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(54) Title: METHOD AND SYSTEM FOR THE ADAPTATION OF THE DRIVING OF A VEHICLE ON A ROADWAY IN ASSOCIATION WITH TAKING A CURVE

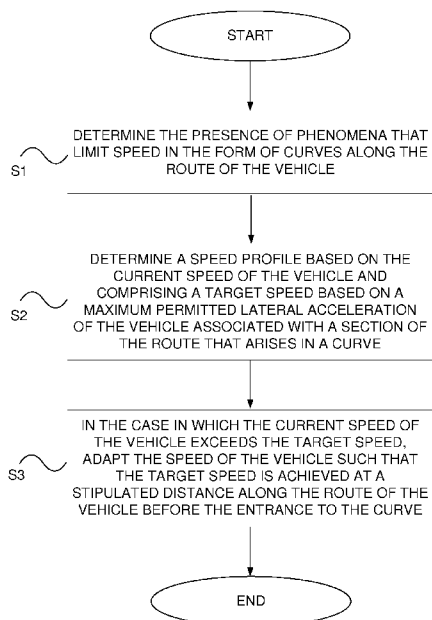


Fig. 4

(57) Abstract: The present invention relates to a method for the adaptation of the driving of a vehicle on a roadway in association with taking a curve, comprising the step to determine (S1) the presence of phenomena that limit speed in the form of curves along the route of the vehicle. The method further comprises the steps: to determine (S2) a speed profile based on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section of the route that arises in a curve; and, in the case in which the current speed of the vehicle exceeds the target speed, to adapt (S3) the speed of the vehicle such that the target speed is achieved at a stipulated distance along the route of the vehicle before the entrance to the curve. The present invention relates also to a system for the adaptation of the driving of a vehicle on a roadway in association with 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 DRIVING OF A VEHICLE ON A ROADWAY IN ASSOCIATION WITH TAKING A CURVE

TECHNICAL AREA

5 The invention relates to a method for the adaptation of the driving of a vehicle on a roadway in association with taking a curve according to the introduction to claim 1. The invention relates to a system for the adaptation of the driving of a vehicle on a roadway in association with taking a curve. The invention relates also to a motor vehicle. The invention relates also to a computer
10 program and a computer program product.

BACKGROUND

Cruise-control systems and similar driver aids are becoming evermore intelligent. Several systems that use map data for the driving of a vehicle in a
15 fuel-efficient manner are now commercially available. These systems, however, are adapted to consider only the appearance of the topography, which in practice means that these functions are appropriate for use on motorways and equivalent roads.

The currently available systems are exclusively built on a preset target
20 speed. The cruise-control systems based on topology are allowed to deviate from this only by a certain percentage or number of kilometres per hour. If the vehicle in question enters a smaller road with curves and speed limitations, it is appropriate to switch off the cruise-control system since the driver must himself or herself even so brake when approaching a possible curve. It is
25 furthermore difficult on smaller roads with many curves for a driver to drive optimally from the perspective of fuel efficiency. This is the case, since it is often difficult to see happens beyond the next curve.

EP2527222 reveals driver assistance for the control of the speed taking into consideration curve data, which have been drawn up using navigational data or sensors of the surroundings, where the speed is adapted before taking a curve to a position in the curve.

5

PURPOSE OF THE INVENTION

One purpose of the present invention is to achieve a method and a system for the adaptation of the driving of a vehicle on a roadway in association with taking a curve that makes safe and comfortable driving possible.

10

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, these purposes are achieved with a method for the adaptation of the driving of a vehicle on a roadway in association with taking a curve, comprising the step to determine the presence of phenomena that limit speed in the form of curves along the route of the vehicle, further comprising the steps: to determine a speed profile based on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section of the route that arises in a curve; and, in the case in which the current speed of the vehicle exceeds the target speed, to adapt the speed of the vehicle such that the target speed is achieved at a stipulated distance along the route of the

vehicle before the entrance to the curve. Safe and comfortable driving is in this way made possible for an experience that inspires confidence in that the target speed is achieved a certain time or distance before the target speed that is required in the curve.

- 5 According to one embodiment, the method comprises the step: in the case in which the current speed of the vehicle lies below or corresponds to the target speed, to adapt the speed of the vehicle such that the target speed is achieved at the distance that corresponds to the target speed. Efficient driving of the vehicle is in this case made possible such that the correct
10 target speed is achieved in the curve.

- According to one embodiment, the method comprises the step to determine the said stipulated distance before the entrance to the curve along the route of the vehicle based on a stipulated absolute prediction interval relative to the distance that corresponds to the target speed. A simple and efficient manner
15 to stipulate the stipulated distance before the entrance to the curve is in this way made possible.

- According to one embodiment, the method comprises the step to determine the said stipulated distance before the entrance to the curve along the route of the vehicle based on a retardation against from a current speed of the
20 vehicle to the said target speed. A simple and efficient manner to stipulate the stipulated distance before the entrance to the curve is in this way made possible.

- According to one embodiment, the method comprises the step to determine the said stipulated distance before the entrance to the curve along the route
25 of the vehicle based on a section of the speed profile corresponding to the retardation before the said curve. A simple and efficient manner to stipulate the stipulated distance before the entrance to the curve is in this way made possible.

According to one embodiment of the method an upper limit is set, in the case in which the section of the speed profile corresponding to retardation before the said curve lies a predetermined position before the distance that correspond to the target speed, on the corresponding distance and/or time
5 before the entrance to the curve. It is in this way avoided that the distance before the entrance to the curve is set an unnecessarily long distance before the curve.

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

10

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
15 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 driving of a vehicle on a roadway in association with taking a curve according to one
20 embodiment of the present invention;

Figure 3a illustrates schematic a curvature profile in the form of a roundabout;

Figure 3b illustrates schematically speed profiles for the curvature profile in Figure 3a;

Figure 4 illustrates schematically a block diagram of a method for the adaptation of the driving of a vehicle on a roadway in association with taking a curve according to one embodiment of the present invention; and

Figure 5 illustrates schematically a computer according to one embodiment
5 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-
10 physical line, such as a wireless connection, for example a radio link or microwave link.

In this document the term “acceleration” refers to both positive and negative acceleration, i.e. acceleration in the form of increasing speed and acceleration in the form of decreasing speed, i.e. retardation.

