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Method for operating a driver assistance system of a motor vehicle with extended learning mode, driver assistance system as well as motor vehicle

The present invention relates to a method for operating a driver assistance system of a motor vehicle, in which in a learning mode of the driver assistance system, during which the motor vehicle is manually maneuvered by a driver along a trajectory from a start position to a target position, the trajectory is recorded as well as objects in the environment of the motor vehicle are captured by at least one sensor of the driver assistance system, and in an operating mode of the driver assistance system, the motor vehicle is at least semi-autonomously maneuvered from the start position to the target position depending on the recorded trajectory and the captured objects. Moreover, the present invention relates to a driver assistance system for a motor vehicle. Finally, the present invention relates to a motor vehicle.

From the prior art, driver assistance systems are known, by which the motor vehicle can be maneuvered from a start position to a target position along a previously stored trajectory. For storing the trajectory, the driver assistance system can first be operated in a learning mode. In the learning mode, the motor vehicle is manually maneuvered by a driver of the motor vehicle. The trajectory, which the motor vehicle travels during manually maneuvering, is stored by the driver assistance system. In a later operating mode, the motor vehicle can then be semi-autonomously or autonomously maneuvered along the stored trajectory. For example, the motor vehicle can be maneuvered along the stored trajectory if it is recognized that the motor vehicle has reached the start position of the trajectory. In this manner, the driver of the motor vehicle can for example be assisted in parking maneuvers in a home zone. Herein, the driver can for example be assisted in daily parking the motor vehicle into a garage of his house or into a parking space at his place of employment.

Hereto, DE 10 2010 023 162 A1 describes a method for assisting a driver of a motor vehicle in parking into a parking spot, in particular into a garage. Therein, in a learning mode of a driver assistance device, reference data about an environmental region of the parking spot is captured with the aid of a sensor device and stored, while the motor vehicle is parked into the parking sport controlled by the driver. Moreover, a reference target position, which is reached by the motor vehicle in the learning mode, is captured. In a following operating mode of the driver assistance device, sensor data is captured by the sensor device and compared to the reference data, wherein the environmental region of

the parking spot is recognized based on the captured sensor data depending on this comparison and hereby the current position of the motor vehicle relative to the reference target position is determined. Depending on the current position of the motor vehicle relative to the reference target position, a parking path is set by the driver assistance device, along which the motor vehicle is parked.

It is the object of the present invention to demonstrate a solution, how a driver assistance system for a motor vehicle can be more reliably and efficiently operated in a learning phase, during which a trajectory and objects in the environment are captured.

According to the invention, this object is solved by a method, by a driver assistance system as well as by a motor vehicle having the features according to the respective independent claims. Advantageous developments of the present invention are the subject matter of the dependent claims.

According to an embodiment of a method for operating a driver assistance system of a motor vehicle, in a learning mode of the driver assistance system, during which the motor vehicle is preferably manually maneuvered by a driver along a trajectory from a start position to a target position, the trajectory is recorded and objects in the environment of the motor vehicle are captured by at least one sensor of the driver assistance system. In an operating mode of the driver assistance system, the motor vehicle is preferably at least semi-autonomously maneuvered from the start position to the target position depending on the recorded trajectory and the captured objects. Furthermore, it is preferably provided that the driver assistance system is additionally operated in the learning mode during travel of the motor vehicle from the target position to the start position and herein the objects in the environment are captured.

A method according to the invention serves for operating a driver assistance system of a motor vehicle. Therein, in a learning mode of the driver assistance system, during which the motor vehicle is manually maneuvered by a driver along a trajectory from a start position to a target position, the trajectory is recorded and objects in the environment of the motor vehicle are captured by at least one sensor of the driver assistance system. Furthermore, the motor vehicle is at least semi-autonomously maneuvered from the start position to the target position depending on the recorded trajectory and the captured objects in an operating mode of the driver assistance system. Moreover, the driver assistance system is additionally operated in the learning mode during travel of the motor

vehicle from the target position to the start position and herein the objects in the environment are captured.

