



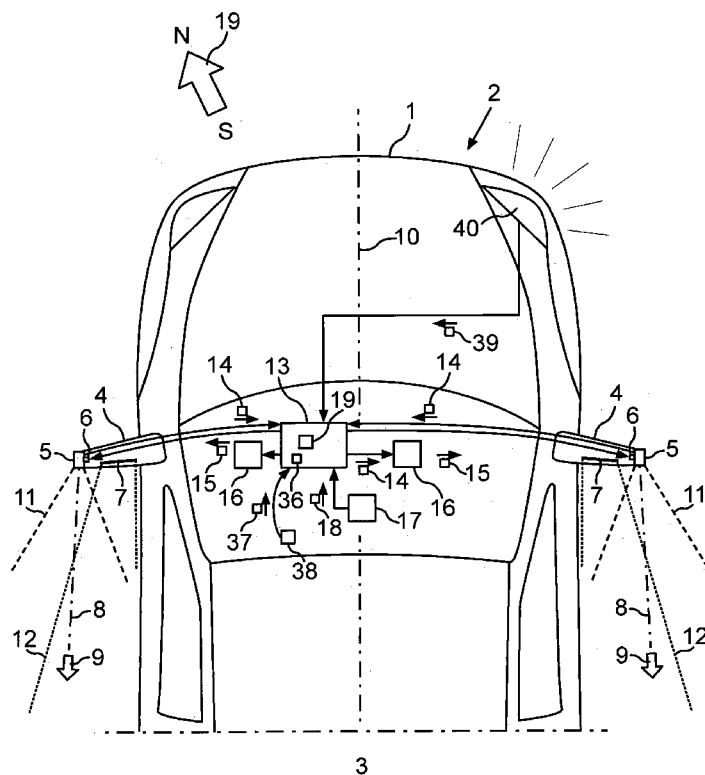
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(54) **Title:** BLIND SPOT SURVEILLANCE IN A VEHICLE**Fig.1**

(57) **Abstract:** The invention is directed to a method for operating a vehicle (1), while the vehicle (1) is driving on a lane (29) of a road (28), wherein a control unit (13) performs the following steps: - Receiving a direction signal (18) from a data capture unit (17), wherein the direction signal (18) indicates the orientation of the vehicle (1) with regard to the road (28), - Detecting a lane change manoeuvre, wherein by the lane change manoeuvre the vehicle (1) moves towards an adjacent lane (31) of the road (28), - Determining a blind spot area (34) covering the adjacent lane (31) on the basis of the direction signal (18), and - Controlling an action unit (5, 6) in dependence on the determined blind spot area (34).

5

Blind spot surveillance in a vehicle

DESCRIPTION:

- 10 The invention relates to a method and a control unit for operating a vehicle in order to surveil a blind spot area of the vehicle.

When adjusting a reflecting side mirror of a vehicle, it is generally not possible to cover the hole area next to the car such that a driver may observe any object in this area by looking into the side mirror. The area not covered by the mirror is called blind spot area. This area is minimized by adjusting the mirrors azimuth direction angle. However the minimization is based on the assumption, that the vehicle and any travelling object driving on an adjacent lane next to the vehicle are travelling in parallel directions. When the vehicle is driving in a curve or is changing lanes, the azimuth direction angle of the mirror is not optimal for this driving situation.

Document CN 103991412 A describes a vehicle with a self-adaption dynamic compensation system for a rear view mirror of an automobile. The system detects the rotation angle of a steering wheel and turns the side mirror in dependence on the detected rotation angle. By means of the self-adaption dynamic compensation system, rear view blind areas are reduced in driving situations where the car is driving through a curve.

Document KR 10 2008 0034682 A describes a camera-based system for assisting a driver while driving a vehicle backwards. A reverse gear determination unit detects the start of backwards driving and a detector for detecting a rotation direction of a steering wheel detects a manipulation direction of the steering wheel in corporation with the reverse gear determination unit. The camera is turned according to the manipulation direction of the steering wheel.

