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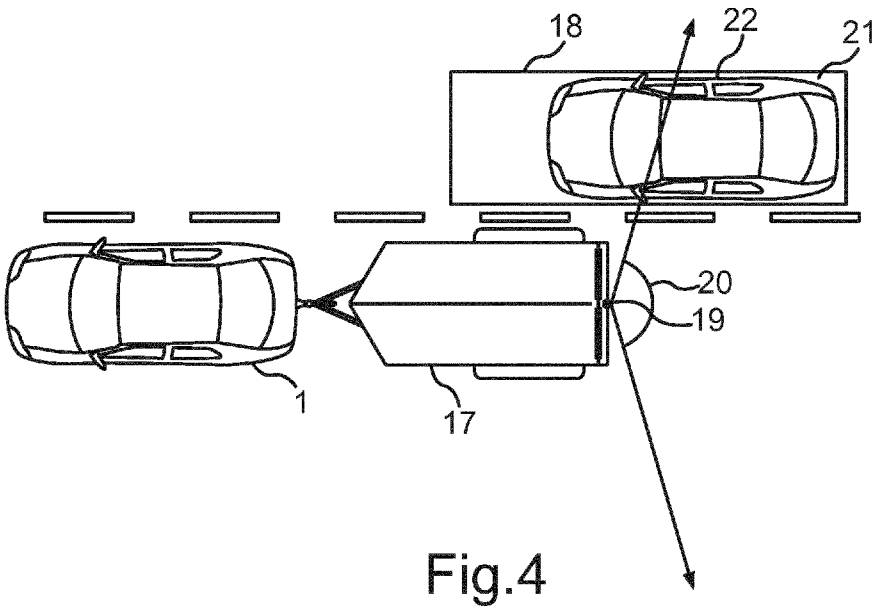


Fig.4

(57) Abstract: In order to render the operation of a combination in particular during maneuvers safer, a method for monitoring a blind spot area (18) of a combination (1, 2) including a motor vehicle (1) and a trailer (17) pulled by it are suggested. The blind spot area (18) relative to a forward driving direction of the combination (1, 17) extends laterally next to and behind the trailer (17). A part (21) of the blind spot area (18) is captured with the aid of a camera (19) on the trailer (17). A blind spot warning signal is generated in dependency on a signal of the camera (19). The camera (19) is arranged on the rear side of the trailer (17), and the captured part (21) of the blind spot area (18) is mainly situated behind the trailer (17).

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[Continued on next page]

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# Monitoring a blind spot area of a combination

The present invention relates to a method for monitoring a blind spot area of a combination including a motor vehicle and a trailer pulled by it, wherein the blind spot area relative to a forward driving direction of the combination is given laterally next to and behind the trailer, by capturing at least one part of the blind spot area by means of a camera on the trailer and generating a blind spot warning signal in dependency on a signal of the camera.

Moreover the present invention relates to a corresponding device for monitoring a blind spot area of the combination. By means of a camera for capturing at least one part of the blind spot area on the trailer and an evaluation device for generating a blind spot warning signal in dependency on a signal of the camera.

It is already known from the prior art to monitor an environmental region of a motor vehicle by capturing the environmental region by means of cameras of a camera system, for instance a surround view camera system, mounted on the vehicle, and by displaying the images captured by the cameras on a display device. In this connection increasingly also three-dimensional representations of the environmental region are displayed on the display device from a so-called third-person perspective. Such third-person perspective shows the environmental region of the motor vehicle as well as the motor vehicle itself from the perspective of a viewer who is external to the vehicle, a so-called virtual camera. Such third-person view can be a top view, in which the viewer looks from above at the motor vehicle. This top view image can be represented on the display device and shows a top side of the motor vehicle with the vehicle roof as well as the environmental region surrounding the motor vehicle. The top view image can be generated by combining raw images captured by the cameras of the camera system. The top view image creates the impression as if it had been captured by a real camera in a position of the virtual camera.