15 In this document, the term “to determine continuously”, for example in the use “to determine continuously the presence of phenomena that limit speed in the form of curves along the route of the vehicle”, refers to a determination in stepless increments or in stepped increments, i.e. in which the determination takes place with a certain repeated occurrence that may be
20 regular and may be based on time or distance.

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.
25 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 driving of a vehicle on a roadway in association with taking a curve according to one embodiment of the present invention.

The system I comprises an electronic control unit 100.

- 5 The system I comprises means 110 to determine continuously the presence of phenomena that limit speed in the form of curves along the route of the vehicle.

The means 110 to determine continuously the presence of phenomena that limit speed in the form of curves along the route of the vehicle includes, according to one variant, a map information unit 112 comprising map data including properties of the roadway along the route of the vehicle, including phenomena that limit speed in the form of curves.

The means 110 to determine continuously the presence of phenomena that limit speed in the form of curves along the route of the vehicle includes, according to one variant, means 114 to determine the position of the vehicle. The means 114 to determine the position of the vehicle comprises a geographical position-determination system to determine continuously the position of the vehicle along its route. An example of a geographical position-determination system is GPS.

- 20 The map information unit 112 and the means 114 to determine the position of the vehicle are comprised, according to one variant, of means 110a to determine the route of the vehicle, where the means to determine the route of the vehicle is arranged to provide predetermined properties of the roadway along the route of the vehicle including phenomena that limit speed in the form of curves along the route of the vehicle. The said map data of the map-information unit 112 include also properties of the roadway along the route of the vehicle, including topography.

Through the map-information unit 112 and the means 114 to determine the position of the vehicle, it is consequently made possible to identify continuously the position of the vehicle and properties of the roadway, including phenomena that limit speed in the form of curves.

- 5 The means 110 to determine continuously the presence of phenomena that limit speed along the route of the vehicle includes, according to one variant, camera means 116. The camera means 116 is arranged to detect properties of the roadway, including phenomena that limit speed in the form of curves. The camera means 116 is arranged to detect the form of the extent of the
10 roadway, including the curvature of the roadway and/or road markings, in order in this way to determine the curvature of the roadway along which vehicle is travelling. The camera means may include one or several cameras for the detection.

- The means 110 to determine continuously the presence of phenomena that
15 limit speed in the form of curves along the route of the vehicle includes means to carry out the said determination based on a predetermined distance and/or time horizon in front of the vehicle along the route of the vehicle

- According to one embodiment, the means 110 to determine continuously the
20 presence of phenomena that limit speed along the route of the vehicle includes means to carry out the said determination based on a predetermined distance horizon in front of vehicle along the route of the vehicle, where the distance horizon constitutes a suitable window in the form of a distance from the current position of the vehicle and forwards along the
25 route of the vehicle. The distance horizon lies, according to one embodiment, in the order of magnitude of a few hundred metres, for example approximately 500 metres.

The distance horizon depends, according to one variant, on the speed of the vehicle. The distance horizon depends, according to one variant, on

considerations of comfort, considerations of fuel efficiency and considerations of the efficiency of the driving, i.e. how time-efficient the driving of the vehicle is. By setting the distance horizon to be relatively short, a more rapid negative acceleration/retardation is required in this case in the event of a phenomenon that limits speed arising, which makes more time-efficient driving of the vehicle possible. By setting the distance horizon to be relatively long, a less rapid negative acceleration/retardation is required in this case in the event of a phenomenon that limits speed arising, which makes more comfortable and/or more fuel-efficient driving of the vehicle possible.

The system I comprises means 120 to determine continuously the speed of the vehicle. The means 120 to determine continuously the speed of the vehicle includes, according to one variant, speed measurement means.

The system I comprises means 140 to determine a speed profile based on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section of the route that arises in a curve along the route.

The means 140 to determine a speed profile based on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section of the route that arises in a curve is arranged for continuous determination.

The required retardation a is determined, according to one variant, through the equation:

$$a = \frac{v^2 - v_0^2}{2 * s}$$

In this equation, v is the speed that corresponds to the target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section that arises in a curve of the route, v_0 is the current speed, a the retardation required, and s the distance to the section arising in the curve.

The means 140 to determine a speed profile based on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section of the route that arises in a curve of the route includes means 142 to determine continuously
5 the driving resistance along the route of the vehicle.

The means 142 to determine continuously the driving resistance along the route of the vehicle include means 142a to determine the gradient resistance. The means 142a to determine gradient resistance includes or is included in means to determine topology along the route of the vehicle, i.e. any gradient
10 of the roadway that is present along the route of the vehicle.

The means 142a to determine gradient resistance includes, according to one variant, a map information unit 112 comprising map data including properties of the roadway along the route of the vehicle including topology along the route of the vehicle, and means to determine the position of the vehicle,
15 comprising, according to one variant, a geographical position-determination system such as GPS to determine continuously the position of the vehicle along its route. The map information unit and the means to determine the position of the vehicle are comprised, according to one variant, of the map information unit 112 and the means 114 to determine the position of the
20 vehicle.

The means 142 to determine continuously the driving resistance along the route of the vehicle include means 142b to determine the frictional properties of the propulsion of the vehicle. The means 142b to determine the frictional properties of the propulsion of the vehicle includes means to determine
25 differences in speed in the wheels during driving/braking, known as "slip". Slip is determined by determining differences in the speeds of the wheels, through, for example, sensor means that measure the rate of revolution of the wheels.

The means 142 to determine continuously the driving resistance along the route of the vehicle include means 142c to determine air resistance. The means 142c to determine air resistance includes modelling means to estimate the air resistance by means of air resistance coefficients and properties of the vehicle, including the frontal area and the speed of the vehicle squared. The means 142c to determine air resistance includes, according to one variant, sensor means to measure air oncoming onto the vehicle, taking the geometry of the vehicle, including air guidance devices to reduce air resistance, into consideration.

10 The means 142 to determine continuously the driving resistance along the route of the vehicle include means 142d to determine rolling resistance. The means 142d to determine rolling resistance includes modelling means to estimate the rolling resistance by means of properties of the vehicle, including the number of axles of the vehicle, the vehicle weight, and, where relevant, the type of tyres.

