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US 20060092073 A1 **US 20050128136 A1**

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(54) Title of the Invention: **Method for operating at least one sensor of a vehicle and vehicle having at least one sensor**
Abstract Title: **Determining a restricted detection range of a sensor of a vehicle**

(57) A method for operating at least one sensor of a vehicle configured for detecting objects lying within a predetermined detection range comprises receiving position data 30 emitted by an object by means of a receiving apparatus of the vehicle to determine a position of the object 40 by means of the position data received. A comparison is made as to whether the determined position lies within the predetermined detection range of the sensor 50. If the determined position lies within the predetermined detection range of the at least one sensor it is determined whether the object is detected by the sensor 60. If the object is not detected by the sensor, an instantaneous detection range of the sensor is further determined 70 by means of the determined position of the object. A reduced detection range of the sensor due to rain, snow or mist for example may be determined.

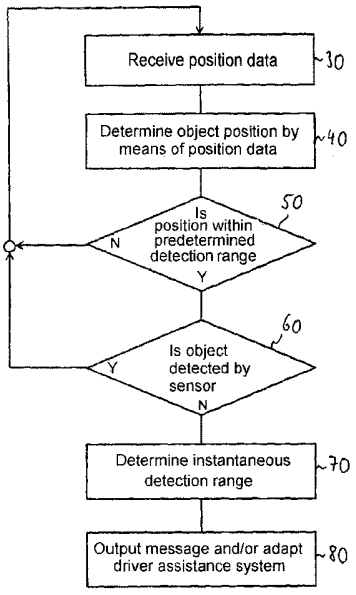


FIG 1

GB 2484794 A

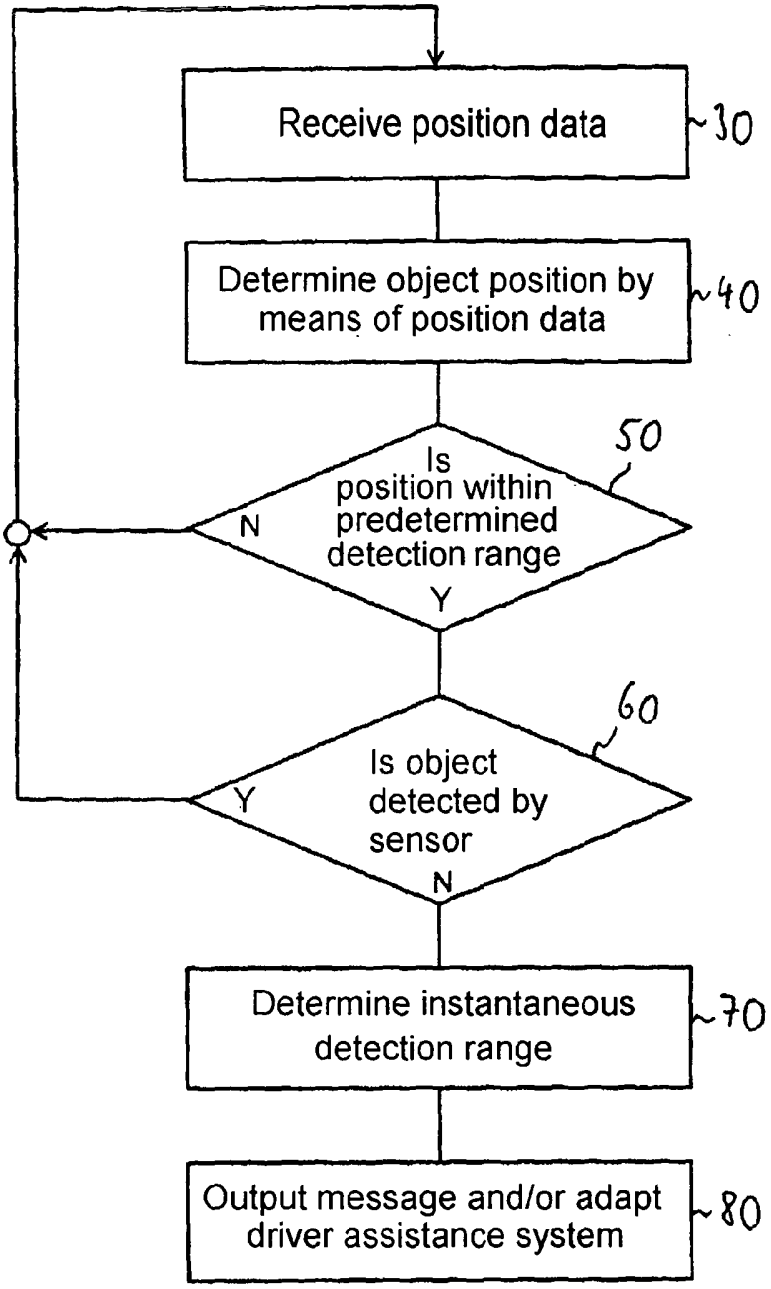

Receive position data
30
Determine object position by means of position data
40
Is position within predetermined detection range
50
N
Y
Is object detected by sensor
60
Y
N
Determine instantaneous detection range
70
Output message and/or adapt driver assistance system
80