In the environment of the motor vehicle blind spot areas may occur. Such blind spot area, which is also referred to as blind spot, describes an area in the environment of the motor vehicle, which despite the use of side mirrors and/or rear view mirrors cannot be viewed by the driver of the motor vehicle. In order to monitor this blind spot area, from the prior art corresponding driver assistance systems are known, which can recognize objects or further traffic participants in the blind spot area and can emit a warning to the driver in

case an object is present in the blind spot area. Such driver assistance system can for instance comprise a surround view camera system.

In the case of combinations, in which a motor vehicle pulls a trailer, there exists a particular problem of blind spot areas. In particular larger trailers obstruct the view of the driver in the lateral and rear areas of the combination relative to the forward driving direction. As a rule particularly large blind spot areas exist to the left and to the right next of the trailer, wherein these blind spots can extend far behind the trailer. Also a surround view camera system of the pulling motor vehicle cannot solve this problem in a satisfactory way. The individual cameras of the surround view system are namely affected by a shading through the trailer.

The document US 9 211 889 B1 discloses an improved blind spot detection for vehicles with trailer. If a yaw rate of the vehicle during a maneuver exceeds a predetermined value, the system determines the length of the trailer. From the trailer length the system establishes blind spot detection zones in the vicinity of the trailer vehicle and to the side of as well as behind the trailer.

Moreover the document US 2013/0107044 A1 describes a blind spot camera system for a combination. A display is provided in the field of vision of the driver. At least one pair of cameras, one each attached on each side of the oversize load trailer, wirelessly supplies video signals to the display. In particular the cameras can be arranged at the front corners of the oversize load trailer. A third camera can be attached on the rear side of the trailer vehicle at the top of the driver's cab. The cameras can swivel by up to 180°.

This means that up to now it is hardly possible or only at great effort to sufficiently monitor the blind spot regions around a vehicle trailer.

The task of the present invention thus consists in providing a simplified device, by means of which a reliable monitoring of at least one part of a blind spot area of a combination can be effected. Moreover, a corresponding method is to be provided.

According to the invention this task is solved by a method according to claim 1 as well as a device according to claim 8. Advantageous further developments of the invention derive in particular from the subclaims.

According to the present invention accordingly a method for monitoring a blind spot area of a combination including a motor vehicle and a trailer pulled by it is provided, wherein the blind spot area relative to a forward driving direction of the combination is given laterally to and behind the trailer. Typically, in the case of a combination blind spot areas exist to the left and to the right of the trailer, which in particular also extend far behind the trailer. This is not only the case for combinations comprising a passenger car and a trailer or a truck and a trailer, but also for articulated trucks and the like.

As part of the method a capturing of at least part of the blind spot area (possibly also the complete blind spot area) is effected with the aid of a camera on the trailer. This means at least one part of the blind spot area to the right and/or to the left of the trailer is monitored by means of the camera mounted on the trailer. Preferably this capturing is effected by means of a single camera on the trailer.

Subsequently a generating of a (predetermined) blind spot warning signal is effected in dependency on a signal of the camera. The signal of the camera consequently is processed and analyzed. This is for instance effected by a blind spot detection algorithm, which can recognize one or several objects or persons in the respective blind spot area. The blind spot warning signal can be an electrical, analogous, or digital signal. Moreover, the blind spot warning signal can also be further processed and converted.

The camera is arranged on the rear side of the trailer and the captured part of the blind spot area is mainly positioned behind the trailer. Thus the camera can for instance be attached in the center top on the trailer and capture the rear space of the trailer. In this connection it is of particular advantage if the camera has a wide angle lens in order to preferably capture an angle area of at least 120°p ossibly even 180°. In this way objects can be captured, which are present behind the trailer and in particular in the blind spot areas to the left and to the right of the trailer.

Preferably the (predetermined) blind spot warning signal is generated only if in the captured part of the blind spot area a vehicle is registered. This also includes the case that the capture sensor system constantly generates a signal, e.g. binary value „0“, and only upon registering a vehicle in the blind spot area the signal value changes to „1“. This consequently means that the formulation “blind spot warning signal is only generated if” also includes the case that a special value of the blind spot warning signal is only generated if the respective condition is fulfilled. The vehicle registered in the blind spot

area can be any kind of vehicle. Of special significance are in any case such vehicles that can move at similar or higher speed than the trailer vehicle of the combination.

