over the link 40 a signal from the means 140 representing parameter data, including lateral acceleration data for the predetermined lateral acceleration, steering wheel angle data for the current steering wheel angle, data for the effective wheelbase, data for the gear ratio of the steering, and, where relevant, data for the understeer gradient.

The electronic control unit 100 is in this case arranged to process the said rate of change of angle data for the rate of change of angle of the steering wheel position including data for the magnitude of the steering wheel position, the said limitation data in order to limit the increase only for steering wheel positions over a predetermined magnitude, and the said time-based data for the time during which the rate of change of angle lies below, with a certain magnitude of the steering wheel position, a predetermined value, in order to determine whether the rate of change of angle has exceeded a predetermined speed and a predetermined magnitude of the steering wheel position, and, in the case in which this is the case, to transmit limitation data

for the limitation of the speed as long as this continues, and a predetermined time after that the rate of change of angle has fallen below a predetermined value.

The electronic control unit 100 is in this case arranged to process the said steering wheel angle data corresponding to a determined turning radius of the vehicle and the said parameter data, including lateral acceleration data for the predetermined lateral acceleration, steering wheel angle data for the current steering wheel angle, data for the effective wheelbase, data for the gear ratio of the steering, and, where relevant, data for the understeer gradient, and the said speed data, in order to determine control data for the control of the speed of the vehicle such that a predetermined lateral acceleration is not exceeded.

Figure 3 illustrates schematically a block diagram of a method for the adaptation of the speed of a vehicle during taking a curve according to one embodiment of the present invention.

According to one embodiment, the method for the adaptation of the speed of a vehicle when taking a curve comprises a step S1. In this step the speed of the vehicle is controlled and in this case the increase of a maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position is limited in such a manner that the increase to a determined extent is allowed only when the rate of change of angle has fallen below a predetermined value.

With reference to Figure 4, there is shown a drawing of a design of an arrangement 500. The control unit 100 that has been described with reference to Figure 2 can comprise in one execution the arrangement 500. The arrangement 500 comprises a non-transient memory 520, a data processing unit 510 and a read/write memory 550. The non-transient memory 520 has a first section of memory 530 in which a computer program, such as an operating system, is stored in order to control the function of the

arrangement 500. Furthermore, the arrangement 500 comprises a bus controller, a serial communication port, I/O means, an A/D converter, a unit for the input and transfer of time and date, an event counter and an interrupt controller (not shown in the drawing). The non-transient memory 520 has also a second section of memory 540.

A computer program P is provided that comprises routines for the adaptation of the speed of a vehicle when taking a curve according to the innovative method. The program P comprises routines to control the speed of the vehicle and in this case limit the increase of a maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position in such a manner that the increase to a determined extent is allowed only when the rate of change of angle has fallen below a predetermined value. The program P may be stored in an executable form or in a compressed form in a memory 560 and/or a read/write memory 550.

When it is described that the data processing unit 510 carries out a certain function, it is to be understood that the data processing unit 510 carries out a certain part of the program that is stored in the memory 560, or a certain part of the program that is stored in the read/write memory 550.

The data processing arrangement 510 can communicate with a data port 599 through a data bus 515. The non-transient memory 520 is intended for communication with the data processing unit 510 through a data bus 512. The separate memory 560 is intended to communicate with the data processing unit 510 through a data bus 511. The read/write memory 550 is arranged to communicate with the data processing unit 510 through a data bus 514. Links associated with the control unit 100, for example, may be connected to the data port 599.

When data is received at the data port 599 it is temporarily stored in the second section of memory 540. When the data that has been received has been temporarily stored, the data processing unit 510 is prepared for the

execution of code in a manner that has been described above. The signals that have been received at the data port 599 can be used by the arrangement 500 to control the speed of the vehicle and in this case limit the increase of a maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position in such a manner that the increase to a determined extent is allowed only when the rate of change of angle has fallen below a predetermined value.

