Title: METHOD AND SYSTEM FOR DETERMINING VEHICLE POSITION

Abstract: The invention concerns a method for determining the position of a vehicle (1) relative to the roadway (10) of the vehicle route, comprising the steps that: continuously estimate (SI) distances between at least one side section of the vehicle and topographic characteristics (30, 32, 130, 132, 230, 232) of the vehicle route proximate to said side section; and determine S2) the lateral position of the vehicle based on distances so estimated. The present invention also concerns a system for determining the position of a vehicle relative to the roadway of the vehicle route. The present invention further concerns a computer program and a computer program product.
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METHOD AND SYSTEM FOR DETERMINING VEHICLE POSITION

TECHNICAL FIELD OF THE INVENTION

The invention concerns a method for determining vehicle position in accordance with the preamble of claim 1. The invention also concerns a system for determining vehicle position in accordance with the preamble of claim 9. The invention also concerns a motor vehicle. The invention further concerns a computer program and a computer program product.

BACKGROUND

Some vehicles are equipped with cameras and/or other sensors that are arranged to detect lane markings on the roadway of the vehicle route, in front of or behind the vehicle, to determine in which lane and where in said lane on the roadway the vehicle is located. This signal can then be used to issue a warning if the vehicle involuntarily moves out of the lane, and/or used to control the vehicle in the lane.

These sensors can encounter problems detecting the road markings temporarily or for longer periods of time, due to worn or nonexistent road markings or winter road conditions.

OBJECT OF THE INVENTION

One object of the invention is to achieve a method for determining vehicle position along the roadway of the vehicle route that is effective and enables reliable determination.
A further object of the present invention is to achieve a system for determining vehicle position along the roadway of the vehicle route that is effective and enables reliable determination.

SUMMARY OF THE INVENTION

These and other objects, which are set forth in 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 types described above, and which further exhibit features as specified in the characterizing part of attached independent claims 1, 9, 17, 18 and 19. Preferred embodiments of the method and the system are defined in attached dependent claims 2-8 and 10-16.

According to the invention, these purposes are achieved by using a method for determining the position of a vehicle relative to the roadway of the vehicle route in accordance with the features in claim 1. An effective means of determining the position of the vehicle relative to the roadway of the vehicle route is thereby achieved that can be utilized alone or as a complement to other determination of the position of the vehicle relative to the roadway of the vehicle route, such as detecting road markings along the roadway of the vehicle route. As a result, a more reliable determination of the position of the vehicle relative to the roadway of the vehicle route is thereby enabled.

According to one embodiment, the method comprises the features in claim 2. Effective estimation of the distance between the vehicle side and side of the road is enabled by utilizing such topographical characteristics.

According to one embodiment, the method comprises the features in claim 3. Such devices enable effective estimation of the distance.
According to one embodiment, the method comprises the features in claim 4. Information is thereby obtained as to whether the vehicle is situated in a lane on the roadway and, if so, which lane and the vehicles position in the lane.

According to one embodiment, the method comprises the features in claim 5. By utilizing a known position of the vehicle to estimate the distance, and taking the approach that this distance to topographical characteristics is constant for a given period of time, this information can be utilized to learn the position of the vehicle relative to the roadway, for example as redundancy to information known about the position of the vehicle from detecting road markings so that, if road markings are undetectable for a section along the roadway, the estimated distance can be used to keep track of the position of the vehicle.

According to one embodiment, the method comprises the features in claim 6. This is an effective way of determining the position of the vehicle.

According to one embodiment, the method comprises the features in claim 7. The confirmation can be made by the driver when he/she knows that the vehicle is in the correct position/correct lane on the roadway.

According to one embodiment, the method comprises the features in claim 8. The determination is made via GPS and map data that can include road width, whereupon this information can be updated continuously so that any changes in the characteristics of the roadway can be taken into account, thereby enabling reliable determination of the position of the vehicle based on said distances.