The means 142 to determine driving resistance F_{res} includes calculation means (not shown in the drawings). The calculation means is arranged, according to one variant, to determine a mean value of the contribution from acceleration a_{resavg} that the driving resistance generates along the relevant distance horizon, where s is the distance from the vehicle to the horizon, i.e. the window that is continuously measured taking the mass m of the vehicle into consideration. This takes place according to:

$$a_{resavg} = \frac{\int_0^s F_{res}(s) * ds}{s * m}$$

The total acceleration required a_{tot} that is required will thus be given by:

$$25 \quad a_{tot}(s) = a + a_{resavg} = \frac{v^2 - v_0^2}{2 * s} + \frac{\int_0^s F_{res}(s) * ds}{s * m}$$

The system I comprises means 150 to determine a maximum permitted lateral acceleration. The means 150 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 distribution of load on the vehicle, 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/s². 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 determination of the maximum speed of the vehicle and thus also the speed profile based on the maximum permitted lateral acceleration uses information about the degree of curvature of the roadway along the route of the vehicle, whereby the following equation A) is used:

$$(A) \quad v_{\max}(s) = \sqrt{\left(\frac{a_{lat, \max}(s)}{c(s)} \right)}$$

where $v_{\max}(s)$ is the maximum speed along the stretch s in front of the vehicle, $a_{lat, \max}(s)$ is the maximum permitted lateral acceleration along the stretch s in front of vehicle, and $c(s)$ is the degree of curvature along the stretch s in front of the vehicle.

The system I comprises means 160 to determine whether the current speed of the vehicle exceeds the target speed. The means to determine whether the current speed of the vehicle exceeds the target speed includes means to compare the current speed of the vehicle with the target speed.

The system I comprises means 170 to adapt, in the case in which the current speed of the vehicle exceeds the target speed, the speed of the vehicle such that the target speed is achieved at a stipulated distance along the route of the vehicle before the entrance to the curve. The stipulated distance along the route of the vehicle before the entrance to the curve and the said distance in the curve form in this case a certain distance s_{preaim} . See Figures 3a and 3b, which are described below.

The system I comprise means 180 to determine the said stipulated distance before the entrance to the curve along the route of the vehicle.

10 The means 180 to determine the said stipulated distance before the entrance to the curve along the route of the vehicle comprises means 182 to determine the said stipulated distance before the entrance to the curve along the route of the vehicle based on a stipulated absolute prediction interval relative to the distance that corresponds to the target speed. The distance s_{preaim} corresponding to the distance between the section that arises in the curve and the section before the entrance to the curve is determined in this case to be a predetermined distance, for example 20 metres.

The means 180 to determine the said stipulated distance before the entrance to the curve along the route of the vehicle comprises means 184 to determine the said stipulated distance before the entrance to the curve along the route of the vehicle based on a retardation from a current speed of the vehicle to the said target speed.

The distance s_{preaim} corresponding to the distance between section that arises in the curve and the section before the entrance to the curve is determined, according to one variant, as a function of a speed, for example an approaching speed limitation, i.e. the target speed, and can consequently be derived from a time t_{preaim} , where the vehicle is thus to have achieved this speed at the corresponding time t_{preaim} before the speed starts to be valid. In this case, s_{preaim} is determined to, where $V_{desired}$ is the desired speed:

$$s_{prelim} = v_{desired} * t_{prelim}$$

The means 180 to determine the said stipulated distance before the entrance to the curve along the route of the vehicle comprises means 186 to determine the said stipulated distance before the entrance to the curve along the route of the vehicle based on a section of the speed profile corresponding to retardation before the said curve.

The means 186 to determine the said stipulated distance before the entrance to the curve along the route of the vehicle based on a section of the speed profile corresponding to the retardation before the said curve comprises means 186a to set, in the case in which the section of the speed profile corresponding to the retardation before the said curve lies at a predetermined position before the said section that corresponds to the target speed, a ceiling on the corresponding distance and/or time before the entrance to the curve.

The means 186a to determine, in the case in which the section of the speed profile corresponding to the retardation before the said curve lies at a predetermined position before the said section that corresponds to the target speed, a ceiling on the corresponding distance and/or time before the entrance to the curve comprises in this case means to determine whether the section of the speed profile corresponding to the retardation before the said curve lies at a predetermined position before the distance that corresponds to the target speed.

During the adaptation of the speed of the vehicle such that the target speed is achieved at a stipulated distance before the entrance to the curve along the route of the vehicle, the acceleration required in the form of retardation a_{tot} will thus be, according to one variant:

$$a_{tot}(s) = \frac{v^2 - v_0^2}{2 * (s - s_{prelim})} + \frac{\int_0^s F_{res}(s) * ds}{s * m}$$

The retardation can take place earlier through adaptation of the speed of the vehicle such that the target speed is achieved at a stipulated distance along the route of the vehicle before the entrance to the curve, i.e. that the retardation is initiated earlier than retardation to achieve the target speed in the curve, and/or more powerfully, such that the vehicle is braked to the speed at the stipulated section in a shorter distance.

The system I comprises means 190 to adapt, in the case in which the current speed of the vehicle lies below or corresponds to the target speed, the speed of the vehicle such that the target speed is achieved at the distance that corresponds to the target speed.

The electronic control unit 100 is connected through a link 10 such that it exchanges signals with the means 110 to determine continuously the presence of phenomena that limit speed in the form of curves along the route of the vehicle. The electronic control unit 100 is arranged to receive over the link 10 a signal from the means 110 that represents data for phenomena that limit speed in the form of curves.

The electronic control unit 100 is connected through a link 10a such that it exchanges signals with the means 110a comprising the map information unit 112 and the means 114 to determine the position of the vehicle. The electronic control unit 100 is arranged to receive over the link 10a a signal from the means 110a that represents map data for phenomena that limit speed in the form of curves along the route of the vehicle and positional data for the position of the curve relative to the vehicle.

The electronic control unit 100 is connected through a link 16 such that it exchanges signals with the camera means 116. The electronic control unit 100 is arranged to receive over the link 16 a signal from the camera means 116 that represents data for phenomena that limit speed in the form of curves including curvature data for curves of the roadway along the route of the vehicle.