It is the object of the present invention to support a driver during a lane change manoeuvre.

This object is solved by the subject matter of the independent claims. Advantageous developments of the invention are specified in the dependent claims.

5 The method according to the invention is for operating a camera-based rear-view system of a vehicle, while the vehicle is driving on a lane of a road. The method is performed by a control unit that is performing the following steps:

- 10 - Receiving a direction signal from a data capture unit, wherein the direction signal indicates the orientation of the vehicle with regard to the road,
- Detecting a lane change manoeuvre, wherein by the lane change manoeuvre the vehicle moves towards an adjacent lane of the road,
- Determining a blind spot area covering the adjacent lane on the basis of the direction signal,
- 15 - Controlling an action unit in dependence on the determined blind spot area. The blind spot area is the area that may not be observed by the driver using the rearward facing side mirror of the vehicle.

20 The invention provides the advantage that the blind spot area is determined in dependence on the orientation of the vehicle with regard to the road. Thus, it may be determined adaptively and more precisely which area of the adjacent lane may not be observed with the vehicles side mirror.

25 The invention also comprises embodiments with additional features that provide further technical advantages.

In one embodiment comprises controlling the action unit comprises turning a detection range of a rear view system of the action unit towards the blind spot area by controlling a moving unit. In one embodiment, the rear view system comprises a reflecting side mirror. In another embodiment the rear view systems comprises a camera-based rear view system, i.e. a rearward-facing camera. By turning the camera the optical axis of the camera is adjusted at least with regard to its azimuth direction angle in relation to the roll axis or longitudinal axis of the vehicle. Especially the angle between the longitudinal axis of the vehicle and the optical axis of the camera is increased, while the vehicle is performing the lane change manoeuvre. During the lane change manoeuvre, the longitudinal axis of the vehicle is oriented in an un-parallel or diagonal manner towards the lane direction of the adjacent lane. The angle is generally a pointed angle or acute angle. An object moving along the adja-

cent lane in the principal direction along the road will be more likely outside the acquisition area of a reflecting side mirror. By adjusting the camera in such a way that it will be directed towards the blind spot area, the driver can regard or observe this blind spot area after the adjustment of the camera. A display will show the camera images showing the content of the blind spot area.

In one embodiment an object detection unit detects an object moving within the blind spot area. Controlling the action unit comprises:

- Activating an output unit of the action unit for warning a driver of the vehicle that the object detection unit detected the object inside the blind spot area, and/or
- Activating a driving control unit of the action unit for changing the steering angle and/or the speed of the vehicle.

The object detection unit may detect the object, e.g. another vehicle, on the basis of e.g. radar signals and/or ultrasonic signals. The output unit may be designed to warn the driver acoustically and/or visually and/or haptically. The output unit may comprise at least one light source, e.g. a light emitting diode (LED), for emitting light signals, e.g. twinkling lights. The output unit may comprise an acoustical source for generating e.g. a noise. The driving control unit may be designed to automatically interrupt the lane change manoeuvre by steering the vehicle and/or reduce speed by decelerating the vehicle.

In one embodiment the blind spot area is determined by determining an angle between a driving trajectory of the vehicle and a lane direction of the adjacent lane. In other words by observing the orientation of the vehicle with regard to the road on the basis of the direction signal, the control unit may observe a change of the driving direction. If the driving direction or driving trajectory points towards the adjacent lane, the driving trajectory and the adjacent lane are at an angle towards another that is an acute angle. For example, if the angle is greater than a predefined value, a lane change manoeuvre may be signalled. The embodiment provides the advantage that the blind spot area is determined adaptively in dependence on the angle at which the vehicle approaches the adjacent lane.