FIG 1

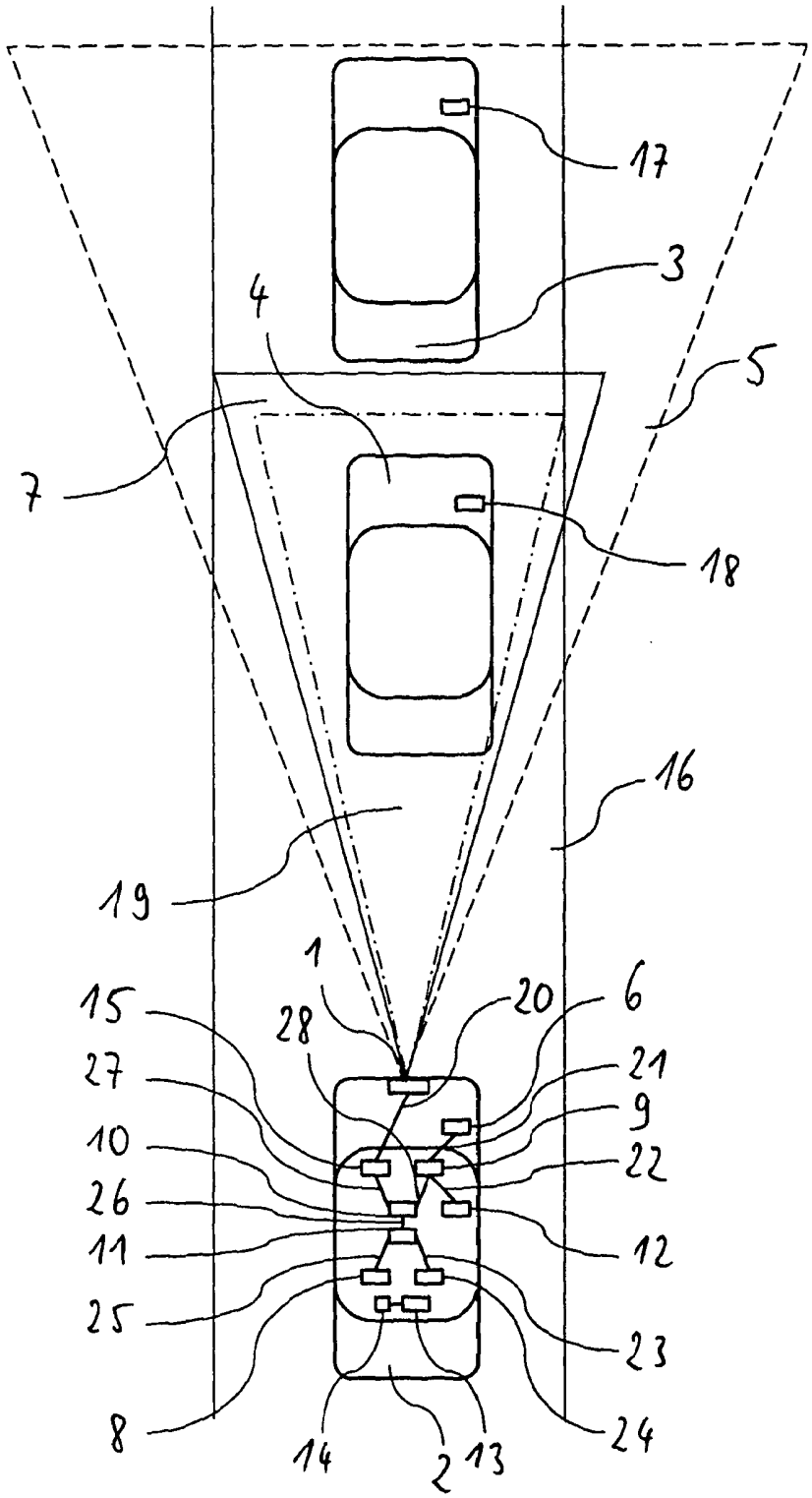


FIG 2

METHOD FOR OPERATING AT LEAST ONE SENSOR OF A VEHICLE AND VEHICLE HAVING AT LEAST ONE SENSOR

DESCRIPTION

The application relates to a method for operating at least one sensor of a vehicle, a vehicle having at least one sensor, a computer program product, and a computer-readable medium.

Known from EP 1 103 823 A2 is a method for adjusting a sensor of a vehicle to determine the distance and the direction of objects relative to the vehicle, in which the distance and directional angle of objects relative to the vehicle is detected continuously during the journey with the aid of the sensor, in which the objects are tracked in time and direction vectors are calculated, in which the relative position of the roadway with respect to the vehicle is determined from the direction vectors and from this the measured direction of travel is determined, in which the direction of travel of the vehicle is calculated continuously with the aid of a yaw-rate sensor and the vehicle speed, in which the difference between the directions of travel determined from the measured values of the sensor and the directions of travel determined by means of the yaw-rate sensor and the vehicle speed are calculated, and in which the angle misalignment of the sensor is calculated from the differences of the directions of travel. A sensor is provided for executing the method, whose adjusting means can be set automatically by drive means.

It is the object of the invention to provide a method for operating at least one sensor of a vehicle, a vehicle having at least one sensor, a computer program product, and a computer-readable medium, which can identify restricted functionality of the sensor.

This object is solved with the subject matter of the independent claims. Advantageous further developments are obtained from the dependent claims.

According to one aspect of the application, a method for operating at least one sensor of a vehicle, where the at least one sensor is configured for detecting objects lying

within a predetermined detection range comprises the following steps. Position data emitted by at least one object is received by means of a receiving apparatus of the vehicle. In addition, a position of the at least one object is determined by means of the position data received from the at least one object and a comparison is made as to whether the determined position lies within the predetermined detection range of the at least one sensor. If the determined position lies within the predetermined detection range of the at least one sensor, it is further determined whether the at least one object is detected by the at least one sensor. If the at least one object is not detected by the at least one sensor, an instantaneous detection range of the at least one sensor is further determined by means of the determined position of the at least one object.