The electronic control unit 100 is connected such that it exchanges signals over a link 20 with the means 120 to determine continuously the speed of the vehicle. The electronic control unit 100 is arranged to receive over the link 20 a signal from the means 120 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 determine a speed profile based on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section that arises in a curve along the route. The electronic control unit 100 is arranged to receive over the link 40a a signal from the means 140 that represents acceleration data for the acceleration required in order to achieve the target speed according to the phenomena that limit speed in the form of curvature data determined at the curve.

The electronic control unit 100 is connected such that it exchanges signals over a link 42 with the means 142 to determine continuously the driving resistance along the route of the vehicle. The electronic control unit 100 is arranged to receive over the link 42 a signal from the means 142 that represents driving resistance data.

The electronic control unit 100 is connected such that it exchanges signals over a link 42a with the means 142a to determine the gradient resistance. The electronic control unit 100 is arranged to receive over the link 42a a signal from the means 142a that represents gradient data for the gradient along the route of the vehicle.

The electronic control unit 100 is connected such that it exchanges signals over a link 42b with the means 142b to determine frictional properties of the propulsion of the vehicle. The electronic control unit 100 is arranged to receive over the link 42b a signal from the means 142b that represents friction data for the frictional properties of the propulsion of the vehicle.

The electronic control unit 100 is connected such that it exchanges signals over a link 42c with the means 142c to determine air resistance. The electronic control unit 100 is arranged to receive over the link 42c a signal from the means 142c that represents air resistance data for the vehicle along
5 the roadway along the route of the vehicle.

The electronic control unit 100 is connected such that it exchanges signals over a link 42d with the means 142d to determine rolling resistance. The electronic control unit 100 is arranged to receive over the link 42d a signal from the means 142d that represents rolling resistance data for the vehicle
10 along the roadway along the route of the vehicle.

The electronic control unit 100 is connected through a link 40b such that it exchanges signals with the means 140 to determine a speed profile based on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a
15 section of the route that arises in a curve along the route. The electronic control unit 100 is arranged to transmit through the link 40b a signal to the means 140 representing speed data for the current speed of the vehicle, data for phenomena that limit speed in the form of curves, distance data for the curve, and driving resistance data.

20 The electronic control unit 100 is connected such that it exchanges signals over a link 50 with the means 150 to determine a maximum permitted lateral acceleration. The electronic control unit 100 is arranged to receive over the link 50 a signal from the means 150 representing lateral acceleration data for the maximum permitted lateral acceleration.

25 The electronic control unit 100 is connected such that it exchanges signals over a link 60a with the means 160 to determine whether the current speed of the vehicle exceeds the target speed. The electronic control unit 100 is arranged to transmit through the link 60a a signal to the means 160

representing speed data for current speed and target speed data for the target speed.

The means 160 to determine whether the current speed of the vehicle exceeds the target speed is arranged to compare the said speed data and
5 target speed data in order in this way to determine data for whether the current speed of the vehicle exceeds the target speed.

The electronic control unit 100 is connected such that it exchanges signals over a link 60b with the means 160 to determine whether the current speed of the vehicle exceeds the target speed. The electronic control unit 100 is
10 arranged to receive over the link 60b a signal from the means 160 that represents data for whether the current speed of the vehicle exceeds the target speed.

The electronic control unit 100 is connected through a link 70a such that it exchanges signals with the means 170 to adapt the speed of the vehicle
15 such that the target speed is achieved at a stipulated distance along the route of the vehicle before the entrance to the curve. The electronic control unit 100 is arranged to transmit through the link 70a a signal to the means 170 representing data that the current speed exceeds the target speed.

The electronic control unit 100 is connected through a link 70b such that it
20 exchanges signals with the means 170 to adapt the speed of the vehicle such that the target speed is achieved at a stipulated distance along the route of the vehicle before the entrance to the curve. The electronic control unit 100 is arranged to receive over the link 70b a signal that represents adaptation data for the adaptation of the speed of the vehicle such that the
25 target speed is achieved at a stipulated distance along the route of the vehicle before the entrance to the curve.

The electronic control unit 100 is connected through a link 80 such that it exchanges signals with the means 180 to determine the stipulated distance before the entrance to the curve along the route of the vehicle. The electronic

control unit 100 is arranged to receive over the link 80 a signal from the means 180 that represents data for the stipulated distance before the entrance to the curve.

5 The electronic control unit 100 is connected through a link 82 such that it exchanges signals with the means 182 to determine the said stipulated distance before the entrance to the curve along the route of the vehicle based on a stipulated absolute prediction interval relative to the distance that corresponds to the target speed. The electronic control unit 100 is arranged to receive over the link 82 a signal from the means 182 that represents data
10 for the stipulated distance before the entrance to the curve.

The electronic control unit 100 is connected through a link 84 such that it exchanges signals with the means 184 to determine the stipulated distance before the entrance to the curve along the route of the vehicle based on a retardation from a current speed of the vehicle to the said target speed. The
15 electronic control unit 100 is arranged to receive over the link 84 a signal from the means 184 that represents data for the stipulated distance before the entrance to the curve.

The electronic control unit is connected through a link 86 such that it exchanges signals with the means 186 to determine the said stipulated
20 distance before the entrance to the curve along the route of the vehicle based on a section of the speed profile corresponding to the retardation before the said curve. The electronic control unit 100 is arranged to receive over the link 86 a signal from the means 186 that represents data for the stipulated distance before the entrance to the curve.

25 The electronic control unit 100 is connected through a link 90a such that it exchanges signals with the means 190 to adapt the speed of the vehicle such that the target speed is achieved at the distance that corresponds to the target speed. The electronic control unit 100 is arranged to transmit through

the link 90a a signal to the means 190 representing data that the current speed lies below or is equal to the target speed.

The electronic control unit 100 is connected through a link 90b such that it exchanges signals with the means 190 to adapt the speed of the vehicle such that the target speed is achieved at the distance that corresponds to the target speed. The electronic control unit 100 is arranged to receive through the link 90b a signal from the means 190 representing adaptation data for the adaptation of the speed of the vehicle such that the target speed is achieved at the distance that corresponds to the target speed.

Figure 3a illustrates schematically a curvature profile in the form of a roundabout with a certain radius of curvature. The vehicle is driven on a roadway and is intended, when taking the curve in the roundabout, to carry out a left turn according to the direction of the arrow A.

Figure 3b illustrates schematically speed profiles for the curvature profile in Figure 3a determined by means of system I according to the present invention.