In one embodiment the blind spot area is determined in dependence on the driving speed of the vehicle. Especially, for a first driving speed the blind spot area may be defined by a first axis of direction. For a second speed greater than the first speed, the blind spot area may be defined by a second axis of

direction wherein the second axis of direction is at a smaller angle towards the longitudinal axis of the vehicle than the first axis of direction. By this embodiment the reaction time of the driver may be considered.

5 In one embodiment the direction signal is received out of an electronic compass (magnetometer) and/or a gyrometer of a vehicle. In other words, an on-board sensor is used for sensing the direction of the lane. A magnetometer is a sensor that signals the direction of the magnetic field in a point of space. The magnetometer may be based on the hall effect. The magnetometer may
10 be integrated in the navigation system of the vehicle. Alternatively, the direction signal can be received out of a mobile device connected to the vehicle. The mobile device may comprise an electronic compass and/or a gyrometer. The mobile device can be, for example, a smartphone or a portable navigation system. This embodiment provides the advantage that the vehicle does
15 not have to be equipped with a magnetometer.

In one embodiment the lane change manoeuvre itself is detected on the basis of the direction signal. For example, a time signal may be generated indicating the orientation of the vehicle in degrees with regard to the north-
20 direction. The temporal derivative of the time signal indicates the change of driving direction which is an indication of a lane change.

Additionally or alternatively, in one embodiment the lane change manoeuvre is detected on the basis of digital map data that describe the geometry of the
25 road. By using digital map data, it can be distinguish between a lane change manoeuvre and a movement along a curved segment of the road. The use of digital map data may also be combined with the use of position data obtained from a GNSS-sensor (GNSS – Global Navigation Satellite System), as for example a GPS-sensor (GPS – Global Positioning System).

30 In one embodiment the lane change manoeuvre is detected in dependence on an activity signal of a turn signal indicator. In other words, if the driver activates the indicator, a lane change manoeuvre is assumed.

35 The invention is also directed to a control unit for a vehicle. The control unit is designed to perform a method that is an embodiment of the inventive method. The control unit may be designed as an electronic control unit that may be installed in a vehicle and may be connected to a camera, a camera moving unit and a display of the vehicle. By receiving a direction signal from a

data capture unit, the control unit may control the camera and the display in the described way.

The invention is also directed to a motor vehicle. The motor vehicle comprises a data capture unit, a control unit and an action unit, wherein:

- the data capture unit is designed to generate a direction signal that indicates the orientation of the vehicle with regard to a road the vehicle is driving on,

- the control unit is designed to detect a lane change manoeuvre, wherein by the lane change manoeuvre the vehicle moves towards an adjacent lane, and to determine a blind spot area covering the adjacent lane on the basis of the direction signal, and to control the action unit in dependence on the determined blind spot area. The control unit is an embodiment of the inventive control unit. The control unit may receive a direction signal from a data capture unit, which may also be installed in the motor vehicle or may be connected to the motor vehicle, for example, by means of a wired connection or a wireless connection.

In one embodiment the action unit comprises a rear view system and a moving unit that is designed to turn a detection range of the rear view system towards the blind spot area. The rear view system may be camera-based. An optical axis of the camera is directed towards a rear area of the vehicle. In other words, the optical axis may be directed towards an area to the left or the right behind the vehicle. An angle enclosed by the optical axis and the longitudinal axis of the vehicle may be in a range from 0° to 45°. The moving unit is designed to adjust an azimuth direction angle of the optical axis in dependence of a control signal of the control unit. The moving unit may comprise, for example, an electric motor and an optional gearing mechanism for turning the camera. A display may be arranged to display camera images to a driver of the vehicle.

The inventive vehicle may be designed as a passenger vehicle or a freight vehicle.

In one embodiment the camera is integrated in a side mirror of the vehicle. The side mirror comprises a reflection mirror for observing the rear area of the vehicle to one side of the vehicle, for example, the left or the right side.