With the aid of the method, the motor vehicle is to be maneuvered from the start position to the target position. For example, the motor vehicle can be maneuvered along the previously recorded trajectory. This is for example suitable for short distances, which are often traveled by the motor vehicle. For example, the method can be used to park the motor vehicle into a garage or a parking space of the driver. The method can also be used to park the motor vehicle in a parking space at the place of employment of the driver. Therein, it is provided that the driver first presets the trajectory in the learning mode, along which the motor vehicle is to be at least semi-autonomously maneuvered at a later time in the operating mode. In the learning mode, the motor vehicle is in particular manually operated by the driver. In addition, the trajectory is recorded with the aid of the driver assistance system in the learning mode. Hereto, the set steering angle and/or the revolutions of at least one wheel of the motor vehicle can for example be continuously recorded. It can also be provided that the position of the motor vehicle is continuously determined with the aid of a satellite-based positioning system.

Moreover, objects in the environment of the motor vehicle are recognized or captured in the learning mode. Therein, the objects are captured with the aid of a sensor of the driver assistance system. The sensor can for example be an ultrasonic sensor, a radar sensor, a lidar sensor, a laser scanner or the like. Preferably, the at least one sensor is a camera. Therein, it is in particular provided that the relative location between the motor vehicle and the respective objects is additionally determined during travel from the start position to the target position. These objects and the position thereof can then be correspondingly stored.

In the following operating mode, the motor vehicle is maneuvered from the start position to the target position with the aid of the driver assistance system. Here, the motor vehicle can be semi-autonomously maneuvered by means of the driver assistance system. Therein, the driver assistance system intervenes in the steering and the driver of the motor vehicle further actuates the accelerator and the brake pedal. Preferably, the motor vehicle is fully autonomously maneuvered along the trajectory. In this case, the driver assistance system also takes over the intervention in a drive engine and a brake system of the motor vehicle. During the at least semi-autonomous maneuvering of the motor vehicle, the objects in the environment of the motor vehicle are captured by the at least one sensor. Therein, a comparison can in particular be effected if the captured objects

correspond to the objects, which have been stored in the learning phase. Thereby, the objects stored in the learning phase can be used as landmarks to maneuver the motor vehicle in the operating phase.

According to an essential aspect of the present invention, it is now provided that the driver assistance system is also additionally activated during travel of the motor vehicle from the target position to the start position. With the aid of the driver assistance system, it can for example be recognized that the motor vehicle is in the target position and is maneuvered towards the start position from there. Hereto, a motion sensor of the motor vehicle and/or data of a satellite-based positioning system can be used. Therein, it can be provided that the motor vehicle is manually maneuvered by the driver from the target position to the start position. It can also be provided that the motor vehicle is at least semi-autonomously maneuvered from the target position to the start position with the aid of the driver assistance system. During the travel from the target position to the start position, the objects in the environment of the motor vehicle are also captured. Thus, the driver assistance system is trained not only during travel from the start position to the target position, but also during travel from the target position to the start position. This for example allows that the learning of the trajectory, which the driver assistance system is to track in the operating mode, can be faster performed. Moreover, it is allowed that the environment of the motor vehicle is also captured during the travel from the target position to the start position. Thus, the objects can for example be captured from another viewing angle or capturing range, whereby further details of the objects can be determined. This overall allows more efficient and more reliable operation of the driver assistance system during the learning phase.

Preferably, the driver assistance system is operated in the learning mode for a predetermined number of travels from the start position to the target position and/or from the target position to the start position. Thus, it is preferably provided that the motor vehicle is maneuvered from the start position to the target position as well as in opposite direction multiple times to record the trajectory and/or capture the objects in the environment of the motor vehicle. For example, it can be provided that the motor vehicle is in total ten times moved between the start position and the target position. In that the learning mode is now additionally also activated during the travel from the target position to the start position, compared to known methods, in which the learning mode is only activated during the travel from the start position to the target position, the number of the travels from the start position to the target position can be halved.

Furthermore, it is advantageous if a digital environmental map is determined based on the captured objects, which describes respective positions of the captured objects in a maneuvering area associated with the trajectory. As already explained, the driver assistance system can include one or more sensors, by which the objects can be captured. Based on the sensor data, which is provided by these sensors, the relative location between the motor vehicle and the respective objects can further be continuously determined. Moreover, based on the sensor data, the spatial dimensions of the objects can be determined. This information can then be used to determine a digital environmental map of the maneuvering area. This maneuvering area describes the area or the region, which surrounds the trajectory. This digital environmental map can be updated in the temporally consecutive travels, in which the learning mode is active. Thus, the motor vehicle can be reliably maneuvered based on the digital environmental map and collisions with the objects can for example be avoided.