The generating of the (predetermined) blind spot warning signal should be effected in real time. Only in this way it can be ensured that the driver is always informed up to date and with as little delay as possible. “Real time” here relates in particular to the fact that the blind spot warning signal is generated with a maximum delay of 200 ms, after entry of an object into the blind spot area. Preferably the generating, however, is effected clearly below 100 ms. Such high requirements to real time are in particular required because the speeds in road traffic require correspondingly low response times.

The generating of the blind spot warning signal can be effected in dependency on a driving signal, which signals a driving state of the combination. For instance the blind spot warning signal, according to which an unknown object is situated in the blind spot area, is only emitted if the combination is driving. In the case of standstill the blind spot warning signal is not emitted. Such driving signal can for instance be provided by the motor vehicle. It can for instance be the speed signal. For the generating of the blind spot signal then this driving signal is also processed.

Especially, the driving signal can contain an information about a speed of the motor vehicle and the blind spot warning signal is only generated, if the speed is higher than or equal to a predetermined minimum speed. This means it is not only checked whether the motor vehicle drives at all, but it is particularly checked whether the motor vehicle has a speed that is higher than a predetermined minimum speed or corresponds to it. Thus, for instance warning signals can be subdued in maneuvering the combination. For instance when driving through a parking area with a combination it is less important whether the vehicles are in a blind spot area next to the trailer.

In a particular embodiment the blind spot warning signal can be an optical, acoustical, and/or haptic signal. As already mentioned in the above, this means that the blind spot warning signal can be a signal that has already been processed further and possibly also has been converted once or several times. For instance from an analogous or digital electrical signal an optical, acoustical, or haptic signal is generated. Corresponding converters for this purpose are generally known.

According to a further embodiment a parameter of the blind spot warning signal is adjusted in dependency on whether a maneuver of the combination is indicated by a

steering movement or the activation of an indicator. A parameter of the blind spot warning singal can for instance be an amplitude or a frequency. For instance the intensity of the blind spot warning signal can be higher if the combination executes a maneuver in comparison with the case that the combination only drives straight on. A maneuver refers to all possible movements of a combination that do not correspond to a mere straight line movement. In particular are included cornering and changing lanes. A parameter of the blind spot warning signal, however, is also the colour of an optical display or the height of the tone of an acoustic signal. This means whilst the emergence of a vehicle in the blind spot area is only indicated yellow in the case of a straight line movement of the combination, same is indicated red in the case of driving along curves or changing lanes. For setting a parameter it is further not necessary that the maneuver of the combination actually already takes place. Rather it is sufficient if the maneuver is only indicated. This may for instance be effected by activating the indicator or by the minimal changing of the position of the steering wheel. Possibly also other indicators of the future performance of the maneuver can be used for changing or setting the parameter of the blind spot warning signal. In this connection the setting or changing can be effected in a binary, a multi-step, or a stepless manner.

According to the invention the above-named task is also solved by a device for monitoring a blind spot area of a combination including a motor vehicle and a trailer pulled by it, wherein the blind spot area relative to a forward driving direction of the combination is given next to and behind the trailer, with a camera for capturing at least part of the blind spot area on the trailer and an evaluation device for generating a (predetermined) blind spot warning signal in dependency on a signal of the camera, wherein the camera is capable of being arranged on the rear side of the trailer in such a way that the captured part of the blind spot area is situated mainly behind the trailer.

For the device according to the invention the same advantages and options for further development as in the above-referenced method according to the invention apply. The respective method features are then to be seen as functional features, which are realized by corresponding means.

Especially the motor vehicle can for instance be equipped with a surround view camera system in order to capture the environment of the vehicle. For the case that then a trailer is connected to the motor vehicle, the rear camera of the trailer can be integrated into the surround view camera system so that ultimately a surround view of the entire combination

can be gained. In this way it is also possible to monitor the blind spot area in the region of the rear part of the trailer.

Especially the device for monitoring a blind spot can be integrated in a driver assistance system. This means that the device in concrete terms is used for supporting a driver of a motor vehicle. Possibly, also the limiting conditions are to be met that are asked for driver assistance systems.