The display may be integrated in the side mirror. In other embodiments, the display is integrated in the central rear mirror inside the vehicle interior. In one embodiment the display is provided as a display screen in the interior of the vehicle. For example, mounted on a dash board.

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In the following, an example is described that illustrates how the invention can be implemented. The figures show:

- 10 Fig. 1 a schematic illustration of an embodiment of the inventive motor vehicle,
- Fig. 2 a schematic illustration of a side mirror of the motor vehicle according to Fig. 1,
- 15 Fig. 3 a schematic illustration of a camera that may be integrated into the side mirror of Fig. 2,
- Fig. 4 a schematic illustration of the vehicle of Fig. 1 during a lane change manoeuvre,
- 20 Fig. 5 a schematic illustration of the vehicle according to Fig. 1 during the lane change manoeuvre of Fig. 4 with its camera adjusted.

25 The example explained in the following is a preferred embodiment of the invention. However, in the embodiment, the described components of the embodiment each represent individual features of the invention to be considered independently of each other, which each develop the invention also independently of each other and thereby are also to be regarded as a component of the invention in individual manner or in another than the shown combination. Furthermore, the described embodiment can also be supplemented by

30 further features of the invention already described.

In the figures elements that provide the same function are marked with identical reference signs, respectively.

35

Fig. 1 shows a bird view of a motor vehicle 1. The motor vehicle 1 can be a passenger vehicle, i.e. a car, or a freight vehicle. Fig. 1 shows the front 2 of the vehicle 1. The rear 3 of the vehicle 1 is not shown. The vehicle 1 may comprise two side mirrors 4. The side mirrors 4 may be constructed in corre-

sponding manner. For this reason, the following description only refers to one single side mirror 4. The side mirror 4 may comprise a camera 5 and a camera moving unit 6. The camera 5 and the camera moving unit 6 represent an action unit. The camera 5 represents a rear view system.

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The side mirror 4 may also comprise a reflecting mirror 7. The camera 5 can be a video camera. The camera 5 can comprise an image sensor for sensing light of different colours for generating colour images. The image sensor can also be designed for sensing light intensity for generating light intensity-based images. The sensor can also be designed for sensing infrared light. An optical axis 8 of the camera 5 is directed towards a rear area 3 of the vehicle. In other words, the viewing direction 9 of the camera 5 points towards the rear area of the vehicle 1. The optical axis 8 does not have to be oriented in parallel to a longitudinal axis 10 of the vehicle. The optical axis 8 and the longitudinal axis 10 may be arranged in an acute angle. A detection range 11 of the camera 5 includes the optical axis 8. The detection range 11 covers a part of the rear area 3 of the vehicle 1 accordingly. By looking into the mirror 7 a driver (not shown) may observe an observation range 12 which is also directed towards the rear 3 of the vehicle 1.

20

The camera 5 and the camera moving unit 6 may be connected to a control unit 13. The control unit 13 may receive camera images 14 from the camera 5. The control unit 13 may control the camera moving unit 6 by sending out a control signal 15 to the moving unit 6. The vehicle 1 may comprise displays 16, one for each camera. The control unit 13 may transmit the camera images 14 of each camera to one of the displays 16 respectively.

25

The control unit 13 may be connected to a compass unit 17. The compass unit 17 represents a data capture unit. The compass unit 17 generates a direction signal 18 which signals the orientation of the vehicle 1 with regard to the earth's magnetic field 19. Alternatively, the direction signal 18 may be generated by a gyrometer. As an example, the angle enclosed between the north-south-axis of the magnetic field 19 and the longitudinal axis 10 of the vehicle 1 may be described by the direction signal 18. The compass unit 17 may be integrated into vehicle 1. For example, the compass unit 17 may be part of a navigation system of the vehicle 1. The compass unit 17 and/or the gyrometer may also be comprised in a portable or mobile device, which may be connected to the vehicle 1. For example, the compass unit 17 may be

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included in a smartphone or a portable navigation system which the driver may have brought with him into the vehicle 1.