A speed profile is in this case determined based on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section P1 that arises in a curve, here the roundabout, of the route.

In the case in which the current speed of the vehicle v_0 exceeds the target speed v , the speed of the vehicle is adapted such that the target speed v is achieved at a stipulated distance P2 along the route of the vehicle before the entrance to the curve, here the roundabout.

In the case in which the current speed of the vehicle lies below or corresponds to the target speed, the speed of the vehicle is adapted such that the target speed is achieved at the distance that corresponds to the target speed.

The full line in Figure 3b thus shows the speed profile that has been determined based on the maximum permitted lateral acceleration.

The dashed line in Figure 3b shows in this case the desired speed profile for the driving of the vehicle where the target speed v is achieved at the stipulated section P2 before the entrance to the curve, where the section P2 is located a distance s_{preaim} before the section P1 in the curve

It is illustrated in Figure 3b how the stipulated section P2 before the entrance to the curve along the route of the vehicle is determined based on a distance of the maximum permitted lateral acceleration based on the speed profile that corresponds to the retardation before the said curve, i.e. in the region for the initiation of retardation according to the speed profile.

The dash-dot line in Figure 3b shows an undesired speed profile.

Figure 4 illustrates schematically a block diagram of a method for the adaptation of the driving of a vehicle on a roadway in association with taking a curve according to one embodiment of the present invention.

According to one embodiment, the method for the adaptation of the driving of a vehicle on a roadway in association with taking a curve comprises a first step S1. The presence of phenomena that limit speed in the form of curves along the route of the vehicle is determined in this step.

According to one embodiment, the method for the adaptation of the driving of a vehicle on a roadway in association with taking a curve comprises a second step S2. A speed profile based on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section of the route that arises in a curve along route is determined in this step.

According to one embodiment, the method for the adaptation of the driving of a vehicle on a roadway in association with taking a curve comprises a third step S3. The speed of the vehicle is in this step adapted, in the case in which

the current speed of the vehicle exceeds the target speed, such that the target speed is achieved at a stipulated distance along the route of the vehicle before the entrance to the curve.

With reference to Figure 5, 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.

There is provided a computer program P that comprises routines for the adaptation of the driving of a vehicle on a roadway in association with taking a curve according to the innovative method. The program P comprises routines to determine the presence of phenomena that limit speed in the form of curves along the route of the vehicle. The program P comprises routines to determine a speed profile based on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section of the route that arises in a curve. The program P comprises routines to adapt, in the case in which the current speed of the vehicle exceeds the target speed, the speed of the vehicle such that the target speed is achieved at a stipulated distance along the route of the vehicle before the entrance to the curve. 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.

- 5 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
10 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
15 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 received on the data port 599 can be used by the arrangement 500 to determine the presence of phenomena that limit speed in the form of curves along the route of the vehicle. The signals received at the data port 599 can
20 be used by the arrangement 500 to determine a speed profile based on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section of the route that arises in a curve. The signals received at the data port 599 can be used by the arrangement 500 to adapt, in the case in which
25 the current speed of the vehicle exceeds the target speed, the speed of the vehicle such that the target speed is achieved at a stipulated distance along the route of the vehicle before the entrance to the curve.

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
5 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
10 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 driving of a vehicle (1) on a roadway in association with taking a curve, comprising the step (S1) to determine the presence of phenomena that limit speed in the form of curves along the route
5 of the vehicle, **characterised by** the steps: to determine (S2) a speed profile based on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section of the route that arises in a curve; and, in the case in which the current speed of the vehicle exceeds the target speed, to adapt (S3) the
10 speed of the vehicle such that the target speed is achieved at a stipulated distance along the route of the vehicle before the entrance to the curve, whereby the stipulated distance is determined based on a stipulated absolute prediction interval relative to the distance that corresponds to the target speed.
- 15 2. The method according to claim 1, comprising the step to adapt, in the case in which the current speed of the vehicle lies below or corresponds to the target speed, the speed of the vehicle such that the target speed is achieved at the distance that corresponds to the target speed.
3. The method according to any one of steps 1-2, comprising the step to
20 determine the said stipulated distance before the entrance to the curve along the route of the vehicle based on a retardation against from a current speed of the vehicle to the said target speed.
4. The method according to any one of claims 1-3, comprising the step to determine the said stipulated distance before the entrance to the curve along
25 the route of the vehicle based on a section of the speed profile corresponding to the retardation before the said curve.
5. The method according to claim 4, whereby an upper limit is set, in the case in which the section of the speed profile corresponding to retardation before the said curve lies a predetermined position before the distance that

correspond to the target speed, on the corresponding distance and/or time before the entrance to the curve.

6. A system (I) for the adaptation of the driving of a vehicle (1) on a roadway in association with taking a curve, comprising means (110) to determine
5 continuously the presence of phenomena that limit speed in the form of curves along the route of the vehicle, **characterised by** means (140) to determine a speed profile on the current speed of the vehicle and comprising a target speed based on a maximum permitted lateral acceleration of the vehicle associated with a section of the route that arises in a curve; and
10 means (170) to adapt, in the case in which the current speed of the vehicle exceeds the target speed, the speed of the vehicle such that the target speed is achieved at a stipulated distance along the route of the vehicle before the entrance to the curve, whereby the stipulated distance is determined based on a stipulated absolute prediction interval relative to the distance that
15 corresponds to the target speed.

7. The system according to claim 6, comprising means (190) to adapt, in the case in which the current speed of the vehicle lies below or corresponds to the target speed, the speed of the vehicle such that the target speed is achieved at the distance that corresponds to the target speed.

20 8. The system according to any one of steps 6-7, comprising means (184) to determine the said stipulated distance before the entrance to the curve along the route of the vehicle based on a retardation from a current speed of the vehicle to the said target speed.

9. The system according to any one of claims 6-8, comprising means (186)
25 to determine the said stipulated distance before the entrance to the curve along the route of the vehicle based on a section of the speed profile corresponding to the retardation before the said curve.

10. The system according to claim 9, comprising means (186a) to set an upper limit, in the case in which the section of the speed profile

corresponding to retardation before the said curve lies a predetermined position before the distance that correspond to the target speed, on the corresponding distance and/or time before the entrance to the curve.