In a concrete embodiment a motor vehicle, to which a trailer is connected, can have such a driver assistance system. In this way the operation of the motor vehicle can be rendered safer in particular during maneuvering.

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 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.

The invention is now explained in more detail with reference to the attached drawings, shown in:

Fig. 1 a motor vehicle comprising a surround view camera system for monitoring blind spot areas around the vehicle;

Fig. 2 a vehicle without trailer having blind spot areas;

Fig. 3 a vehicle with trailer and blind spot areas;

Fig. 4 a combination according to the invention with monitored blind spot area.

The embodiments described in more detail in the following represent preferred embodiments of the present invention. In this connection it is to be considered that the individual features can be realized not only in the described feature combinations, but can also be realized taken alone or in other technically reasonable combinations.

Fig. 1 shows a motor vehicle 1, which in the present case is configured as passenger car. The motor vehicle 1 is in particular configured for pulling a trailer, which is not shown in Fig. 1. The motor vehicle 1 preferably comprises a driver assistance system 2, which can support a driver of a motor vehicle in driving the motor vehicle 1. The driver assistance system 2 advantageously comprises a surround view camera system 3 for monitoring an environmental region 4 of the motor vehicle 1. In this connection the driver assistance system advantageously comprises four cameras 5a, 5b, 5c, and 5d mounted on the vehicle. A first camera 5a is attached in a front area 6 of the motor vehicle 1 and serves for capturing raw images showing the environmental region 4 in front of the motor vehicle 1. A second camera 5b is attached in the rear area 7 of the motor vehicle 1 and serves for capturing raw images showing the environmental region 4 behind the motor vehicle 1. A third camera 5c is attached to a left side 8 of the motor vehicle 1 and serves for capturing raw images showing the environmental region to the left next to the motor vehicle, and a fourth camera 5d is attached on a right side 9 of the motor vehicle 1 and serves for capturing raw images showing the environmental region 4 to the right next to the motor vehicle 1.

The raw images or raw video frames captured by the cameras 5a, 5b, 5c, and 5d can be displayed on a display device 10 of the driver assistance system 2 in the form of a video. On the basis of raw images an evaluation device, which for instance can be contained in a control device 11 or ECU (electronic control unit) on the vehicle side, creates a virtual view, for instance a top view. As will be set out below, in the evaluation device also a predetermined or raw-image-based warning signal can be generated in dependency on the data or signals of one or several cameras.

For further explanation of the invention, to start with, on the basis of the Figs. 2 and 3 the optical situation for the driver of the motor vehicle is represented. In particular are the blind spot areas explained in more detail.

In Fig. 2 a motor vehicle 1 is shown, which is driving on a lane 12. In driving direction to the right next to the lane 12 is a right lane 13 and in driving direction to the left next to the lane 12 is the left lane 14. The individual lanes are separated from each other by road markings 15.

For observing the environment of the vehicle 1 the driver during driving commonly can look to the front and to the side. For observing the rear space he has side mirrors and a rear mirror at his disposal. By means of these mirrors, however, as a rule blind spot areas 16 cannot be captured. These blind spot areas 16 typically of a common motor vehicle, in particular a passenger car, extend at a certain lateral distance to the right and to the left next to the motor vehicle 1. In Fig. 2 these blind spots 16 are schematically indicated. They extend typically from about the rear axis to about a vehicle length behind the motor vehicle or even further. In the lateral direction the blind spot areas 16 are approximately located on the right lane 13 and the left lane 14.

The situation of the blind spot areas around a vehicle changes entirely, if the vehicle pulls a trailer 17, which is indicated in Fig. 3. In particular the blind spot areas as a rule grow much larger. In Fig. 3 for the sake of simplicity only a right blind spot 18 to the right next to the trailer 17 is drawn in. It typically extends nearly along the entire trailer length and as a rule also far behind the trailer 17. Also the width of the wide angle 18 in most cases is considerably larger than that of the blind spot 16 in the case of a simple motor vehicle 1 without trailer. From this it is immediately comprehensible that a motor vehicle 1 with trailer 17 represents a much greater operational danger than if these blind spots 18 are not especially monitored. In particular in the case of maneuvers of the combination, which do not mean mere straight line driving, due to the blind spot areas high safety risks are given.