The method for operating the at least one sensor of the vehicle according to the application whereby the position of the at least one object is determined by means of the received position data and if the determined position lies within the predetermined detection range of the at least one sensor, it is determined whether the object is detected by the sensor and, if the object is not detected by the sensor, an instantaneous detection range of the at least one sensor is determined by means of the determined position of the at least one object, enables a restricted functionality of the at least one sensor to be identified. This is advantageously accomplished by means of components already provided in the vehicle, in particular by means of data of the receiving apparatus.

The method according to the application further has the advantage that in addition to identifying the restricted functionality of the at least one sensor or identifying a restricted range of the sensor, an instantaneous detection range, i.e. a value corresponding to the reduced range of the at least one sensor as accurately as possible, is additionally determined. Consequently, the degree of restriction of the functionality of the at least one sensor can additionally be determined.

The application starts from the consideration that the position of the at least one object can be determined both by means of the data determined by the at least one sensor and also by means of the position data received from the at least one object and therefore there is some redundancy. The present application utilizes this redundancy in an advantageous manner.

The at least one sensor is preferably configured as an acoustic sensor, in particular as an ultrasound sensor, or as an electromagnetic sensor, in particular a run-time-based

sensor, for example as a radar sensor or as a lidar sensor, or as an optical sensor, for example as an optical camera. The said sensors, which are also designated as environment sensors, are increasingly provided for vehicles. Depending on the physical principle for detecting objects, these sensors can be subject to limitations or have detection problems in cases of heavy precipitation, hail, snow, or mist, i.e. particles in the air between sensor and object, and when the sensor surface is contaminated or covered, since the emitted energy is already reflected by the dirt or the precipitation particles. In particular with lidar sensors, the functionality can be significantly restricted in the said cases. The identification of a restricted functionality is therefore particularly highly advantageous for the said types of sensors.