11. A vehicle (1) comprising a system (I) according to any one of claims 6-10.
- 5 12. A computer program (P) for the adaptation of the driving of a vehicle on a roadway in association with 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
- 10 according to claims 1-5.
13. A computer program product comprising a digital storage medium that stores the computer program according to claim 12.

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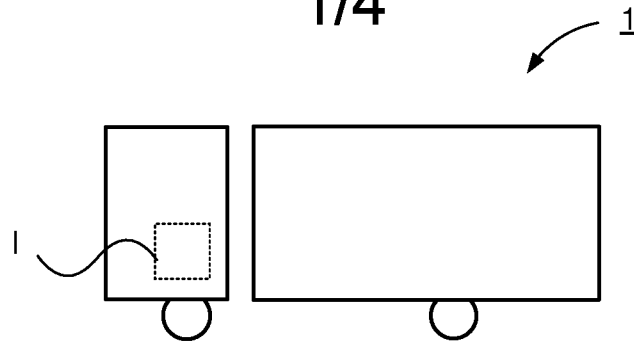


Fig. 1

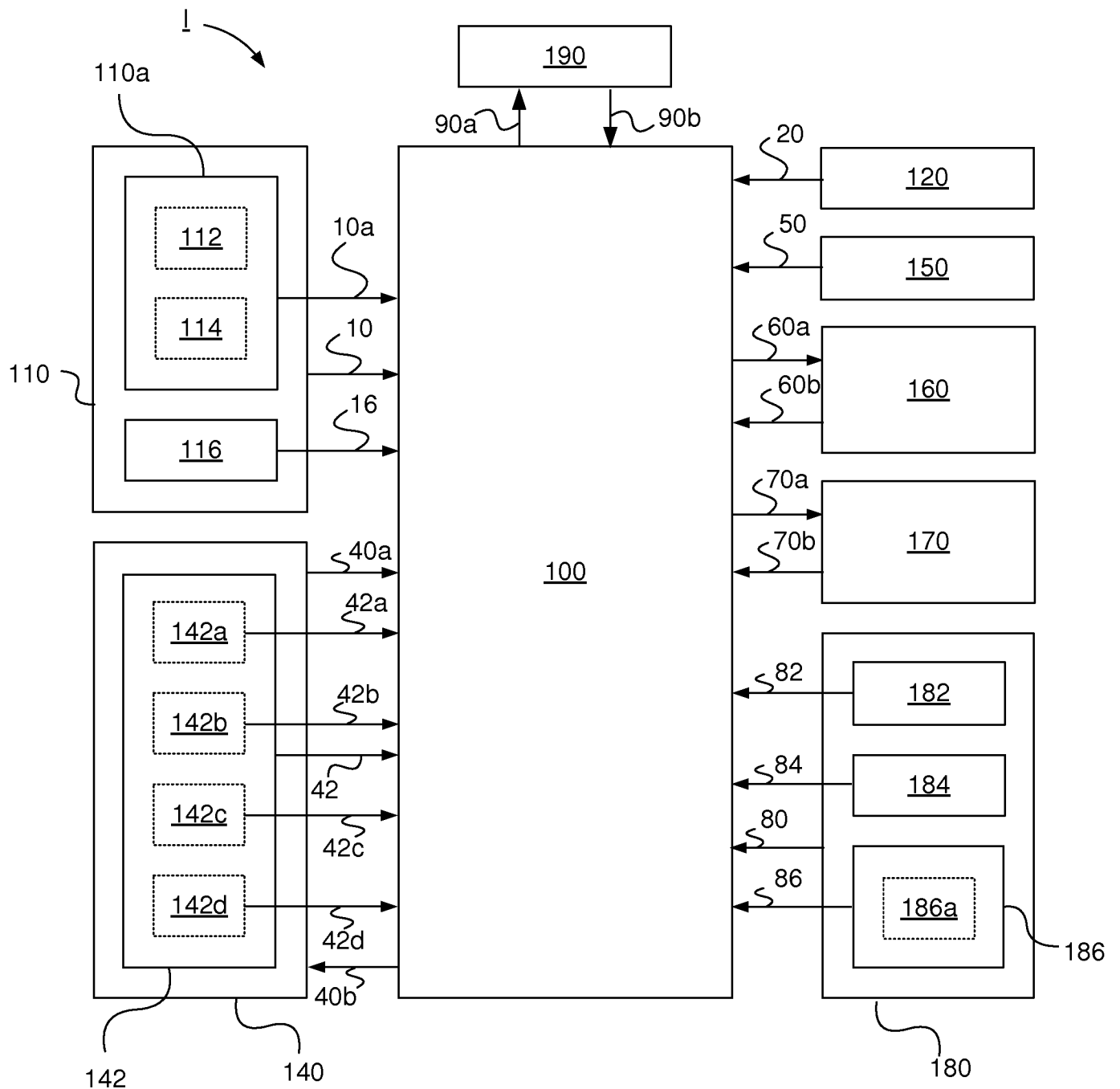


Fig. 2

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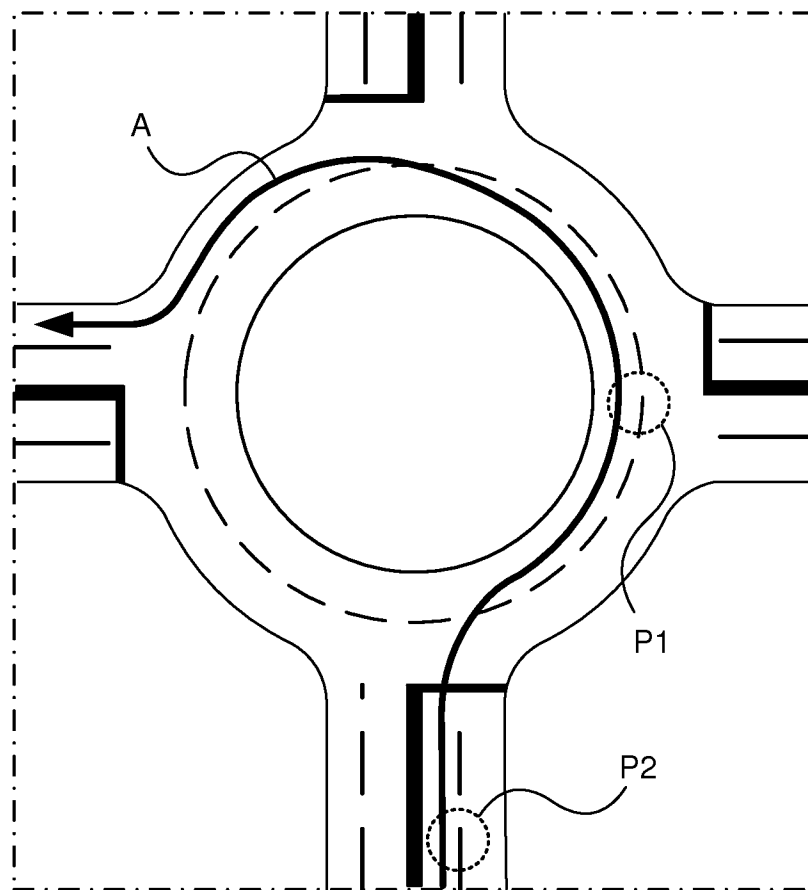