For this reason it is suggested to install on or in the rear part of the trailer 17 a camera 19, which can monitor a wide area 20 behind the trailer 27. This area 20 can be referred to as aperture angle of the lens system of the camera 19. The area 20 must be at least large enough for at least a part 21 of the blind spot area 18 to be captured by the camera 19. Here, too, it is to be stressed once more that also to the left of the combination 1, 17 a blind spot area 18 is given, which for the sake of simplicity is also not drawn in Fig. 4, but is equally captured by the camera 19.

The camera 19 can interact with other cameras 5a to 5d of the motor vehicle 1 e. g. for a surround view, or else also provide separate images for the display device 10 in the motor

vehicle 1 (cf. Fig. 1). A blind spot detection algorithm can be used for further processing the signals of the respective camera system. In certain circumstances the algorithm and/or the camera system is to be adjusted to the size of the trailer in order to generate reliably corresponding blind spot warning signals.

It is particularly advantageous if the algorithm or the monitoring device monitors the blind spot areas 18 or parts thereof, as soon as the motor vehicle drives at or above a predetermined minimum speed. As soon as then namely a vehicle 22 drives into the monitored part 21 of the blind spot area 18, a warning can be issued to the driver of the motor vehicle 1, which informs him of the presence of the vehicle 22 in the blind spot area 18. A corresponding evaluation device, which evaluates the signals of the rear camera 19 of the trailer 17, can be integrated within the control device 11 of the vehicle 1 or a corresponding driver assistance system 2 (see Fig. 1). In the course of the evaluation the evaluation device can generate a blind spot warning signal, which is of visual, acoustic, or tactile nature. For instance the steering wheel or the driver seat can be caused to vibrate if in the case of a maneuver of the combination a vehicle 22 is present in the blind spot area 18.

Otherwise, if the algorithm or the monitoring device does not recognize any other object or vehicle in the blind spot area 18, the driver can safely perform the intended maneuvers. He then either does not receive a warning signal or free driving is indicated to him. This can be a clear aid to the driver in changing lanes or during overtaking.

In case, though, the camera 19 together with the blind spot detection algorithm for instance detects the vehicle 22 in the blind spot area 18, a warning is issued to the driver in order to lower the risk of a collision. The intensity of the warning can be made dependent on how close the vehicle 22 is to the combination 1, 17. For instance the volume, the brightness, or the vibration amplitude can be adjusted to the detected closeness of the two vehicles. Also the colour of a warning signal can change for instance from orange to red as the vehicle 22 is coming closer towards the combination 1, 17.

However, in order to avoid too frequent warning or erroneous warnings, the warning should be made dependent on whether the driver of the combination actually wishes to perform a maneuver. This is because only then a collision is impending and a clear warning should be generated. The mere driving of another vehicle 22 through a blind spot area 18 namely does not automatically present a danger and is for instance a common situation on multi-lane roads in urban areas or on motorways. As indicative of the fact that

the driver of a combination wishes to perform a maneuver for instance can be seen the activation of an indicator or the turning of a steering wheel. Corresponding sensor values can be also evaluated in the evaluation device for generating the blind spot warning signal.

This additional functionality of a trailer camera for blind spot monitoring raises the safety of the combination considerably. In particular it allows the driver to perform the most varied maneuvers, as he can trust that the blind spot areas of the combination are reliably monitored.

Patentansprüche

1. Method for monitoring a blind spot area (18) of a combination (1, 17) including a motor vehicle (1) and a trailer (17) pulled by it, wherein the blind spot area (18) relative to a forward driving direction of the combination (1, 17) is given laterally next to and behind the trailer (17), by
   - capturing at least one part (21) of the blind spot area (18) with the aid of a camera (19) on the trailer (17) and
   - generating a blind spot warning signal in dependency on a signal of the camera (19),

   characterized in that
   - the camera (19) is arranged on the rear side of the trailer (17) and the captured part (21) of the blind spot area (18) is located mainly behind the trailer (17).