In a further embodiment of the method, a message is additionally output inside the vehicle if the at least one object is not detected by the at least one sensor. The vehicle occupants, in particular the vehicle driver, can thereby advantageously have their attention drawn to the restricted range or functionality of the at least one sensor and thereby warned and optionally carry out measures to restore the full functionality of the sensor, for example if this is contaminated or covered. The message can therefore include a warning and/or a request for cleaning the at least one sensor.

In a further advantageous embodiment of the method, the determined instantaneous detection range is transmitted to at least one driver assistance system of the vehicle. The at least one driver assistance system is preferably selected from the group consisting of an adaptive speed regulating system, an emergency braking system, and a navigation system. At the same time, preferably at least one parameter of the at least one driver assistance system is adapted to the determined instantaneous detection range. For example, a desired speed of the adaptive speed regulating system, which is also designated as ACC (Adaptive Cruise Control), is reduced or an automatic emergency braking of the vehicle by means of the emergency braking system is introduced earlier. The said embodiments therefore advantageously enable driver assistance systems, in particular systems for the active safety of the vehicle, to be increasingly adapted to the instantaneous conditions and thereby further improved.

The position of the at least one object can be a position relative to the vehicle. This has the advantage that a relative position to the vehicle can be determined in a particularly simple manner by means of data determined by the at least one sensor.

In a further embodiment of the method, the determination of the position of the at least one object by means of the position data received from the at least one object includes a determination of a distance of the at least one object from the vehicle. The instantaneous detection range of the at least one sensor can be determined in such a manner that the determined distance of the at least one object from the vehicle forms an upper limit of the instantaneous detection range. An instantaneous range of the at least one sensor determined in such a manner advantageously agrees to the highest possible extent with the actual reduced range of the sensor.

The receiving apparatus is preferably part of a vehicle-to-vehicle communication apparatus and/or a vehicle-to-infrastructure communication apparatus of the vehicle. Corresponding communication apparatus are increasingly provided for vehicles, whereby the receiving apparatus can advantageously be integrated in these communication apparatuses.

In a preferred embodiment, the position data emitted by the at least one object is additionally provided with information about the time of its determination. As a result, a temporal synchronization of the position data with data of the at least one sensor can be accomplished.

Furthermore, the position data emitted by the at least one object can additionally be provided with information about the dimensions of the at least one object. As a result, the position of the at least one object can be determined very precisely by means of the position data received from the at least one object.

In a further embodiment of the method, a speed of the at least one object is additionally determined by means of position data received from the at least one object. As a result, relevant objects, for example, another vehicle driving in front of the vehicle, can be distinguished in a particularly simple manner from irrelevant objects in the surroundings of the vehicle.

If position data are received from a plurality of objects within the predetermined detection range and respectively one position of the plurality of objects is determined, it is preferably determined whether the plurality of objects are each detected by the at least one sensor. If at least two of the plurality of objects are not detected by the at least one sensor, the instantaneous detection range of the at least one sensor is

thereby determined by means of the determined position of that non-detected object which has the shortest distance from the vehicle.

The application further relates to a vehicle comprising at least one sensor, where the at least one sensor is configured for detecting objects within a predetermined detection range. The vehicle additionally comprises a receiving apparatus configured for receiving position data emitted by at least one object and a position determining apparatus configured for determining a position of the at least one object by means of the position data received from the at least one object. The vehicle further comprises a first determination apparatus configured to determine whether the at least one object is detected by the at least one sensor if the determined position lies within the predetermined detection range of the at least one sensor. Furthermore, the vehicle comprises a second determination apparatus configured to determine an instantaneous detection range of the at least one sensor by means of the determined position of the at least one object if the at least one object is not detected by the at least one sensor.