Therein, it is in particular provided that the motor vehicle is at least semi-autonomously maneuvered in the maneuvering area by means of the driver assistance system in the operating mode based on the digital environmental map. The objects, which are stored in the digital environmental map, can be used as landmarks in the operating mode. In the operating mode, the objects in the environment of the motor vehicle can be captured by the sensor and compared to the objects, which are stored in the digital environmental map. This allows maneuvering the motor vehicle in reliable manner in the maneuvering area based on the digital environmental map. Therein, it is in particular provided that the motor vehicle is fully autonomously maneuvered with the aid of the driver assistance system.

According to a further configuration, the objects in front of the motor vehicle in direction of travel, laterally next to the motor vehicle and/or behind the motor vehicle in direction of travel are captured in the operating mode. The driver assistance system can comprise multiple sensors. Preferably, these sensors are disposed distributed at the motor vehicle. For example, a sensor can be provided, which is disposed in a front area of the motor vehicle and which can capture an environmental region in front of the motor vehicle in direction of travel. Moreover, a further sensor can be disposed in a rear area of the motor vehicle, by which an environmental region behind the motor vehicle in direction of travel can be captured. Furthermore, respective sensors can be disposed in the lateral areas of the motor vehicle, by which the environmental regions lateral to the motor vehicle can then be captured. The sensors can in particular be cameras, by which image sequences

of the respective environmental regions can be provided. With the aid of a corresponding image recognition algorithm, the objects in the environment of the motor vehicle can then be recognized and optionally be classified. It can also be provided that the driver assistance system comprises further sensors, such as for example ultrasonic sensors, radar sensors, lidar sensors or laser scanners. The objects can be additionally captured by these sensors. It can also be provided that a corresponding fusion of the sensor data of the different sensors is performed to recognize the objects in the environment.

In a further configuration, the objects are captured by the at least one sensor in front of the motor vehicle in direction of travel and/or laterally next to the motor vehicle during travel from the start position to the target position. Furthermore, it is preferably provided that the objects are captured by the at least one sensor behind the motor vehicle in direction of travel and/or laterally next to the motor vehicle during travel from the target position to the start position. During the travel from the start position to the target position, the area in front of the motor vehicle in direction of travel and laterally next to the motor vehicle can be continuously captured. Upon travel in the opposite direction, the sensors can be activated, by which the area behind the motor vehicle and laterally next to the motor vehicle can be captured. Thus, the objects can respectively be captured based on the side, which is relevant to the travel from the start position to the target position in the operating mode of the driver assistance system. Thus, reliable maneuvering of the motor vehicle from the start position to the target position can be allowed in the operating mode.

Basically, it can also be provided that the same environmental region of the motor vehicle is captured both during the travel from the start position to the target position and during the travel from the target position to the start position. Thus, objects can for example be captured from a first side upon travel from the start position to the target position and can be captured from a second side opposing the first side upon travel from the target position to the start position. Thus, it can be prevented in reliable manner that blind areas, in which objects are not captured by the sensors, arise. These blind areas can for example arise in that an area is shadowed for the sensor by an object.

Furthermore, it is advantageous if the motor vehicle is maneuvered along the recorded trajectory in the operating mode. In the learning mode, the trajectory can be recorded with the aid of motion sensors of the motor vehicle. In the following operating mode of the driver assistance system, the motor vehicle can be maneuvered along this trajectory.

Therein, it can also be provided that it is continuously examined if objects or obstacles are in the environment of the motor vehicle and if a collision between the motor vehicle and one of these objects impends during the operating mode. Therein, it can further be examined if the motor vehicle can avoid the object if a collision between the motor vehicle and the object impends. In this case, it can be departed from the trajectory in certain areas in maneuvering the motor vehicle. This allows reliably maneuvering the motor vehicle during the operating mode.

A driver assistance system according to the invention for a motor vehicle is adapted for performing a method according to the invention and the advantageous configuration thereof. The driver assistance system can include at least one sensor, by which objects in the environment of the motor vehicle can be captured. Further, the driver assistance system can comprise a motion sensor, by which the motion of the motor vehicle can be continuously determined. In addition, the driver assistance system can comprise an electronic controller, by which for example a digital environmental map can be provided. Further, the trajectory can be determined and recorded by the controller.

A motor vehicle according to the invention includes a driver assistance system according to the invention. The motor vehicle is in particular formed as a passenger car.

The preferred embodiments presented with respect to the method according to the invention and the advantages thereof correspondingly apply to the driver assistance system according to the invention as well as to the motor vehicle according to the invention.