5 The control unit 13 may comprise a computation unit 19. The computation unit 19 may comprise a micro-controller or micro-processor. By means of the computation unit 19 the control unit 13 may perform the following method concerning the adjustment of the optical axis 8 of the camera 5 while the vehicle 1 is performing a lane change manoeuvre.

10 For the following explanation, references made to Fig. 2 and Fig. 3.

Fig. 2 and Fig. 3 show the side mirror 4 with the camera 5. The camera 5 may comprise a lens section 21 and optionally an illumination section 22. The lens section 21 may be arranged to receive light from the surroundings 23 of the vehicle 1. The received light is conducted to the optical sensor. The illumination unit 22 may be designed to illuminate the surroundings 23. For example, the illumination unit 22 may be designed to emit infrared light. The camera 5 may be supported pivotable around a rotation axis 24 in the side mirror 4. By moving or pivoting the camera 5, the camera moving unit 6 changes an azimuth direction angle 25 of the optical axis 8 in dependence on the control signal 15. The camera moving unit 6 may comprise, for example, an electric motor 26 and a gear mechanism 27 for adjusting the azimuth direction angle 25 of the camera 5.

25 Fig. 4 and Fig. 5 illustrate, how the control unit may support a driver during a lane change manoeuvre of vehicle 1.

Fig. 4 and Fig. 5 show the vehicle 1 during the lane change manoeuvre. The example assumes, that vehicle 1 is moving along a road 28. The driver was driving on a first lane 29 along a travelling direction 30. The driver wants to change to a second lane 31. For example, the lane 31 is the adjacent lane on the right of lane 29. On lane 31, an object 32 is moving, for example another car. The object 32 is moving along the lane direction 33 of lane 31, i.e. in the same direction as the travelling direction 30. Fig. 4 illustrates, that the driver may not see the object 32 by using the mirror 7 with the observation range 12. The object 32 is inside a blind spot area 34 which is the area behind the driver and outside the observation range 12 of side mirror 7. The reason for the fact that object 32 is outside the observation range 12 is, that the vehicle

1 is not moving in parallel to object 32. The longitudinal axis 10 and the lane direction 33 are at an angle 35, which is an acute angle.

5 The computation unit 19 detects the lane change manoeuvre, for example on the basis of the direction signal 18. The computation unit 19 may also consider digital map data 36 that describe the geometry of the road 28 especially the arrangement of lanes 29 and 31. The computation unit 19 may also receive coordinates or a geo-position 37 from a receiver 48 for receiving a signal from a GNSS, for example a GPS. Computation unit 19 may also receive
10 an activity signal 39 from an indicator 40 which may be activated or controlled by the driver.

After the beginning of the lane change manoeuvre has been detected by computation unit 19, computation unit 19 may determine angle 35 on the basis
15 on the direction signal 18 and the map data 36. The computation unit 19 may then determine the blind spot area 34. In other words, computation unit 19 may generate geometric data describing the position of blind spot area 34.

20 After the blind spot area 34 has been determined, computation unit 19 may generate the control signal 15 for activating the camera moving unit 6. The camera moving unit 6 changes the azimuth direction angle 25 of camera 5 such that the optical axis 8 of camera 5 is turned towards the blind spot area 34. In other words, detection range 11 is moved to cover the blind spot area
25 34 (see Fig. 5). The camera images 40 generated by camera 5 are visualized to the driver by means of one of the displays 16. The object 32 is therefore displayed or shown to the driver on display 16. The driver can thus see object 32 although object 32 does not appear in mirror 7. The driver is thus informed about the existence or the position of object 32 next to vehicle 1. The
30 driver can then react on the situation during the lane change manoeuvre.

For capturing the direction signal, the best element is an electrical-compass, then the control unit can calculate a value for the action unit to compensate the driver's view. A gyro maybe a second considered possibility, as it can
35 solve the problem in some specific situations, e.g. if the target lane is parallel of the current lane.