The application further relates to a computer program product that, when it is implemented on a processing unit of a vehicle, instructs the processing unit to execute the following steps. The processing unit is instructed to receive position data emitted by at least one object by means of a receiving apparatus of the vehicle. The processing unit is further instructed to determine a position of the at least one object by means of the position data received from the at least one object and compare whether the determined position lies within the predetermined detection range of the at least one sensor. If the determined position lies within the predetermined detection range of the at least one sensor, the processing unit is instructed to determine whether the at least one object is detected by the at least one sensor. Furthermore, if the at least one object is not detected by the at least one sensor, the processing unit is instructed to determine an instantaneous detection range of the at least one sensor by means of the determined position of the at least one object.

The application further relates to a computer-readable medium on which a computer program product according to the said embodiment is stored.

The vehicle, the computer program product, and the computer-readable medium according to the application exhibit the advantages already specified in connection with the method according to the application, which will not be listed again at this point to avoid repetitions.

The vehicle in the aforesaid embodiments is preferably a motor vehicle, in particular an automobile or a truck.

The subject matter of the application is now explained in detail with reference to the appended figures.

Figure 1 shows a flow diagram of a method for operating at least one sensor of a vehicle according to one embodiment of the application;

Figure 2 shows a vehicle having a sensor according to one embodiment of the application.

Figure 1 shows a flow diagram of a method for operating at least one sensor of a vehicle, where the at least one sensor is configured for detecting objects within a predetermined detection range, according to one embodiment of the application.

The at least one sensor is typically configured as an acoustic sensor, in particular as an ultrasound sensor, or as an electromagnetic sensor, in particular a run-time-based sensor, for example as a radar sensor or as a lidar sensor, or as an optical sensor, for example as an optical camera. The vehicle is preferably a motor vehicle, in particular an automobile.

In the embodiment shown, in a step 30 position data emitted by at least one object is received by means of a receiving apparatus of the vehicle, where the receiving apparatus is preferably part of a vehicle-to-vehicle communication apparatus and/or a vehicle-to-infrastructure communication apparatus of the vehicle.

In a step 40, a position of the at least one object is determined by means of position data received from the at least one object.

Furthermore, in a step 50 a comparison is made to determine whether the determined position lies within the predetermined detection range of the at least one sensor.

If the determined position does not lie within the predetermined detection range of the at least one sensor, steps 30 and optionally 40 are executed repeatedly.

If the determined position lies within the predetermined detection range of the at least one sensor, it is determined in a step 60 whether the at least one object is detected by the at least one sensor.

If the at least one object is detected by the at least one sensor, step 30 and optionally steps 40 and 50 are executed repeatedly. In addition, a confidence level for measurement data of the at least one sensor can optionally be increased in one or more driver assistance systems of the vehicle.

If the at least one object is not detected by the at least one sensor, in a step 70 an instantaneous detection range of the at least one sensor is determined by means of the determined position of the at least one object.

In the embodiment shown in a step 80 a message is additionally output inside the vehicle if the at least one object is not detected by the at least one sensor. The message can be an acoustic and/or an optical message.

It is also possible for a message to be output inside the vehicle if the determined instantaneous detection range of the at least one sensor lies below a predetermined threshold value where the threshold value can in particular be selected with reference to the predetermined detection range.

Additionally or alternatively in step 80, the determined instantaneous detection range is transmitted to at least one driver assistance system of the vehicle, for example, an adaptive speed regulating system, an emergency braking system. and/or a navigation system. At least one parameter of the at least one driver assistance system is adapted to the determined instantaneous detection range.

Furthermore, the position data emitted by the at least one object can be provided with information about the time of its determined, i.e. with a time stamp, for example, with a time stamp of a CAN bus system.

In the event of objects, in particular vehicles, not being identified by the at least one sensor from a determined distance, the embodiment shown thus enables a range of the sensor reduced to this distance, for example, due to precipitation, to be concluded. Vehicle occupants, in particular the vehicle driver, can thereby have their attention drawn to a restricted range of the sensor and thereby warned accordingly and driver

assistance systems can be adapted thereto, for example, by reducing the desired speed of the adaptive speed regulating system.

In the event of a general non-identification of objects, i.e. if no object for which position data are available, is detected by the sensor 1, in an extended embodiment contamination or covering of the sensor can additionally be concluded and the attention of the occupants of the vehicle 2, in particular the driver, can be drawn to this and for example, be requested to clean the sensor 1.