Further features of the invention are apparent from the claims, the figures and the description of figures. The features and feature combinations mentioned above in the description as well as the features and feature combinations mentioned below in the description of figures and/or shown in the figures alone are usable not only in the respectively specified combination, but also in other combinations or alone without departing from the scope of the invention. Thus, implementations are also to be considered as encompassed and disclosed by the invention, which are not explicitly shown in the figures and explained, but arise from and can be generated by separated feature combinations from the explained implementations. Implementations and feature combinations are also to be considered as disclosed, which thus do not have all of the features of an originally formulated independent claim. Moreover, implementations and feature combinations are to be considered as

disclosed, in particular by the implementations set out above, which extend beyond or deviate from the feature combinations set out in the relations of the claims.

Now, the invention is explained in more detail based on preferred embodiments as well as with reference to the attached drawings.

There show:

- Fig. 1 a motor vehicle according to an embodiment of the invention, which comprises a driver assistance system;
- Fig. 2 the motor vehicle, which is moved between a start position and a target position in a learning mode of the driver assistance system;
- Fig. 3 the motor vehicle during the travel from the target position to the start position; and
- Fig. 4 the motor vehicle during the travel from the target position to the start position according to a further embodiment.

In the figures, identical and functionally identical elements are provided with the same reference characters.

Fig. 1 shows a motor vehicle 1 according to an embodiment of the present invention in a plan view. In the present case, the motor vehicle 1 is formed as a passenger car. The motor vehicle 1 includes a driver assistance system 2. The driver assistance system 2 in turn includes an electronic controller 3. Moreover, the driver assistance system 2 includes at least one sensor 4. In the present embodiment, the driver assistance system 2 includes four sensors 4, which are disposed distributed at the motor vehicle 1. Presently, one of the sensors 4 is disposed in a rear area 5 of the motor vehicle 1, one of the sensors 4 is disposed in a front area 7 of the motor vehicle 1 and the remaining two sensors 4 are disposed in a respective lateral area 6 of the motor vehicle 1, in particular in an area of the wing mirrors. Presently, the number and arrangement of the sensors 4 of the driver assistance system 2 are to be purely exemplarily understood.

An environment 8 of the motor vehicle 1 can be captured by the sensors 4. The sensors 4 are in particular formed as cameras. An image sequence or video data can be provided by the cameras, which describe the environment 8. This video data can be transmitted from the sensors 4 to the controller 3. The images or video data can be evaluated and objects 10 can be recognized in the images by means of the controller 3. Hereto, a corresponding object recognition algorithm can be used by the controller 3. Alternatively thereto, the individual sensors 4 can comprise respective image processing units, by which the objects 10 in the images can be recognized. In this case, information about the objects 10 recognized in the images can be transmitted from the respective sensors 4 to the controller 3.

Moreover, the driver assistance system 2 includes a motion sensor 9, by means of which a motion of the motor vehicle 1 can be recorded. For example, a steering angle and/or revolutions of at least one wheel of the motor vehicle 1 can be continuously determined by the motion sensor 9. In addition, the motion sensor 9 can comprise a receiver 10 for a satellite-based positioning system, by which the position of the motor vehicle 1 can be continuously determined. The motion sensor 9 is also connected to the controller 3 for data transmission.

In the operation of the driver assistance system 2, it can be differentiated between a learning mode and an operating mode. In the learning mode, during which the motor vehicle 1 is manually maneuvered by a driver, a trajectory 11 can be recorded. Such a trajectory 11 is illustrated in Fig. 2. This trajectory 11 extends from a start position 12 to a target position 13. The start position 12 can for example be associated with a road, which leads to a house or a habitation of the driver of the motor vehicle 1. The target position 13 can for example be associated with a parking space or a garage of the driver. In the learning mode, the motion of the motor vehicle 1 can be continuously determined by means of the motion sensor 9. Herefrom, the trajectory 11 can then be determined and stored by means of the controller 3. Therein, it can be provided that the trajectory 11 can be recorded up to a maximum length of for example 50 m. Moreover, objects 10 are stored as landmarks during manually maneuvering the motor vehicle 1 by the driver or in the learning mode. Further, it can in particular be provided that a relative location of the objects 10 to the trajectory 11 is respectively stored. In the following operating mode of the driver assistance system 2, the motor vehicle 1 is then maneuvered along the recorded trajectory 11.