2. Method according to claim 1,
   characterized in that
   the blind spot warning signal is generated only if in the captured part (21) of the blind spot area (18) a vehicle (22) is registered.

3. Method according to 1 or 2,
   characterized in that
   the generating of the blind spot warning signal with a maximum delay of 200 ms after entry of an object into the blind spot area.

4. Method according to any one of the preceding claims,
   characterized in that
   the generating of the blind spot warning signal is effected in dependency on the driving signal, which signals a driving state of the combination (1, 17).

5. Method according to claim 4,
   characterized in that
   the driving signal contains information about a speed of the motor vehicle (1) and

the blind spot warning signal is generated only if the speed is higher than or equal to a predetermined minimum speed.

6. Method according to any one of the preceding claims,
characterized in that
the blind spot warning signal is an optical, acoustical, and/or haptic signal.

7. Method according to any one of the preceding claims,
characterized in that
a parameter of a blind spot warning signal is adjusted in dependency on whether a maneuver of the combination (1, 17) is indicated by a steering movement or by activating an indicator.

8. Device for monitoring a blind spot area (18) of a combination (1, 17) including a motor vehicle (1) and a trailer pulled by it (17), wherein the blind spot area (18) relative to a forward driving forward of the combination (1, 17) is given laterally next to and behind the trailer (17), comprising
   - a camera (19) for capturing at least one part (21) of the blind spot area (18) on the trailer (17) and
   - an evaluation device (11) for generating a blind spot warning signal in dependency on a signal of the camera (19),

   characterized in that
   - the camera (19) is arrangeable on the rear side of the trailer (17) in such a way that the captured part of the blind spot area (18) is positioned mainly behind the trailer (17).

9. Driver assistance system (2) comprising a device according to claim 4.

10. Motor vehicle (1), to which a trailer (17) is attached and which is equipped with a driver assistance system (2) according to claim 5.