Fig. 3a

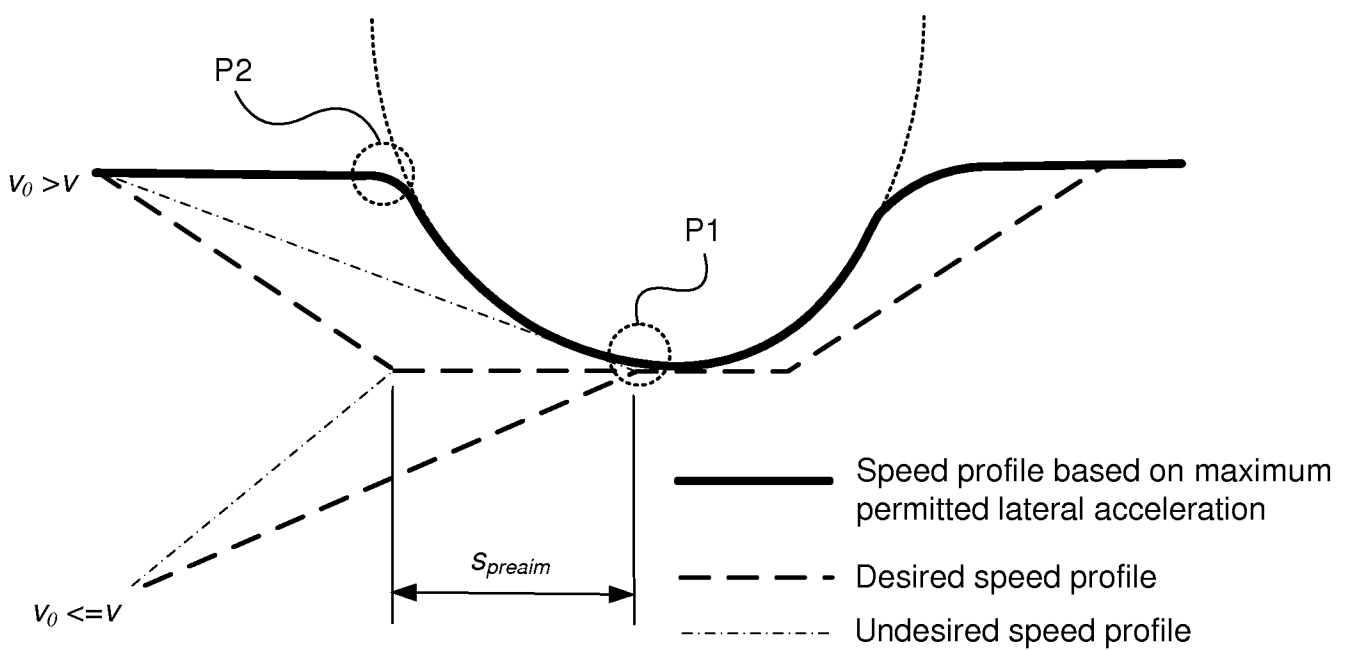


Fig. 3b

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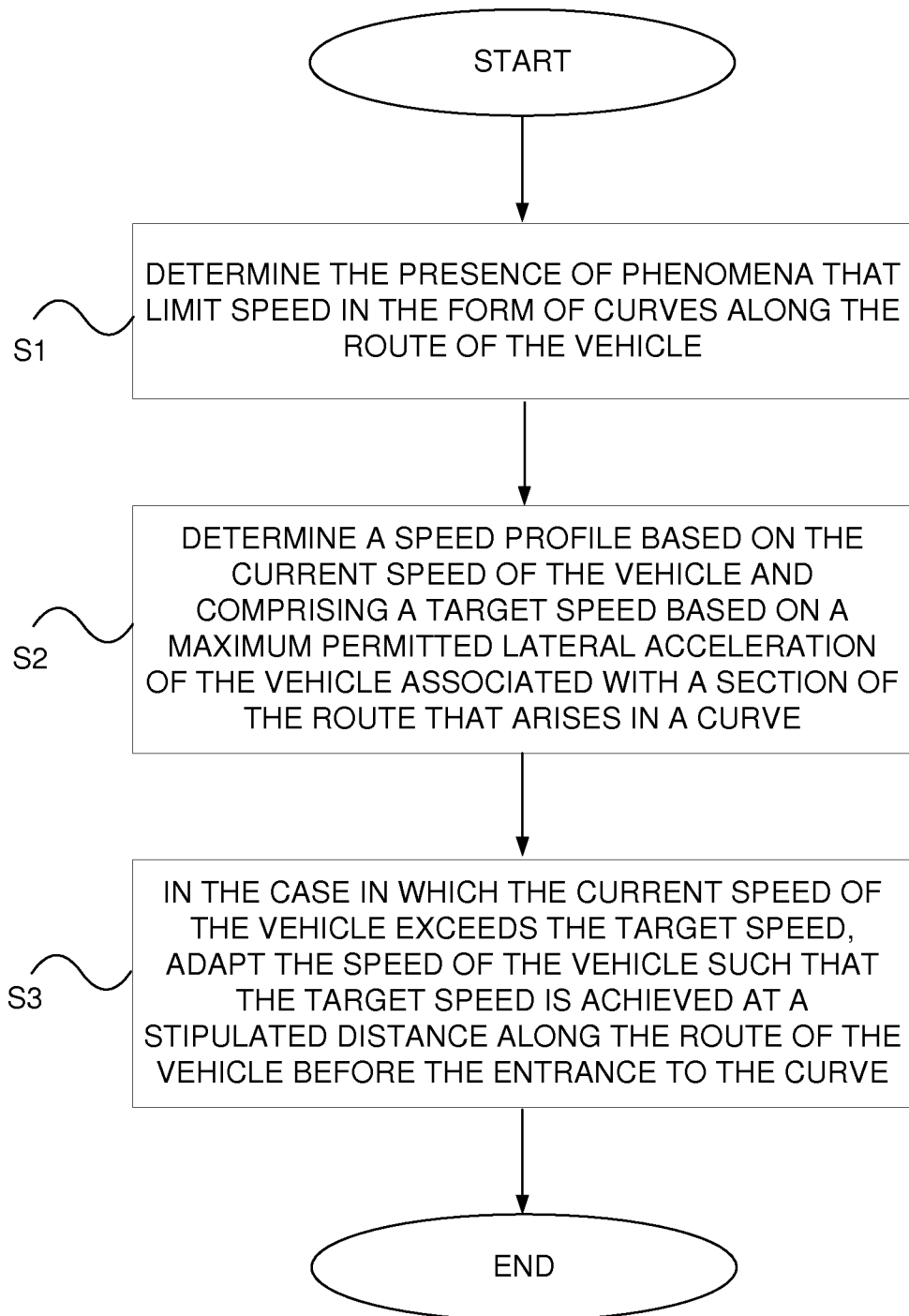