According to the invention, these purposes are also achieved by means of a system for determining the position of a vehicle relative to the roadway of the vehicle route in accordance with the features in claim 9. An effective way of determining the position of the vehicle relative to the roadway of the vehicle route is thereby obtained that can be utilized alone or as a complement to other determination of the position of the vehicle relative to the roadway of
the vehicle route, such as detecting the road markings along the roadway of the vehicle route. As a result, a more reliable determination of the position of the vehicle relative to the roadway of the vehicle route is thereby enabled.

According to one embodiment, the system comprises the features in claim 10. Effective distance estimation between vehicle side and the side of the road is achieved by utilizing such topographic characteristics.

According to one embodiment, the system comprises the features in claim 11. Such devices enable effective estimation of the distance.

According to one embodiment, the system comprises the features in claim 12. Information is thereby obtained as to whether the vehicle is situated in a lane on the roadway and, if so, which lane and its position in the lane.

According to one embodiment, the system comprises the features in claim 13. By utilizing a known vehicle position to estimate the distance, and taking the approach that this distance to topographical characteristics is constant for a given period of time, this information can be utilized to learn the position of the vehicle relative to the roadway, for example as redundancy to information known about the position of the vehicle from detecting road markings so that, if road markings are undetectable for a section along the roadway, the estimated distance can be used to keep track of the position of the vehicle.

According to one embodiment, the system comprises the features in claim 14. This is an effective way of determining the position of the vehicle.

According to one embodiment, the system comprises the features in claim 15. The confirmation can be made by the driver when he/she knows that the vehicle is in the correct position/in the correct lane on the roadway.

According to one embodiment, the system comprises the features in claim 16. The determination is made via GPS and map data that can include road width, whereupon this information can be updated continuously so that any changes in the characteristics of the roadway can be taken into account,
thereby enabling reliable determination of the position of the vehicle based on said distances.

DESCRIPTION OF THE DRAWING

5 The present invention will be better understood with reference to the following detailed description, read in conjunction with the attached drawings, wherein the same reference designations refer to the same elements consistently in the many views, and in which:

Fig. 1 schematically illustrates a motor vehicle according to an embodiment of the present invention;

Fig. 2 schematically illustrates a block diagram of a system for determining vehicle position according to an embodiment of the present invention;

Fig. 3 schematically illustrates a top view of a motor vehicle that is traveling on a roadway;

Figs. 4a-b schematically illustrate a rear view of a motor vehicle that is traveling on a roadway;

Fig. 5 schematically illustrates a block diagram of a method according to an embodiment of the present invention; and

Fig. 6 schematically illustrates a computer according to an embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

The term "link" refers herein to a communications link, which can 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 or microwave link.

The term "topographic characteristics" in the expression "topographic characteristics of the vehicle route" refers herein to any suitable reference point proximate to a side section of the vehicle for estimating distance, including objects, in the form of road barriers, and/or side markings, and/or roadway terminations, and/or existing sloped sections, and/or fence sections, in connection with the roadway.

The term "side section of the vehicle" refers herein to the right and/or left side of the vehicle and/or a lengthwise side section, i.e. in the longitudinal direction of the vehicle, along one side of the vehicle.

Fig. 1 schematically illustrates a motor vehicle 1 according to an embodiment of the present invention. The exemplified vehicle 1 consists of a heavy vehicle in the form of a truck with a cab 2. The vehicle can alternatively consist of any suitable vehicle, such as a bus or automobile. The vehicle contains a system 1 for determining vehicle position according to the present invention.

Fig. 2 schematically illustrates a block diagram of a system 1 for determining vehicle position according to an embodiment of the present invention.

The system 1 comprises an electronic control unit 100 for said determination.

The system 1 comprises distance-estimating means 110 for continuously estimating distances between at least one side section of the vehicle and topographic characteristics of the vehicle route proximate to said side section. Said distance-estimating means comprise side sensor devices. Said side sensor devices consist according to one embodiment of camera devices, radar devices and/or laser measuring devices. Any suitable distance-estimating means for continuously estimating distances between said side section and said topographic characteristics can be used.
The system I further comprises, according to one variant, vehicle position-
determining means 120 for determining the lateral position of the vehicle relative to said roadway.