Figure 2 shows a vehicle 2 with a sensor 1 according to one embodiment of the application. In the embodiment shown, the vehicle 2 is a motor vehicle in the form of an automobile.

The sensor 1 is configured to detect objects within a predetermined detection range 5, depicted schematically by means of a dashed line. For example, the sensor 1 is a radar sensor or a lidar sensor.

The vehicle 2 is located on a roadway 16 which, in the embodiment shown, is single-track in the direction of travel of the vehicle 2. In front of the vehicle 2 two object 3 and 4 in the form of other automobiles are located on the roadway 16 within the predetermined detection range 5 of the sensor 1.

The vehicle 2 has a receiving apparatus 6 which is in particular configured to receive position data emitted by the transmitting apparatus 17 of the object 3 and by a transmitting apparatus 18 of the object 4. The receiving apparatus 6 is part of a vehicle-to-vehicle or of a vehicle-to-infrastructure communication apparatus of the vehicle 2 and the transmitting apparatuses 17 and 18 are part of a vehicle-to-vehicle or of a vehicle-to-infrastructure communication apparatus of the other vehicles, i.e. the objects 3 or 4.

In addition, the vehicle 2 has position determining apparatus 9 which is configured for determining the position in particular of the objects 3 and 4 by means of the position data received from these objects. For this purpose, the position determining apparatus 9 is connected to the receiving apparatus via a connecting line 21.

In the embodiment shown, the position determining apparatus 9 is configured for determining the position of the objects 3 and 4 by means of the received position data

and by means of a position of the vehicle 2 determined by a position determining apparatus 12 of the vehicle 2. For this purpose the position determining apparatus 12 is connected to the position determining apparatus 9 via a connecting line 22 and is typically part of a navigation system of the vehicle 2.

The vehicle 2 furthermore has a position determining apparatus 15 which is configured to determine a position of at least one object detected by the sensor 1 by means of data from the sensor 1. For this purpose, the position determining apparatus 15 is connected to the sensor 1 via a signal line 20.

In addition, the vehicle 2 has a first determination apparatus 10. The first determination apparatus 10 is configured to determine whether those objects from which position data have been received by means of the receiving apparatus 6 and their determined position lie within the predetermined detection range 5 of the sensor 1, are detected by the sensor 1. To this end, the first determination apparatus 10 is connected to the position determining apparatus 9 via a connecting line 28 and to the position determining apparatus 15 via a connecting line 27.

The first determination apparatus 10 is further connected to a second determination apparatus 11 of the vehicle 2 via a connecting line 26, where the second determination apparatus 11 is configured to determine an instantaneous detection range 7 of the sensor 1 by means of a determined position of at least one object not detected by the sensor 1, whose determined position lies within the predetermined detection range 5.

In the embodiment shown, an actual detection range 19 of the sensor 1, depicted schematically by means of a dot-dash line, is reduced compared with the predetermined detection range 5, for example, by heavy precipitation in the form of rain, snow or hail and/or mist. The object 3 is therefore located outside the actual detection range 19 and is consequently not detected by the sensor 1. In the embodiment shown, the object 4 is located inside the actual detection range 19 and is therefore detected by the sensor 1.

Accordingly, in the embodiment shown, the first determination apparatus 10 determines that the object 3 is not determined by the sensor 1 although it is located within the predetermined detection range 5. The second determination apparatus 11 determines an instantaneous detection range 7 of the sensor 1 depicted schematically by a continuous line, by means of the determined position of the object 3. In this case, the

instantaneous detection range 7 of the at least one sensor 1 is determined in such a manner that a determined distance of the object 3 from the vehicle 2 forms an upper limit of the instantaneous detection range 7.

In an alternative embodiment the second determination apparatus 11 determines the instantaneous detection range 7 of the sensor 1 by means of the determined position of the object 4, i.e. that determined object having the greatest distance from the vehicle 2. At the same time, the determined distance 4 from the vehicle 2 forms the lower limit of the instantaneous detection range 7.

In addition, in the embodiment shown, the second determination apparatus 11 transmits the determined instantaneous detection range 7 to at least one driver assistance system 8 of the vehicle 2, for example, to an adaptive speed regulating system, an emergency braking system and/or a navigation system. The driver assistance system 8 is thereby configured to adapt at least one parameter to the determined instantaneous detection range 7.