Fig. 4

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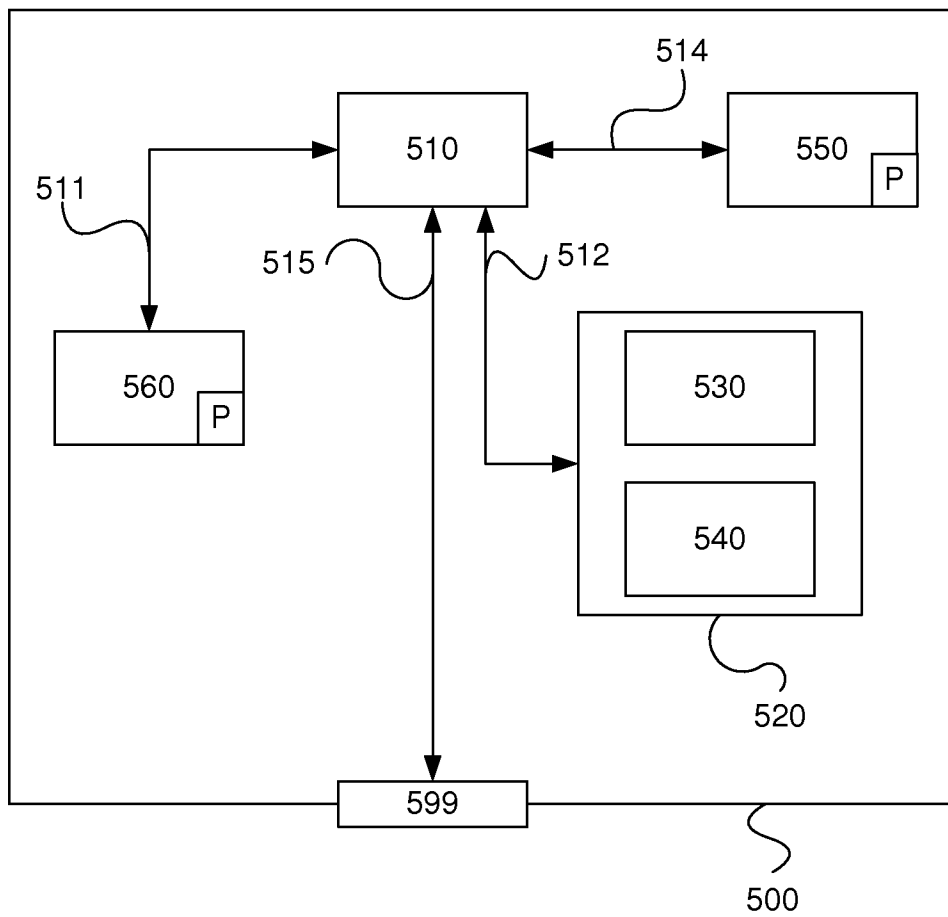


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2015/050572

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, B60T, 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	US 20090198426 A1 (YASUI YOSHIYUKI ET AL), 6 August 2009 (2009-08-06); figures 2 and 4; paragraphs [0008], [0055]-[0064], [0083] --	1-13
A	GB 2343016 A (BOSCH GMBH ROBERT), 26 April 2000 (2000-04-26); page 6, second paragraph; figure 2 --	1-13
A	US 20070225882 A1 (YAMAGUCHI KAZUHI ET AL), 27 September 2007 (2007-09-27); whole document --	1-13
A	DE 10258167 A1 (SCANIA CV AB), 31 July 2003 (2003-07-31); whole document --	1-13

☒ 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

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

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

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

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Date of the actual completion of the international search

21-09-2015

Date of mailing of the international search report

21-09-2015

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2015/050572

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 20120203440 A1 (MATSUNAGA MASAKI), 9 August 2012 (2012-08-09); whole document -- -----	1-13

Continuation of: second sheet**International Patent Classification (IPC)*****B60W 30/14*** (2006.01)***B60K 31/00*** (2006.01)***B60T 8/1755*** (2006.01)***B60W 40/072*** (2012.01)***B60W 40/109*** (2012.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2015/050572

US	20090198426 A1	06/08/2009	CN	101497336 A	05/08/2009
			EP	2085280 A2	05/08/2009
			JP	2009179251 A	13/08/2009
			JP	5257923 B2	07/08/2013
			US	8412433 B2	02/04/2013
GB	2343016 A	26/04/2000	DE	19848236 A1	27/04/2000
			JP	2000127798 A	09/05/2000
US	20070225882 A1	27/09/2007	US	7548805 B2	16/06/2009
DE	10258167 A1	31/07/2003	NONE		
US	20120203440 A1	09/08/2012	CN	102639378 A	15/08/2012
			DE	112009005449 T5	04/04/2013
			JP	5168420 B2	21/03/2013
			US	9067571 B2	30/06/2015
			WO	2011074115 A1	23/06/2011