According to one variant, said vehicle position-determining means comprise road marking-detecting means 122 for detecting road markings on said roadway. Said road marking-detecting means 122 according to one variant comprise camera devices.

According to one variant, said vehicle position-determining means 120 comprise confirming means 124 for confirming a desired lateral position of the vehicle relative to said roadway. Said confirmation is made according to one variant in that, for example, the driver manually confirms the position of the vehicle by means of said confirming means 124 when the driver is aware of the current lateral position of the vehicle and that the current lateral position of the vehicle is the desired one, i.e. that the vehicle is in the correct lane on the roadway.

According to one variant, said vehicle position-determining means 120 comprise route-determining means 126 to furnish predetermined characteristics of the roadway along the vehicle route and the position of the vehicle along the vehicle route.

Said route-determining means 126 according to one variant comprise a map information unit 126a containing said characteristics of the roadway, wherein said characteristics of the roadway according to one variant comprise information about the width of the road, the number of lanes, the width of the lanes, and the distance from the side of the road to topographic characteristics such as road barriers or the like. Said route-determining means further comprise a geographical position-determining system 126b, such as GPS.
Said vehicle position-determining means 120 can comprise one or more of said road marking-detecting means 122, said confirming means 124 and said route-determining means 126.

The system comprises vehicle position-processing means 130 for processing information regarding the position of the vehicle along the roadway of the vehicle route. Said vehicle position-processing means 130 according to one variant comprise warning means arranged to warn the driver if, for example, the vehicle is deviating from the lane in which it is traveling. Said vehicle position-processing means 130 according to one variant comprise vehicle position-correcting means to correct the position of the vehicle if the vehicle deviates from the desired position on the roadway, for example, by deviating from the lane in which it is traveling. Said vehicle position-processing means 130 can comprise both said warning means and said vehicle position-correcting means.

The electronic control unit 100 is signal-connected to said distance-estimating means 110 via a link 105. The electronic control unit 100 is arranged via the link 105 to receive a signal from the distance-estimating means 110 representing distance data between the side section of the vehicle and topographic characteristics of the vehicle route proximate to said side section.

The electronic control unit 100 is signal-connected to said vehicle position-determining means 120 via a link 115. The electronic control unit 100 is arranged via the link 115 to receive a signal from the vehicle position-determining means 120 representing lateral position data for the lateral position of the vehicle relative to said roadway.

According to one variant, the electronic control unit 100 is signal-connected to said road marking-detecting means 122 via a link 116. The electronic control unit 100 is arranged via the link 116 to receive a signal from the road
marking-detecting means 122 representing road marking data for the lateral position of the vehicle relative to said detected road marking.

According to one variant, the electronic control unit 100 is signal-connected to said confirming means 124 via a link 117. The electronic control unit 100 is arranged via the link 117 to receive a signal from the confirming means 124 representing data confirming that the lateral position of the vehicle relative to the roadway is correct.

According to one variant, the electronic control unit 100 is signal-connected to said route-determining means 126 via a link 118. The electronic control unit 100 is arranged via the link 118 to receive a signal from the route-determining means 126 representing roadway characteristics at the current position along the vehicle route.

The electronic control unit 100 is arranged so as to determine, based on said distance data and said lateral position data, the current lateral position of the vehicle relative to the roadway of the vehicle route.

According to one variant, the electronic control unit 100 is signal-connected to said vehicle position-processing means 130 via a link 135. The electronic control unit 100 is arranged via the link 135 to send a signal from the vehicle position-processing means 130 representing lateral position data relative to the roadway of the vehicle route at the current position along the vehicle route.