Presently, the motor vehicle 1 is manually maneuvered by the driver from the start position 12 to the target position 13 at a first time t_1 . Herein, the driver can activate the learning mode of the driver assistance system 2. In the learning mode, the sensor 4 disposed in the front area 7 as well as the sensors 4 disposed in the lateral areas 6 can be activated. Thus, objects 10 in front of the motor vehicle 1 in direction of travel as well as laterally next to the motor vehicle 1 can be captured. Presently, this is schematically shown by the area 14a. During the travel from the start position 12 to the target position 13, objects 10 are therein captured in a maneuvering area 15. The maneuvering area 15 results by the range of the sensors 4 or by the capturing ranges of the sensors 4.

Furthermore, it is provided that the driver assistance system 2 is operated in the learning mode also during the travel from the target position 13 to the start position 12. Presently, the motor vehicle 1 is maneuvered from the target position 13 to the start position 12 at the second time t_2 . In this case, the sensor 4 disposed in the rear area 5 as well as the two sensors 4 disposed in the lateral areas 6 are activated. Presently, this is exemplified by the area 14b. Thus, it is also possible that objects 10 in the maneuvering area 15 are captured during the travel in opposite direction, thus from the target position 13 to the start position 12. It can for example be recognized with the aid of the motion sensor 9 that the motor vehicle 1 is in the target position 13 and is moved from there towards the start position 12. In this case, the driver assistance system 2 can be automatically transferred into the learning mode.

Fig. 3 shows the motor vehicle 1, which is maneuvered from the target position 13 towards the start position 12. Furthermore, a capturing range 16 is shown, which describes that range, in which objects 10 can be captured by the sensor 4, which is disposed in the front area 7. Presently, an object 10 in the form of a wall is in the environment 8 of the motor vehicle 1. Thereby, a blind area 17 arises, in which objects 10 cannot be captured by the sensor 4. This blind area 17 is shadowed for the sensor 4 by the object 10.

Fig. 4 shows the motor vehicle 1 of Fig. 3, which is maneuvered from the target position 13 towards the start position 12, at a later time. Here, the capturing range 16' is further shown, in which objects 10 can be captured by the sensor 4 disposed in the rear area 5. In this case too, a blind area 17' arises for this sensor 4. In that the sensor 4 in the rear area 5 is activated in maneuvering the motor vehicle 1 from the target position 13 to the start position 12, an area 18 can thus also be captured, which corresponds to the previously described blind area 17 of the sensor 4 in the front area 7. Thereby, those

sides or areas of the objects 10 can be captured, which are reliably captured for the later travel from the start position 12 to the target position 13, during which the driver assistance system 2 is operated in the operating mode.

Claims

1. Method for operating a driver assistance system (2) of a motor vehicle (1), in which in a learning mode of the driver assistance system (2), during which the motor vehicle (1) is manually maneuvered by a driver along a trajectory (11) from a start position (12) to a target position (13), the trajectory (11) is recorded as well as objects (10) in an environment (8) of the motor vehicle (1) are captured by at least one sensor (4) of the driver assistance system (2), and in an operating mode of the driver assistance system (2), the motor vehicle (1) is at least semi-autonomously maneuvered from the start position (12) to the target position (13) depending on the recorded trajectory (11) and the captured objects (10), characterized in that the driver assistance system (2) is additionally operated in the learning mode during travel of the motor vehicle (1) from the target position (13) to the start position (12) and herein the objects (10) in the environment (8) are captured.
2. Method according to claim 1, characterized in that the driver assistance system (2) is operated in the learning mode for a predetermined number of travels from the start position (12) to the target position (13) and/or from the target position (13) to the start position (12).
3. Method according to claim 1 or 2, characterized in that a digital environmental map is determined based on the captured objects (10), which describes respective positions of the captured objects (10) in a maneuvering area (15) associated with the trajectory (11).
4. Method according to claim 3, characterized in that the motor vehicle (1) is at least semi-autonomously maneuvered in the maneuvering area (15) by means of the driver assistance system (2) in the operating mode based on the digital environmental map.

5. Method according to any one of the preceding claims, characterized in that
the objects (10) are captured in front of the motor vehicle (1) in direction of travel, laterally next to the motor vehicle (1) and/or behind the motor vehicle (1) in direction of travel in the operating mode.
6. Method according to claim 5, characterized in that
the objects (10) are captured by the at least one sensor (4) in front of the motor vehicle (1) in direction of travel and/or laterally next to the motor vehicle (1) during travel from the start position (12) to the target position.
7. Method according to claim 5 or 6, characterized in that
the objects (10) are captured by the at least one sensor (4) behind the motor vehicle (1) in direction of travel and/or laterally next to the motor vehicle (1) during travel from the target position to the start position (12).
8. Method according to any one of the preceding claims, characterized in that
the motor vehicle (1) is maneuvered along the recorded trajectory (11) in the operating mode.
9. Driver assistance system (2) for a motor vehicle (1), which is adapted to perform a method according to any one of the preceding claims.
10. Motor vehicle (1) with a driver assistance system (2) according to claim 9.