The combination of camera and a moving unit is a possible action unit. A rotated slave mirror is another possibility, it can compensate the driver's view too, and be of lower cost. Then it is not camera-based.

- 5 Moreover, the action unit not only can compensate the driver's view, but also can warn the driver by twinkling LED signals and/or some noise, if a side radar is integrated. Moreover, the car can initiate a deceleration to avoid a crash.
- 10 Overall, the example shows how a blind spot area eliminating system is provided by the invention.

CLAIMS:

1. Method for operating a vehicle (1), while the vehicle (1) is driving on a lane (29) of a road (28), wherein a control unit (13) performs the following steps:
5
- Receiving a direction signal (18) from a data capture unit (17), wherein the direction signal (18) indicates the orientation of the vehicle (1) with regard to the road (28),
- Detecting a lane change manoeuvre, wherein by the lane change manoeuvre the vehicle (1) moves towards an adjacent lane (31) of the road (28),
10
- Determining a blind spot area (34) covering the adjacent lane (31) on the basis of the direction signal (18),
- Controlling an action unit (5, 6) in dependence on the determined blind spot area (34).
15
2. Method according to claim 1, wherein controlling the action unit (5, 6) comprises:
- Turning a detection range of a rear view system (5) of the action unit (5, 6) towards the blind spot area (34) by controlling a moving unit (6).
20
3. Method according to claim 2, wherein the rear view system (5) comprises a reflecting side mirror (7) and/or a rearward-facing camera (5).
- 25 4. Method according to any of the preceding claims, wherein an object detection unit detects an object (32) moving within the blind spot area (34) and wherein controlling the action unit (5, 6) comprises:
- Activating an output unit of the action unit for warning a driver of the vehicle that the object detection unit detected the object inside the blind spot area, and/or
30
- Activating a driving control unit of the action unit for changing the steering angle and/or the speed of the vehicle.
5. Method according to any of the preceding claims, wherein the blind spot area (34) is determined by determining an angle (35) between a driving trajectory of the vehicle (1) and a lane direction (33) of the adjacent lane (31).
35
6. Method according to any of the preceding claims, wherein the blind spot

area (34) is determined in dependence on the driving speed of the vehicle (1).

5 7. Method according to any of the preceding claims, wherein the direction signal (18) is received out of an electronic compass (17) and/or a gyrometer of the vehicle (1) or of a mobile device connected to the vehicle (1).

8. Method according to any of the preceding claims, wherein the lane change manoeuvre is detected on the basis of the direction signal (18).

10

9. Method according to any of the preceding claims, wherein the lane change manoeuvre is detected on the basis of digital map data that describe the geometry of the road (28).

15 10. Method according to any of the preceding claims, wherein the lane change manoeuvre is detected in dependence on an activity signal of a turn signal indicator.

20 11. Control unit (13) that is designed to perform a method according to any one of the preceding claims.

12. Motor vehicle (1) comprising a data capture unit (17), a control unit (13) and an action unit (5, 6), wherein
25 - the data capture unit (17) is designed to generate a direction signal (18) that indicates the orientation of the vehicle with regard to a road (28) that the vehicle (1) is driving on,
- the control unit (13) is designed to detect a lane change manoeuvre, wherein by the lane change manoeuvre the vehicle (1) moves towards an adjacent lane (31), and to determine a blind spot area (34) covering the
30 adjacent lane (34) on the basis of the direction signal (18), and to control the action unit (5, 6) in dependence on the determined blind spot area (34).

35 13. Motor vehicle (1) according to claim 12, wherein the action unit (5, 6) comprises a rear view system (5) and a moving unit (6) that is designed to turn a detection range of the rear view system (5) towards the blind spot area (34).