According to one variant, the electronic control unit 100 is arranged so as to determine, taking the approach that the distance to said topographic characteristics of the vehicle route proximate to said side section, such as road barriers or the like, is constant along the route, at least for a period of time/stretch, and by means of said signal representing distance data and lateral position data from said road marking-detecting means 122, the position of the vehicle in the lane on the roadway.
This is achieved according to one variant by comparing distance data with position data, where a specific distance to said topographic characteristics corresponds to a desired position on the roadway, whereupon this position can be maintained by continuously estimating distances between at least one side section of the vehicle and topographic characteristics of the vehicle route proximate to said side section.

In the event that the signal representing lateral position data from detecting by means of said road marking-detecting means 122 disappears for a time on a stretch of road because the road markings are not detectable, it is hereby made possible to determine the position of the vehicle along the roadway of the vehicle route with said distance data.

According to one variant, the electronic control unit 100 is arranged so as to determine, taking the approach that the distance to said topographic characteristics of the vehicle route proximate to said side section, such as road barriers or the like, is constant along the route, at least for a period of time/stretch, and by means of said signal representing distance data and confirmation data 124, the position of the vehicle in the lane on the roadway, whereupon the position of the vehicle along the roadway of the vehicle route is determined by means of said distance data.

According to one variant, said distance-estimating means 110 are contained in one electronic control unit and said vehicle position-determining means 120 in another electronic control unit.

Fig. 3 schematically illustrates a top view of a motor vehicle 1 that is traveling on a roadway 10, and Figs. 4a-b a rear view of a motor vehicle 1 that is traveling on a roadway 10.

Fig. 3 illustrates a roadway 10 with two lanes 10a, 10b, roadside markings 12 and road markings 14 that divide the roadway into lanes. The vehicle 1 is traveling on the roadway 10 in one of the lanes 10a. The vehicle 1 contains a first side sensor device 20 arranged on a side section on the one side 1a of
the vehicle 1 so as to continuously estimate distances between the side section of the vehicle 1 and topographic characteristics 30 of the vehicle route proximate to said side section, and a second side sensor device 22 arranged on a side section on the opposite other side 1b of the vehicle so as to continuously measure distances between the side section of the vehicle and topographic characteristics 32 of the vehicle route proximate to said side section. Respective sensing devices 20, 22 are arranged to detect the distance between side section and topographic characteristics 30, 32 via detection fields 20a, 22a. Said side sensor devices can consist of camera devices, radio devices and/or laser measuring devices.

The vehicle contains road marking-detecting means 40, according to one variant camera devices 40, to detect road markings 12, 14 on said roadway 10. Said road marking-detecting means 40 are arranged to detect road markings via a field of vision 40a. Said road marking-detecting means 40 can be arranged on the front of the vehicle and/or the back of the vehicle for said detecting of road markings 12, 14.

Side sensor devices 20, 22 and camera devices 40 are contained along with an electronic control unit in a system, for example, according to Fig. 2. By determining the position of the vehicle by means of signals from the road marking-detecting means 40 representing position data and then comparing with distance data from side sensor devices 20, 22, it is possible to determine, by continuously estimating the distance between at least one side section of vehicle 1 and topographic characteristics 30, 32 of the vehicle route proximate to said side section, the position of the vehicle 1 even if the road markings 14 are not visible to the road marking-detecting means 40.

In Fig. 4a, said topographic characteristics of the vehicle route proximate to said side section consist of road barriers 130, 132 on respective sides of the roadway. In Fig. 4b, said topographic characteristics of the vehicle route proximate to the one side section consist of a sloped section 230 that can consist of an upward incline from one side of the roadway or a ditch or the
equivalent, and of vegetation 232 in the form of trees proximate to the other opposite side section.

Fig. 5 schematically illustrates a block diagram of a method for determining the position of a vehicle relative to the roadway of the vehicle route according to an embodiment of the present invention.

According to one embodiment, the method for determining the position of a vehicle relative to the roadway of the vehicle route comprises a first step S1. In this step, distances between at least one side section of the vehicle and topographic characteristics of the vehicle route proximate to said side part are estimated continuously.

According to one embodiment, the method for determining the position of a vehicle relative to the roadway of the vehicle route comprises a second step S2. In this step the lateral position of the vehicle is determined based on distances so determined.