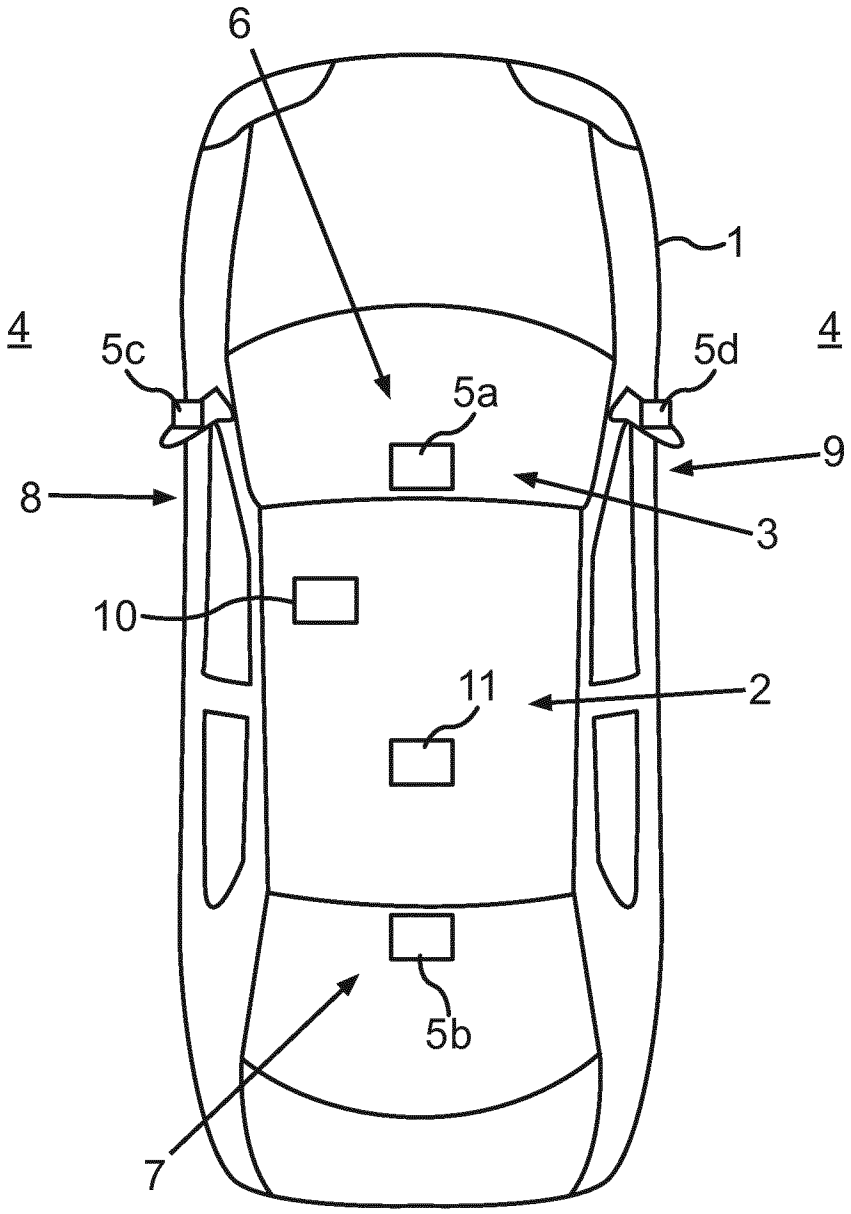


Fig.1

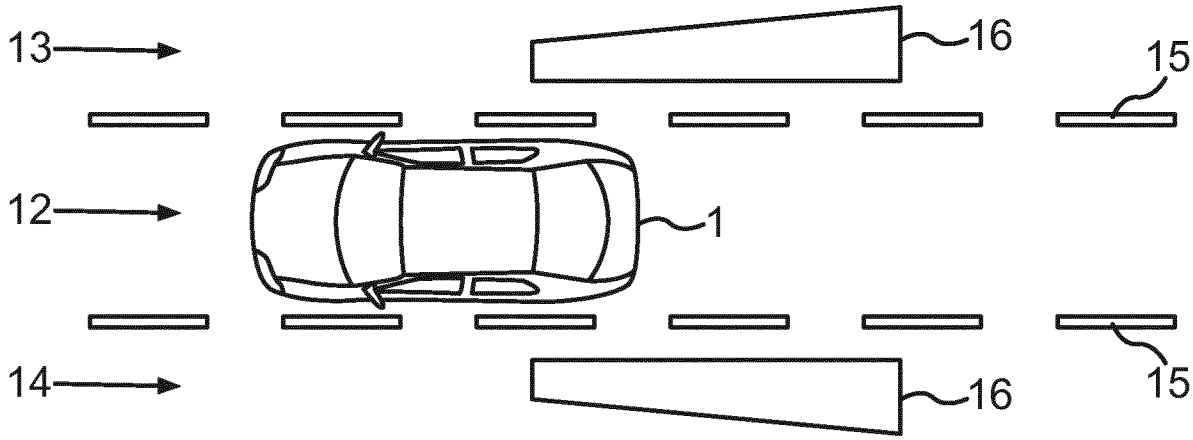


Fig.2

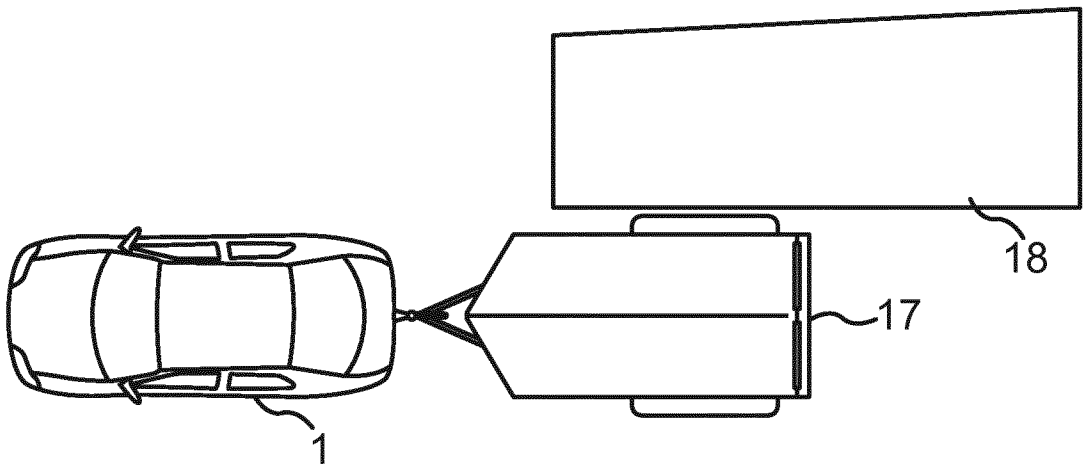


Fig.3

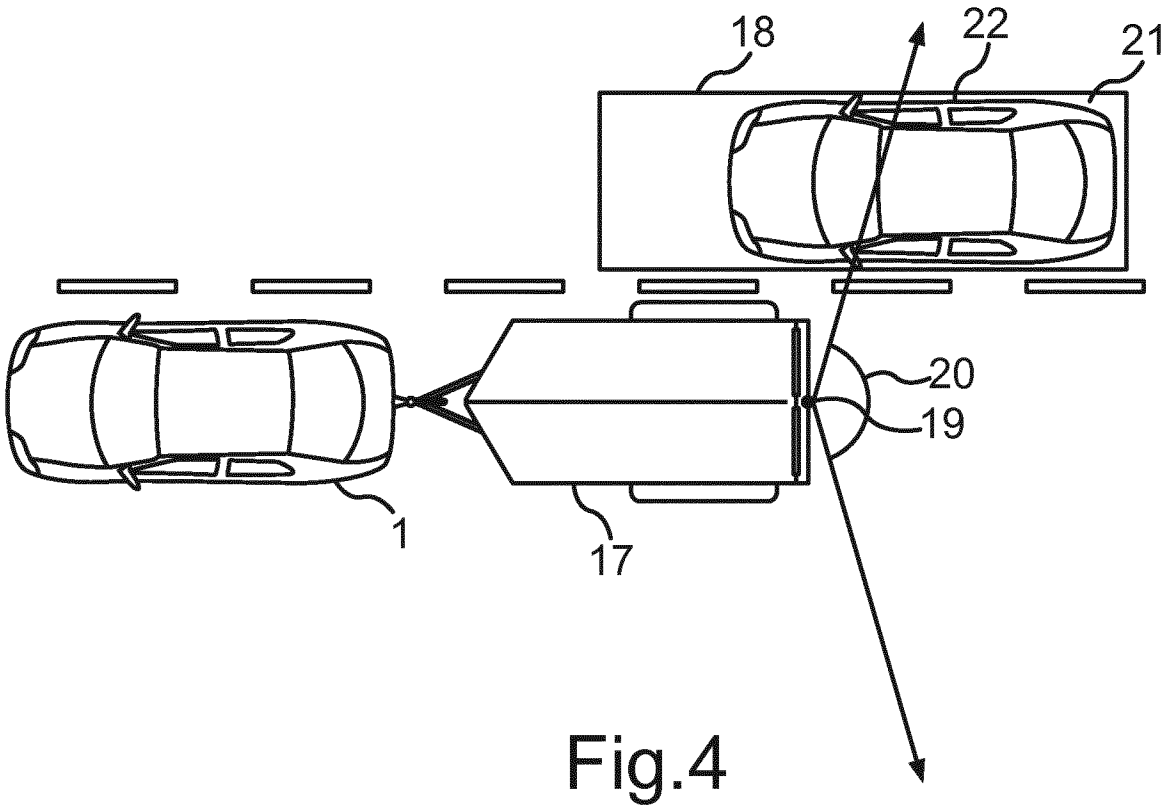


Fig.4

# INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/079649

A. CLASSIFICATION OF SUBJECT MATTER
INV. G08G1/16 B60W30/18
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)
G08G B60W

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 2005 036714 A1 (DAIMLER CHRYSLER AG [DE]) 8 February 2007 (2007-02-08) paragraph [0026]; figure 2 | 1-4,6-8, 10 |
| A | WO 01/85491 A1 (AUTOMOTIVE TECH INT [US]) 15 November 2001 (2001-11-15) figure 9 | 1-10 |

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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

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

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

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

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 8 February 2018 | 15/02/2018 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Kyriakides, Leonidas |

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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