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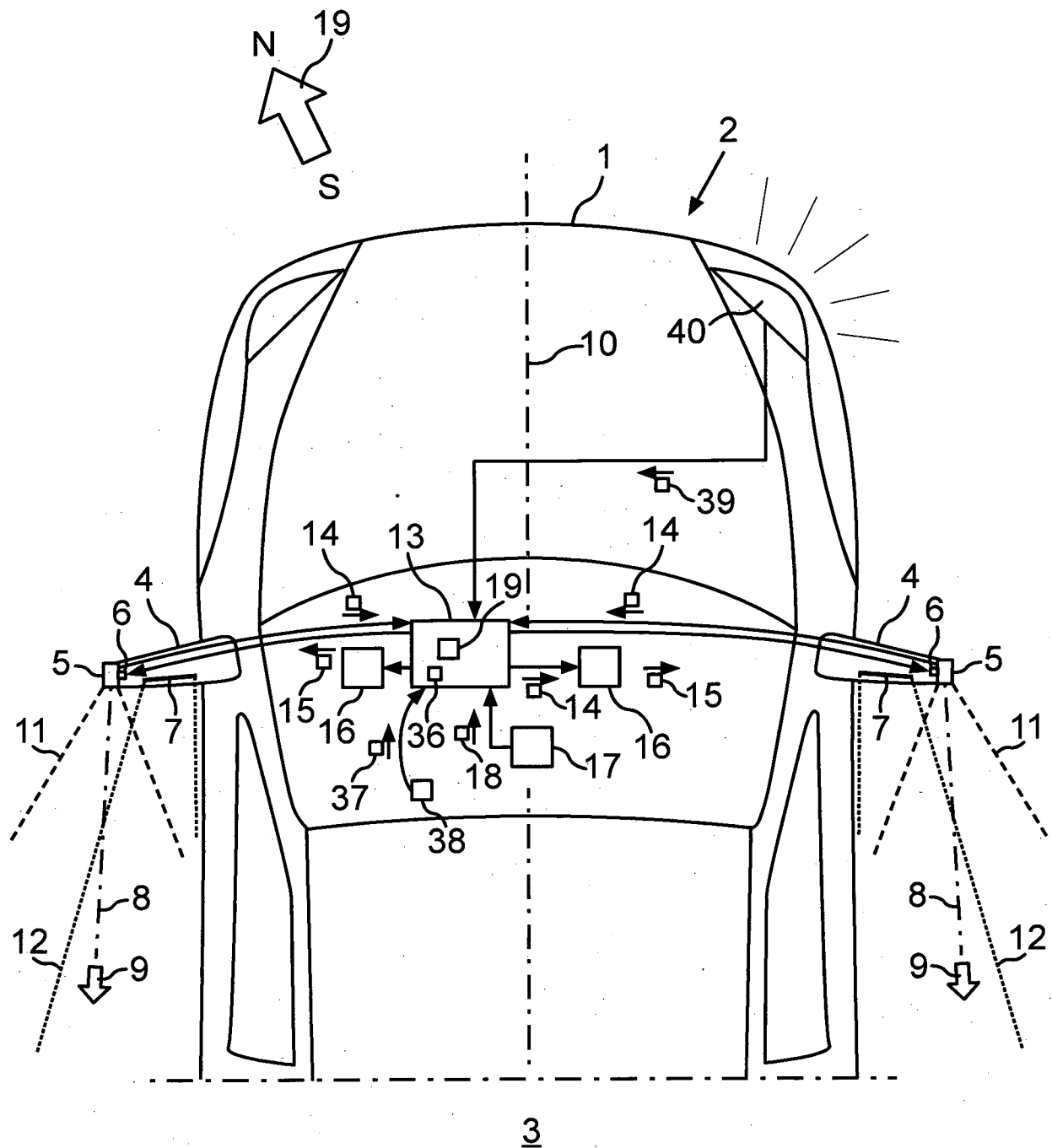