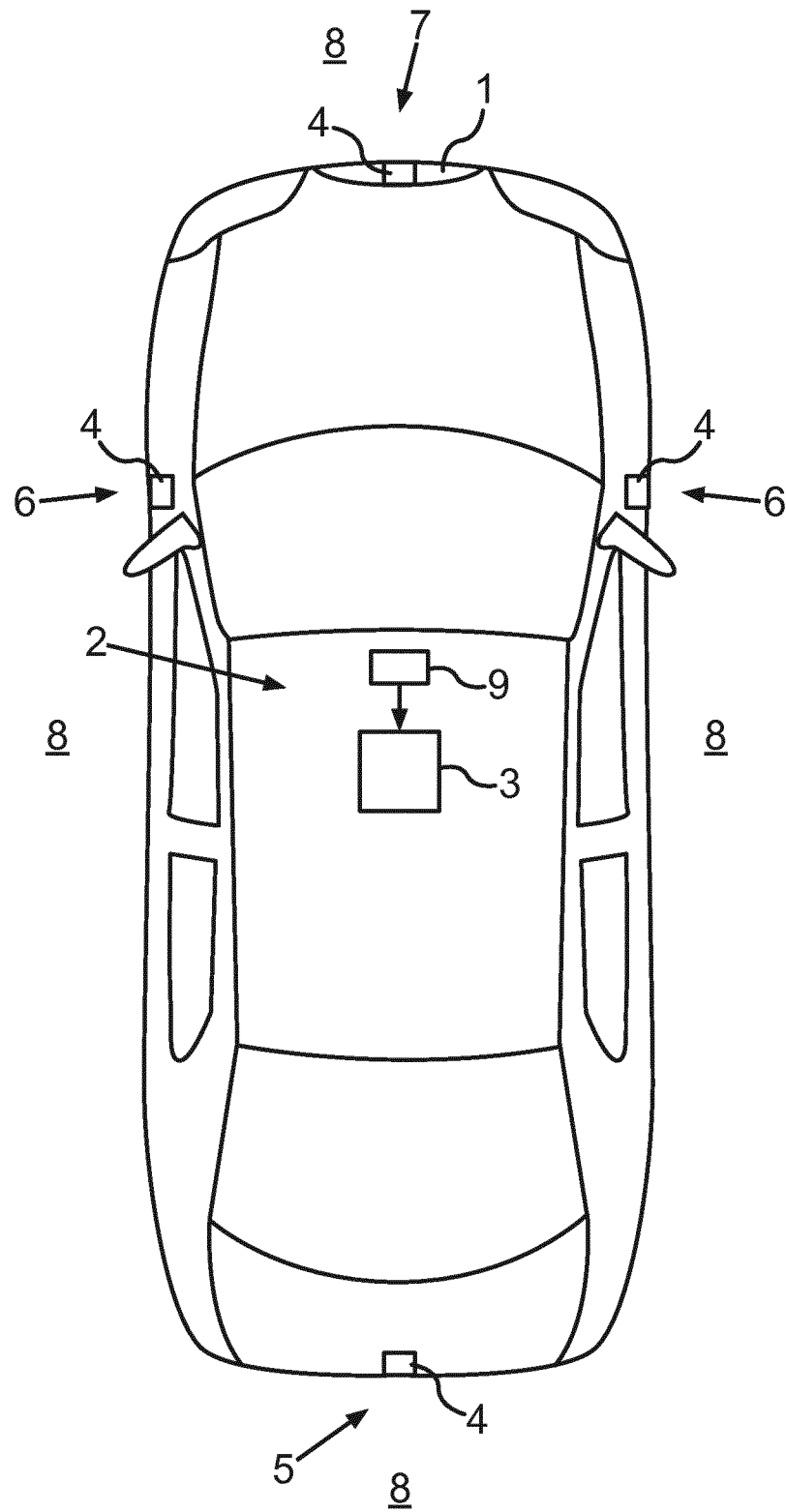


Fig.1

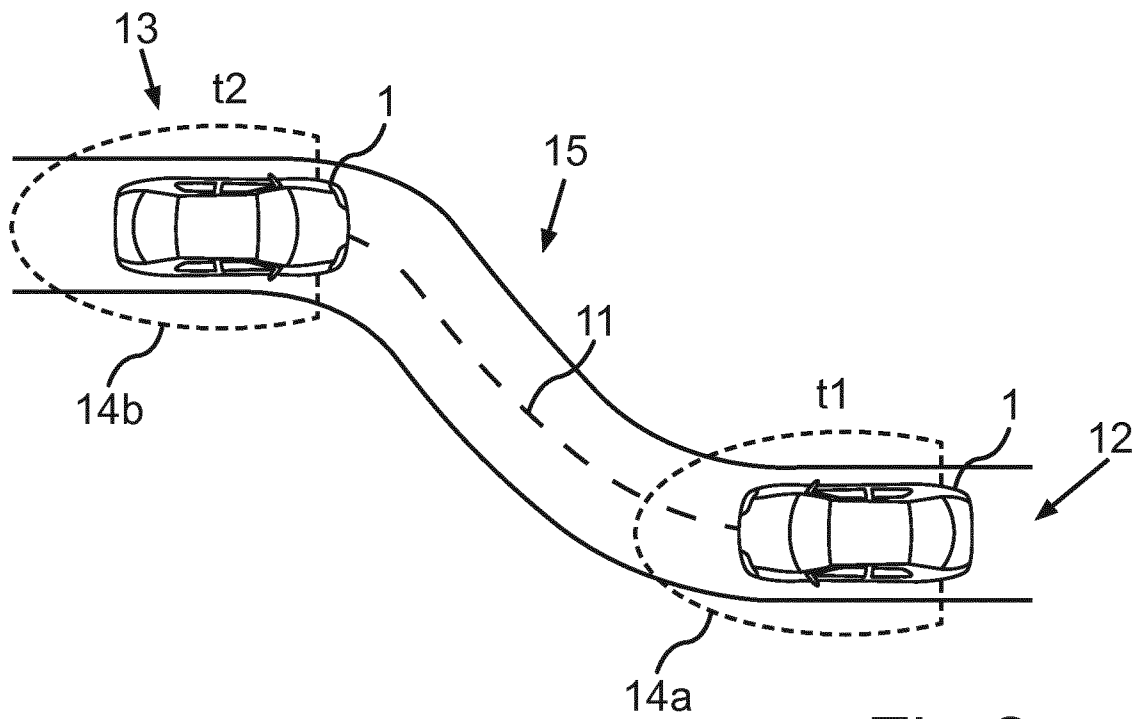


Fig.2

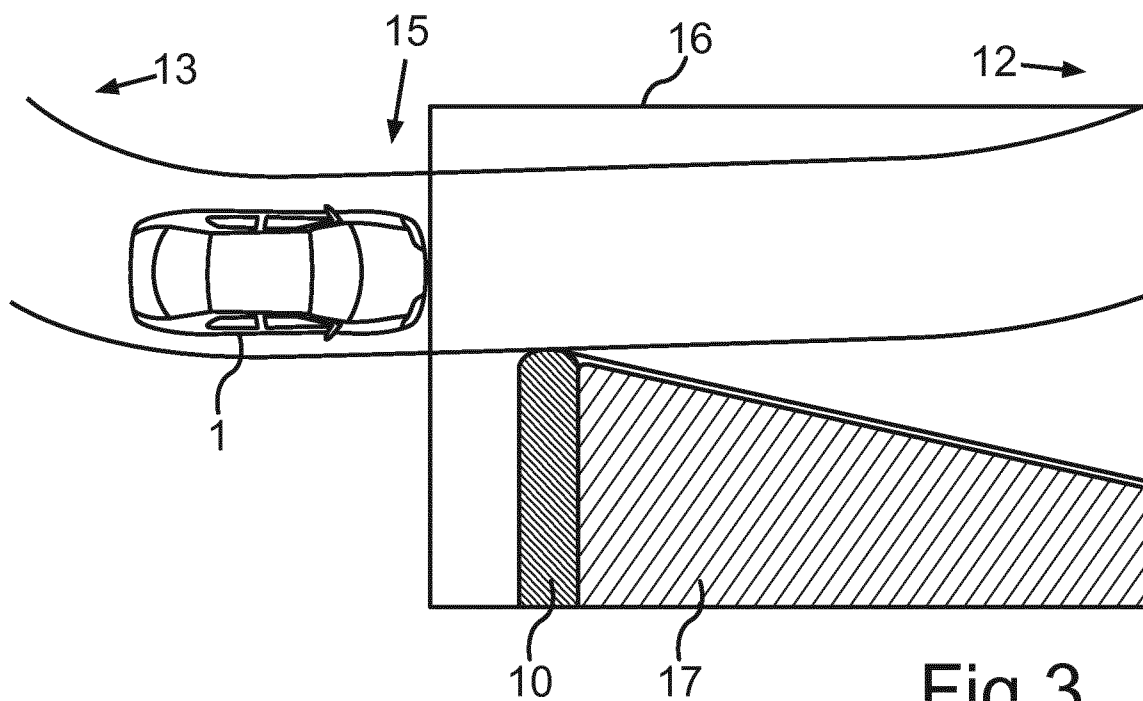


Fig.3

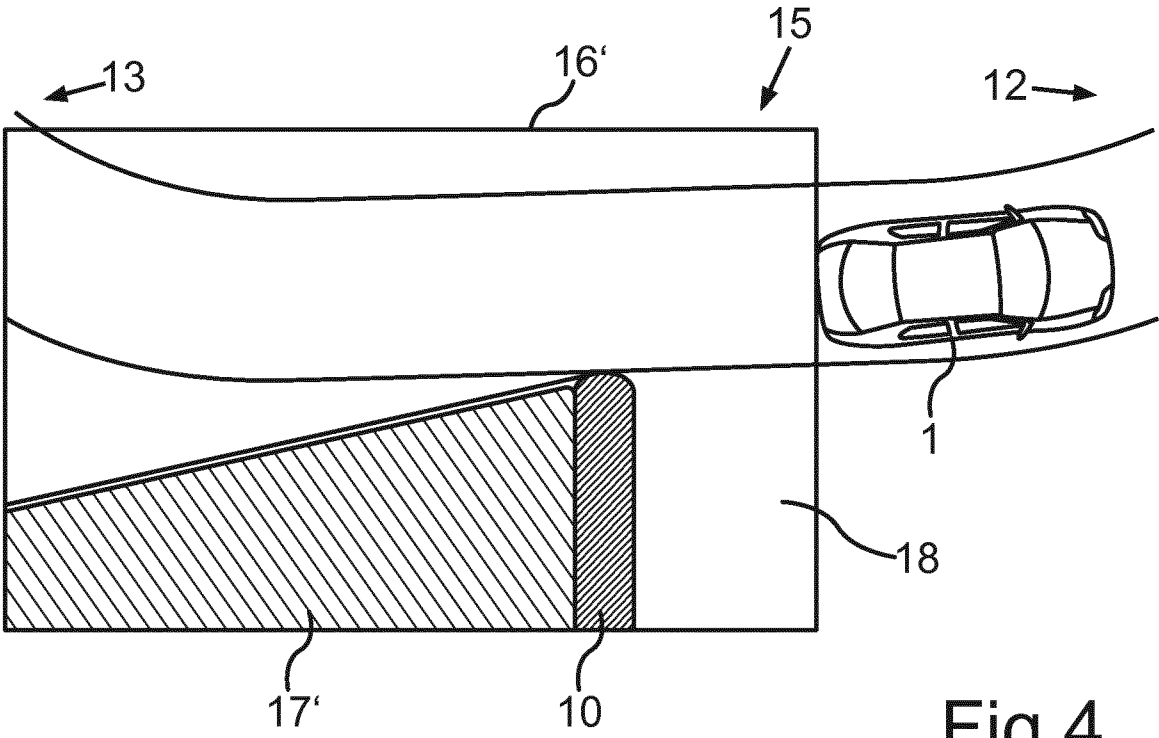


Fig.4

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2017/079023

A. CLASSIFICATION OF SUBJECT MATTER
 INV. B62D15/02
 ADD.

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)
 B62D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, 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	DE 10 2013 015348 A1 (DAIMLER AG [DE]) 10 April 2014 (2014-04-10) paragraphs [0020], [0022], [0024], [0025], [0028], [0032], [0039], [0041], [0044], [0045], [0048], [0051]; claims; figures -----	1-10
A	DE 10 2010 023162 A1 (VALEO SCHALTER & SENSOREN GMBH [DE]) 15 December 2011 (2011-12-15) paragraphs [0047] - [0049]; claims; figures -----	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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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

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Ducher, Alban

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/079023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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