With reference to Fig. 6, a diagram is presented of an embodiment of an apparatus 500. The control unit 100 described with reference to Fig. 2 can, in an embodiment, comprise the apparatus 500. The apparatus 500 contains a non-volatile memory 520, a data-processing unit 510 and a read/write memory 550. The non-volatile memory 520 has a first memory section 530 in which a computer program, such as an operating system, is stored in order to control the function of the apparatus 500. The apparatus 500 further contains a bus controller, a serial communication port, I/O devices, an A/D converter, a time and date input and transfer unit, an event counter and a termination controller (not shown). The non-volatile memory 520 also has a second memory section 540.

A computer program P is provided that contains routines to enable determination of the position of a vehicle relative to the roadway of the vehicle route according to the inventive method. The program P contains routines for continuously estimating distances between at least one side
section of the vehicle and topographic characteristics 30, 32; 130, 132; 230, 232 of the vehicle route proximate to said side section. The program P contains routines for determining the lateral position of the vehicle based on distances so estimated. The program P can be stored in an executable form or in a compressed form in a memory 560 and/or in a read/write memory 550.

When it is stated that the data-processing unit 510 performs a given function, it is to be understood that the data-processing unit 510 executes 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 device 510 can communicate with a data port 599 via a data bus 515. The non-volatile memory 520 is intended to communicate with the data-processing unit 510 via a data bus 512. The separate memory 560 is intended to communicate with the data-processing unit 510 via a data bus 511. The read/write memory 550 is arranged to communicate with the data-processing unit 510 via a data bus 514. For example, the links associated with the control unit 100 can be connected to the data port 599.

When data are received at the data port 599, they are stored temporarily in the second memory section 540. Once received input data have been stored temporarily, the data-processing unit 510 is arranged so as to execute code in a manner as described above. The received signals at the data port 599 can be used by the apparatus 500 to continuously estimate distances between at least one side section of the vehicle and topographic characteristics 30, 32; 130, 132; 230, 232 of the vehicle route proximate to said side section. The received signals at the data port 599 can be used by the apparatus 500 to determine the lateral position of the vehicle based on distances so estimated.

Parts of the methods described herein can be carried out by the apparatus 500 with the help of the data-processing unit 510, which runs the program.
stored in the memory 560 or the read/write memory 550. When the apparatus 500 runs the program, the methods described herein are carried out.

The foregoing description of the preferred embodiments of the present invention has been provided for illustrative and descriptive purposes. It is not intended to be exhaustive, or to limit the invention to the variants described. Many modifications and variations will obviously be apparent to a person skilled in the art. The embodiments have been chosen and described in order to best explicate the principles of the invention and its practical applications, and to thereby enable a person skilled in the art to understand the invention in terms of its various embodiments and with the various modifications that are applicable to its intended use.
CLAIMS

1. A method for determining the position of a vehicle (1) relative to the roadway (10) of the vehicle route, characterized by the steps of:
   - continuously estimate (S1) distances between at least one side section of the vehicle and topographic characteristics (30, 32; 130, 132; 230, 232) of the vehicle route proximate to said side section; and
   - based on distances so estimated, determine (S2) the lateral position of the vehicle.

2. A method according to claim 1, wherein said topographic characteristics (30, 32) comprise objects, for example road barriers (130, 132), and/or side markings, roadway terminations, and/or vegetation (232), and/or existing sloped sections (23), and/or fence sections, in connection with the roadway.

3. A method according to claim 1, wherein the step of continuously estimating said distances is carried out by means of side sensor devices (20, 22; 110) on the vehicle (1), such as camera devices, radar devices and/or laser measuring devices.

4. A method according to any of claims 1-3, wherein said determination of the lateral position of the vehicle (1) comprises the step of determining the lateral position of the vehicle relative to said roadway (10).

5. A method according to claim 4, comprising the step of estimating, based on said known vehicle position relative to said roadway (10), distances to said topographic characteristics (30, 32; 130, 132; 230, 232) from the roadway.