Parts of the methods described here may be carried out by the arrangement 500 with the aid of the data processing unit 510, which runs the program stored in the memory 560 or in the read/write memory 550. When the arrangement 500 runs the program, the method described here is executed.

The description above of the preferred embodiments of the present invention has been given for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the variants that have been described. Many modifications and variations will be obvious for one skilled in the arts. The embodiments have been selected and described in order to best describe the principles of the invention and its practical applications, and thus to make it possible for one skilled in the arts to understand the invention for various embodiments and with the various modifications that are appropriate for the intended use.

CLAIMS

1. A method for the adaptation of the speed of a vehicle (1) when taking a curve, **characterised by** the step to control (S1) the speed of the vehicle and in this case limit the increase of a maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position in such a manner that the increase to a determined extent is allowed only when the rate of change of angle has fallen below a predetermined value.

2. The method according to claim 1, comprising the step to permit raising of the maximum permitted instantaneous speed only a specified time after the rate of change of angle has fallen below a predetermined value.

3. The method according to claim 1 or 2, whereby the step to limit the raising of the maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position takes place only for steering wheel positions greater than a predetermined magnitude.

4. The method according to any one of claims 1-3, comprising the step to control the speed of the vehicle based on the steering wheel angle of the vehicle corresponding to a determined turning radius such that a predetermined lateral acceleration is not exceeded.

5. The method according to claim 4, whereby the step of controlling the speed of the vehicle at the steering wheel angle includes the step of determining a maximum permitted instantaneous speed based on the vehicle parameters: the said predetermined lateral acceleration, the said steering wheel angle, the effective wheelbase, the gear ratio of the steering, and, where appropriate, the understeer gradient of the vehicle.

6. A system (I) for the adaptation of the speed of a vehicle (1) when taking a curve, **characterised by** means (110) to control the speed of the vehicle and in this case limit the increase of a maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position in such a

manner that the increase to a determined extent is allowed only when the rate of change of angle has fallen below a predetermined value.

7. The system according to claim 6, comprising means (120) to permit raising of the maximum permitted instantaneous speed only a specified time after the rate of change of angle has fallen below a predetermined value.

8. The system according to claim 6 or 7, whereby the means (110) to limit the raising of the maximum permitted instantaneous speed based on the rate of change of angle of the steering wheel position takes place only for steering wheel positions greater than a predetermined magnitude.

9. The system according to any one of claims 6-8, comprising means (140) to control the speed of the vehicle based on the steering wheel angle of the vehicle corresponding to a determined turning radius such that a predetermined lateral acceleration is not exceeded.

10. The system according to claim 9, whereby the means (140) to control the speed of the vehicle based of the steering wheel angle of the vehicle includes means (140a) to determine a maximum permitted instantaneous speed based on the vehicle parameters: the said predetermined lateral acceleration, the said steering wheel angle, the effective wheelbase, the gear ratio of the steering, and, where appropriate, the understeer gradient of the vehicle.

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

12. A computer program (P) for the adaptation of the speed of a vehicle when taking a curve, where the said computer program (P) comprises program code that, when it is run by an electronic control unit (100) or by another computer (500) connected to the electronic control unit (100), causes the electronic control unit (100) to carry out the steps according to claims 1-5.

13. A computer program product comprising a digital storage medium that stores the computer program according to claim 12.