Furthermore, in the embodiment shown the vehicle 2 has an output apparatus 24 configured for outputting a message inside the vehicle 2 if at least one object, whose determined position lies within the predetermined detection range 5 is not detected by the sensor 1. The output apparatus 24 is preferably configured as an acoustic and/or an optical output apparatus and can, for example, be part of a combi-instrument and/or an information and entertainment system of the vehicle 2.

The second determination apparatus 11 is thereby connected to the driver assistance system 8 via a connecting line 25 and to the output apparatus 24 via a connecting line 23.

In the event of a general non-identification of objects, i.e. if no object for which position data are available, is detected by the sensor 1, contamination or covering of the sensor can further be concluded and the attention of the occupants of the vehicle 2, in particular the driver, can be drawn to this and for example, be requested to clean the sensor 1.

Furthermore, in the embodiment shown the vehicle 2 has a processing unit 13 and a computer-readable medium 14, where a computer program product is stored on the computer-readable medium 14, which when executed on the processing unit 13,

instructs the processing unit to perform the said steps of the method according to the application, in particular the embodiment shown in Figure 1, by means of the said elements. To this end, the processing unit 13 is connected directly or indirectly to the said components in a manner not shown in detail.

The embodiment shown starts from the consideration that systems for the active safety of vehicles are in particular based on so-called environment sensors such as, for example, radar sensors, lidar sensors, and/or optical cameras which measure the surroundings relative to the vehicle, e.g. in the form of distances and angles.

By means of systems having so-called vehicle-to-vehicle communication, also known as V2V communication ("vehicle to vehicle" communication) or vehicle-to-infrastructure communication, also known as V2R communication ("vehicle to roadside" communication), the relative position of two vehicles to one another or the relative position of one vehicle to an object of the traffic infrastructure can also be determined. If a vehicle is fitted with V2V and with environment sensors, the relative position to a preceding vehicle, also fitted with V2V is therefore determined both via V2V and by environment sensor and there is a redundancy. The said embodiment advantageously uses this redundancy.

The embodiment shown therefore enables an identification of a restricted range of an environment sensor and contamination of a defect of the sensor by using additional V2V equipment and consequently a use of technology provided in the vehicle to avoid sensor errors in active safety systems.

Although at least one exemplary embodiment has been shown in the preceding description, various amendments and modifications can be made. The said embodiments are merely examples and are not intended to restrict the range of validity, the applicability, or the configuration in any way. On the contrary the preceding description provides the person skilled in the art with a plan for implementing at least one exemplary embodiment, where numerous amendments can be made in the function and the arrangement of elements described in an exemplary embodiment without departing from the scope of protection of the appended claims and their legal equivalent.

Reference list

1	Sensor
2	Vehicle
3	Object
4	Object
5	Predetermined detection range
6	Receiving apparatus
7	Instantaneous detection range
8	Driver assistance system
9	Position determining apparatus
10	Determination apparatus
11	Determination apparatus
12	Position determining apparatus
13	Processing unit
14	Medium
15	Position determining apparatus
16	Roadway
17	Transmitting apparatus
18	Transmitting apparatus
19	Actual detection range
20	Signal line
21	Connecting line
22	Connecting line
23	Connecting line
24	Output line
25	Connecting line
26	Connecting line
27	Connecting line
28	Connecting line
30	Step
40	Step
50	Step
60	Step
70	Step
80	Step

PATENT CLAIMS

1. A method for operating at least one sensor (1) of a vehicle (2), wherein the at least one sensor (1) is configured for detecting objects (3, 4) within a predetermined detection range (5) and wherein the method comprises the following steps:

- receiving position data emitted by at least one object (3, 4) by means of a receiving apparatus (6) of the vehicle (2),
- determining a position of the at least one object (3, 4) by means of the position data received from the at least one object (3, 4) and determining whether the determined position lies within the predetermined detection range (5) of the at least one sensor (1),
- if the determined position lies within the predetermined detection range (5) of the at least one sensor (1), determining whether the at least one object (3, 4) is detected by the at least one sensor (1),
- if the at least one object (3) is not detected by the at least one sensor (1), determining an instantaneous detection range (7) of the at least one sensor (1) by means of the determined position of the at least one object (3).