6. A method according to claim 4 or 5, wherein the step of determining the lateral position of the vehicle relative to said roadway (10) comprises detecting road markings (12, 14) on said roadway (10).
7. A method according to any of claims 4-6, wherein the step of determining the lateral position of the vehicle (1) relative to said roadway (10) comprises confirming a desired lateral position of the vehicle relative to said roadway (10).

8. A method according to any of claims 4-7, wherein the step of determining the lateral position of the vehicle (1) relative to said roadway (10) comprises the utilization of predetermined characteristics of said roadway (10) and the position of the vehicle (1) along the vehicle route.

9. A system for determining the position of a vehicle (1) relative to the roadway of the vehicle route, characterized by means (20, 22; 100, 110) for continuously estimating distances between at least one side section of the vehicle (1) and topographic characteristics (30, 32; 130, 132; 230, 232) of the vehicle route proximate to said side section; and means (40; 110; 120) for determining the lateral position of the vehicle (1) based on distances so estimated.

10. A system according to claim 9, wherein said topographic characteristics (30, 32) comprise objects, such as road barriers (130, 132), and/or side markings, and/or roadway terminations, and/or vegetation (232), and/or existing sloped sections (23), and/or fence sections, in connection with the roadway.

11. A system according to claim 9 or 10, wherein said means for continuously estimating said distances comprise side sensor devices (20, 22; 110) on the vehicle, such as camera devices, radar devices and/or laser measuring devices.

12. A system according to any of claims 9-11, wherein said determination of the lateral position of the vehicle (1) comprises means (40; 100, 120) for determining the lateral position of the vehicle (1) relative to said roadway (10).
13. A system according to claim 12, comprising means (100) for estimating, based on said known vehicle position relative to said roadway (10), distances to said topographic characteristics (30, 32; 130, 132; 230, 232) from the roadway (10).

14. A system according to claims 12 or 13, wherein said means for determining the lateral position of the vehicle relative to said roadway comprise means (122) for detecting road markings on said roadway.

15. A system according to any of claims 12-14, wherein said means for determining the lateral position of the vehicle relative to said roadway comprise means (124) for confirming a desired lateral position of the vehicle (1) relative to said roadway (10).

16. A system according to any of claims 12-15, wherein said means for determining the lateral position of the vehicle relative to said roadway comprise means (126) for utilizing predetermined characteristics of said roadway and the position of the vehicle along the vehicle route.

17. A motor vehicle (1) containing a system according to any of claims 9-16.

18. A computer program (P) for determining the position of a vehicle relative to the roadway of the vehicle route, wherein said computer program (P) contains program code which, when it is run by an electronic control unit (100; 500) or another computer (500) connected to the electronic control unit (100; 500), enables the electronic control unit to perform the steps according to claims 1-9.

19. A computer program product comprising a digital storage medium that stores the computer program according to claim 18.
START

CONTINUOUSLY ESTIMATE THE DISTANCE BETWEEN AT LEAST ONE SIDE SECTION OF THE VEHICLE AND TOPOGRAPHIC CHARACTERISTICS OF THE VEHICLE ROUTE PROXIMATE TO SAID SIDE SECTION

S1

DETERMINE THE LATERAL POSITION OF THE VEHICLE BASED ON DISTANCES SO DETERMINED

S2

END

Fig. 5
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: B60W, B62D, G08G

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

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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<td>DE 10337845 A1 (BOSCH GMBH ROBERT), 31 March 2005 (2005-03-31); paragraphs [0003], [0015]-[0017], [0020]; figures 1, 2, 3; claim 1</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search 18-06-2013

Date of mailing of the international search report 19-06-2013

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Form PCT/ISA/210 (second sheet) (July 2009)
## DOCUMENTS CONSIDERED TO BE RELEVANT

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International Patent Classification (IPC)

B62D 75/02 (2006.01)
B60W30/12 (2006.01)
B60W 40/072 (2012.01)
G08G 7/76 (2006.01)
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