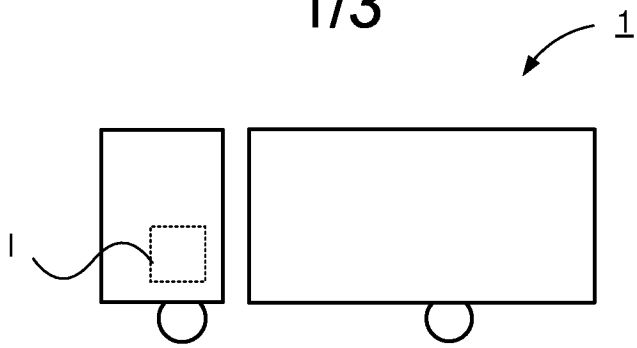

1
I

Fig. 1

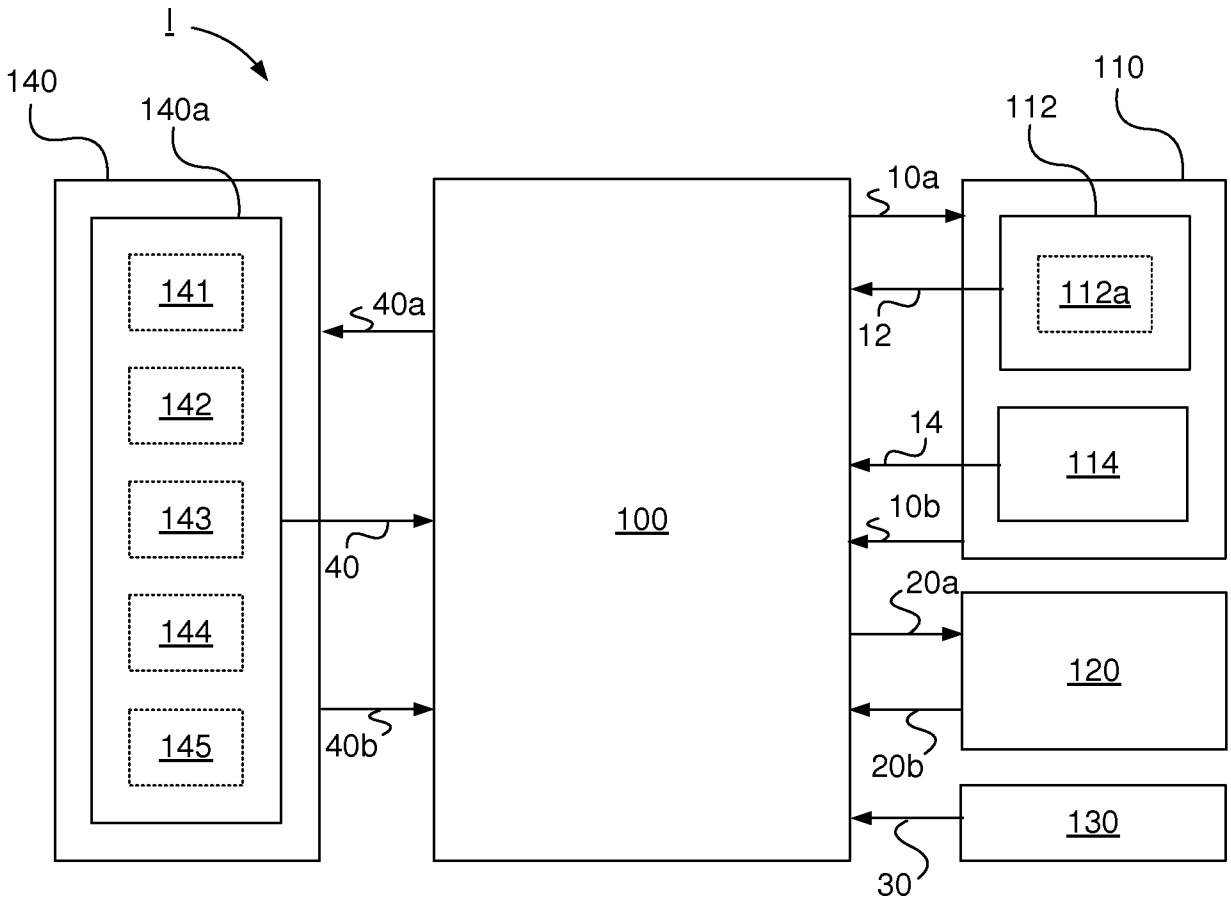

I
140
140a
141
142
143
144
145
40a
40
40b
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10a
12
14
10b
20a
20b
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110
112
112a
114
120
130