2. The method according to claim 1, wherein the at least one sensor (1) is configured as an acoustic sensor or electromagnetic sensor.

3. The method according to claim 1 or claim 2, wherein a message is additionally output inside the vehicle (2) if the at least one object (3) is not detected by the at least one sensor (1).

4. The method according to any one of the preceding claims, wherein the determined instantaneous detection range (7) is transmitted to at least one driver assistance system (8) of the vehicle (2).

5. The method according to claim 4, wherein the at least one driver assistance system (8) is selected from the group consisting of an adaptive speed regulating system, an emergency braking system, and a navigation system.

6. The method according to claim 4 or claim 5, wherein at least one parameter of the at least one driver assistance system (8) is adapted to the determined instantaneous detection range (7).

7. The method according to any one of the preceding claims, wherein the position of the at least one object (3, 4) is a position relative to the vehicle (2).

8. The method according to any one of the preceding claims, wherein the determination of the position of the at least one object (3, 4) by means of the position data received from the at least one object (3, 4) includes a determination of a distance of the at least one object (3, 4) from the vehicle (2).

9. The method according to claim 8, wherein the instantaneous detection range (7) of the at least one sensor (1) is determined in such a manner that the determined distance of the at least one object (3) from the vehicle (2) forms an upper limit of the instantaneous detection range (7).

10. The method according to any one of the preceding claims, wherein the receiving apparatus (9) is part of a vehicle-to-vehicle communication apparatus and/or a vehicle-to-infrastructure communication apparatus of the vehicle (2).

11. The method according to any one of the preceding claims, wherein the position data emitted by the at least one object (3, 4) is additionally provided with information about the time of its determination.

12. The method according to any one of the preceding claims, wherein if position data from a plurality of objects (3, 4) is received within the predetermined detection range (5) and respectively one position of the plurality of objects is determined, it is determined whether the plurality of objects (3, 4) are each detected by the at least one sensor (1) and wherein, if at least two of the plurality of objects (3, 4) are not detected by a sensor (1), the instantaneous detection range (7) of the at least one sensor (1) is determined by means of the determined position of that non-detected object that has the shortest distance from the vehicle (2).

13. A vehicle comprising

- at least one sensor (1), wherein the at least one sensor (1) is configured for detecting objects (3, 4) within a predetermined detection range (5),
- a receiving apparatus (6) configured for receiving position data emitted by at least one object (3, 4),
- a position determining apparatus (9) configured for determining a position of the at least one object (3, 4) by means of the position data received from the at least one object (3, 4),
- a first determination apparatus (10) configured to determine whether the at least one object (3, 4) is detected by the at least one sensor (1) if the determined position lies within the predetermined detection range (5) of the at least one sensor (1),
- a second determination apparatus (11) configured to determine an instantaneous detection range (7) of the at least one sensor (1) by means of the determined position of the at least one object (3) if the at least one object (3) is not detected by the at least one sensor (1).

14. A computer program product that, when it is implemented on a processing unit (13) of a vehicle (2), instructs the processing unit (13) to execute the following steps:

- receive position data emitted by at least one object (3, 4) by means of a receiving apparatus (6) of the vehicle (2),
- determine a position of the at least one object (3, 4) by means of the position data received from the at least one object (3, 4) and compare whether the determined position lies within the predetermined detection range (5) of the at least one sensor (1),
- if the determined position lies within the predetermined detection range (5) of the at least one sensor (1), determine whether the at least one object (3, 4) is detected by the at least one sensor (1),
- if the at least one object (3) is not detected by the at least one sensor (1), determine an instantaneous detection range (7) of the at least one sensor (1) by means of the determined position of the at least one object (3).

15. A computer-readable medium on which a computer program product according to claim 14 is stored.

Application No:	GB1117237.6	**Examiner:**	Simon Colcombe
Claims searched:	1-15	**Date of search:**	23 January 2012

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1, 13, 14 at least	US2005/128136 A1 (WITTENBERG) EPO & WPI abstracts; Drawings and related description; paragraphs 5, 6, 15, 16, in particular
A	-	US2006/092073 A1 (BOECKER)

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

G01S

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC

International Classification:

Subclass	Subgroup	Valid From
G01S	0007/40	01/01/2006
G01S	0007/497	01/01/2006
G01S	0007/52	01/01/2006