Fig. 2

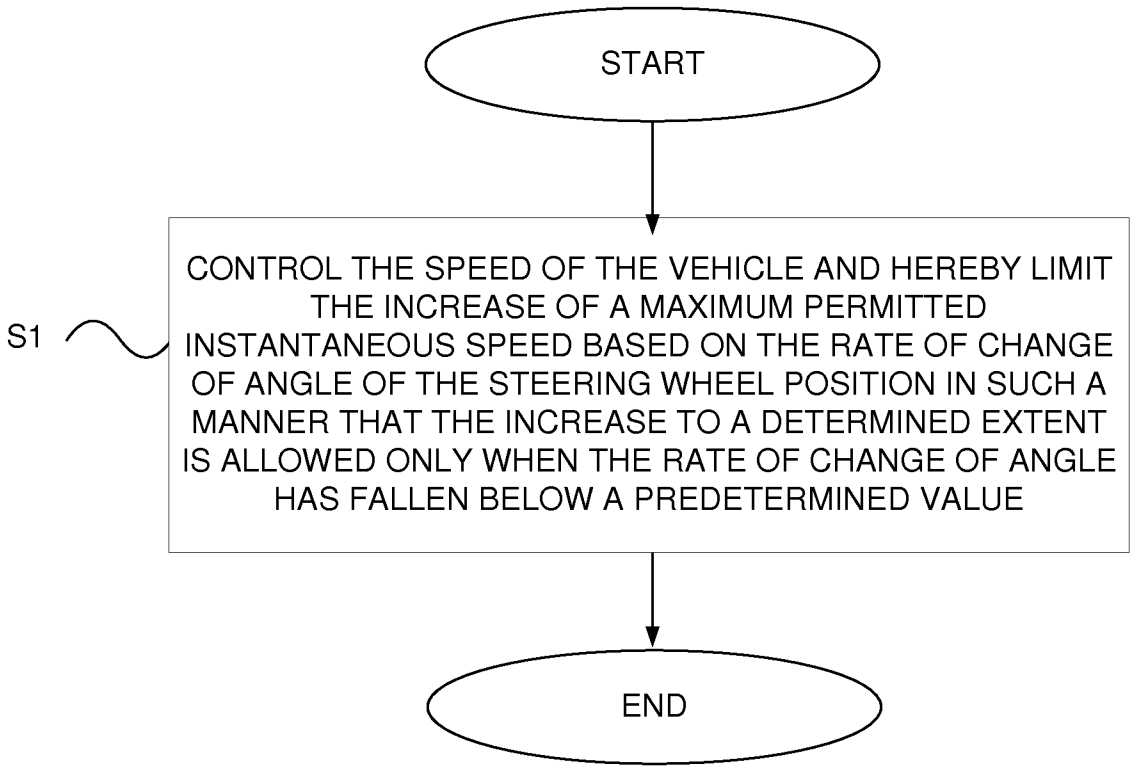

START
S1
CONTROL THE SPEED OF THE VEHICLE AND HEREBY LIMIT THE INCREASE OF A MAXIMUM PERMITTED INSTANTANEOUS SPEED BASED ON THE RATE OF CHANGE OF ANGLE OF THE STEERING WHEEL POSITION IN SUCH A MANNER THAT THE INCREASE TO A DETERMINED EXTENT IS ALLOWED ONLY WHEN THE RATE OF CHANGE OF ANGLE HAS FALLEN BELOW A PREDETERMINED VALUE
END

Fig. 3

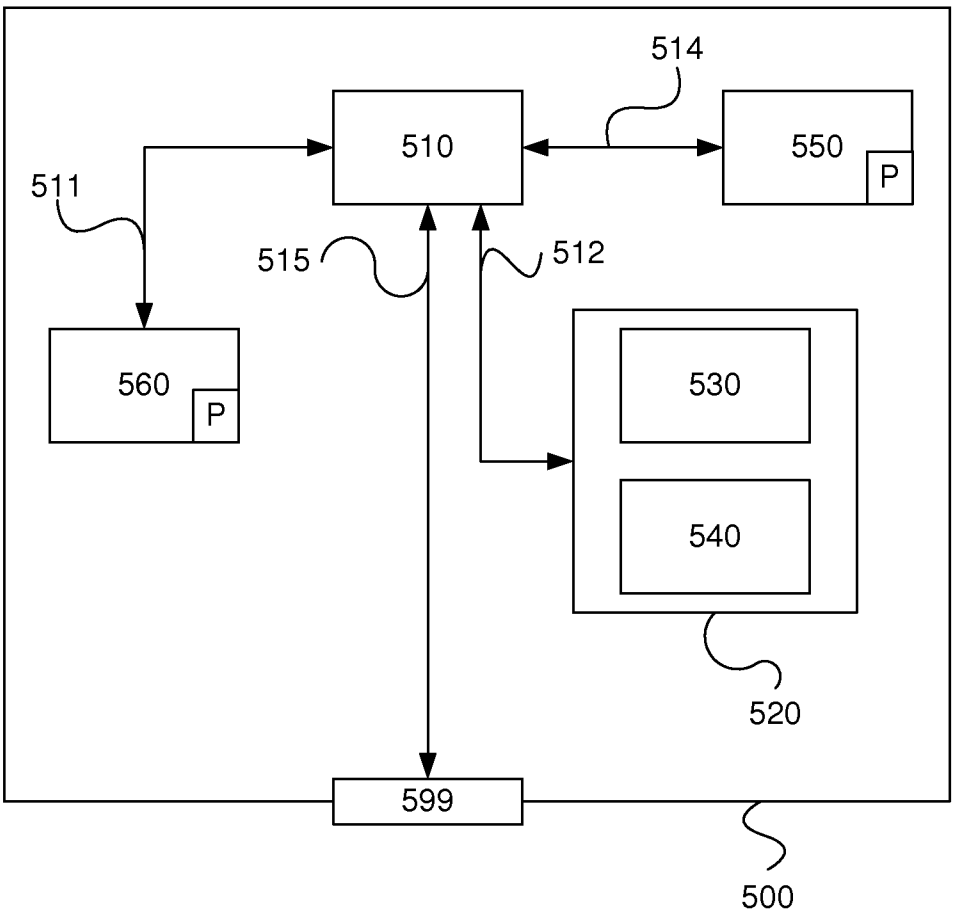


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2015/050573

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: B60K, B60W

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2674387 A1 (ATLET AB - (B8) UNICARRIERS EUROP AB [SE]), 18 December 2013 (2013-12-18); figure 5; paragraphs [0002], [0008]-[0012], [0020]. [0025], [0039]-[0043]	1-3, 6-8, 11-13
Y	--	1-13
Y	US 20040215384 A1 (KUMMEL MARTIN ET AL), 28 October 2004 (2004-10-28); paragraphs [0002]-[0057]	1-13
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A	US 5996724 A1 (SHIMIZU YASUO ET AL), 7 December 1999 (1999-12-07); claim 1	1-13
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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
17-09-2015	17-09-2015

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2015/050573

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 20080300766 A1 (KUMABE HAJIME ET AL), 4 December 2008 (2008-12-04); paragraphs [0034]-[0047] -- --------	1-13

International application No.
PCT/SE2015/050573

Continuation of: second sheet

International Patent Classification (IPC)

B60W 30/02 (2012.01)
B60K 28/16 (2006.01)
B60K 31/00 (2006.01)
B60W 30/14 (2006.01)
B60W 40/072 (2012.01)

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