Fig.1

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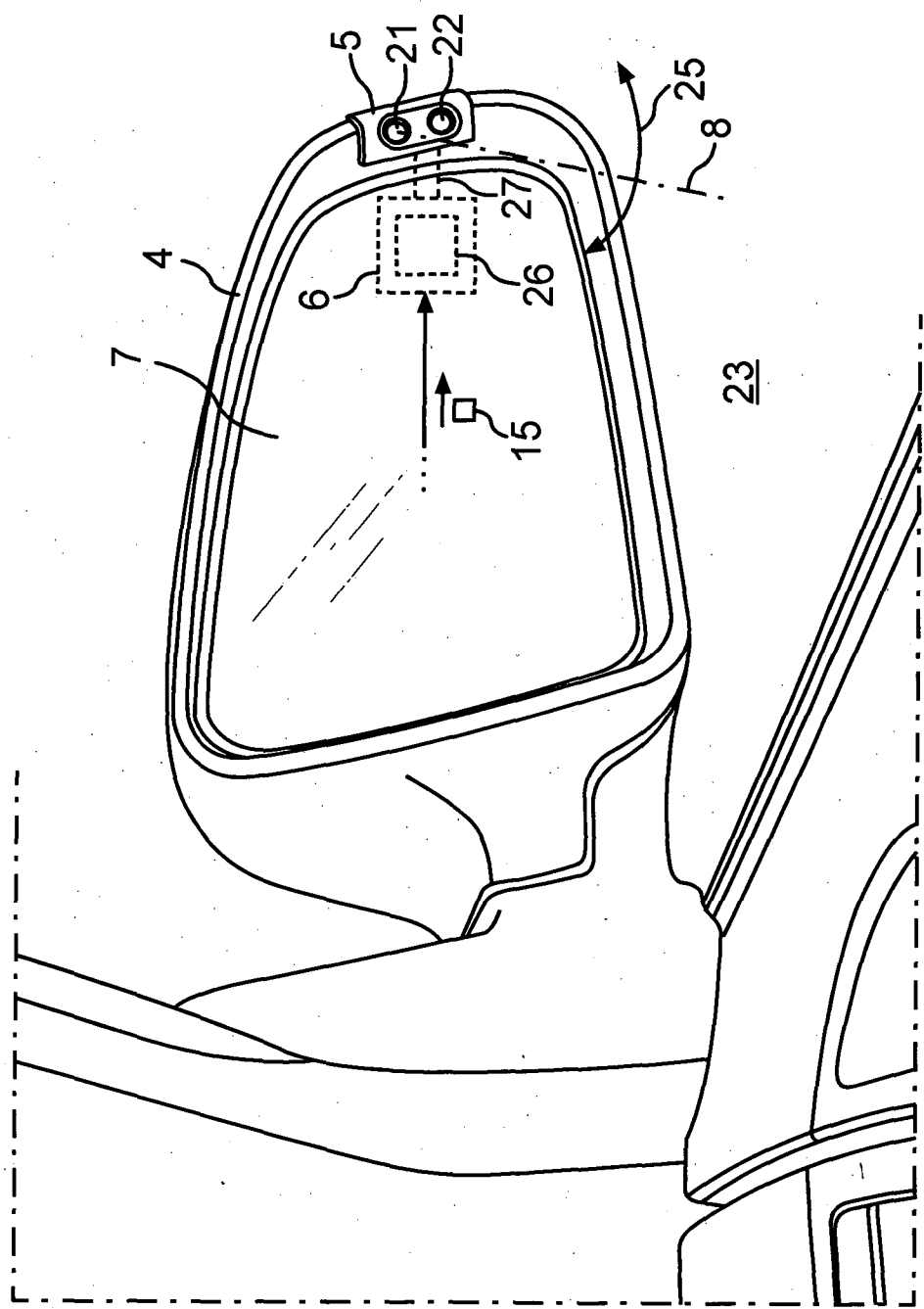


Fig.2

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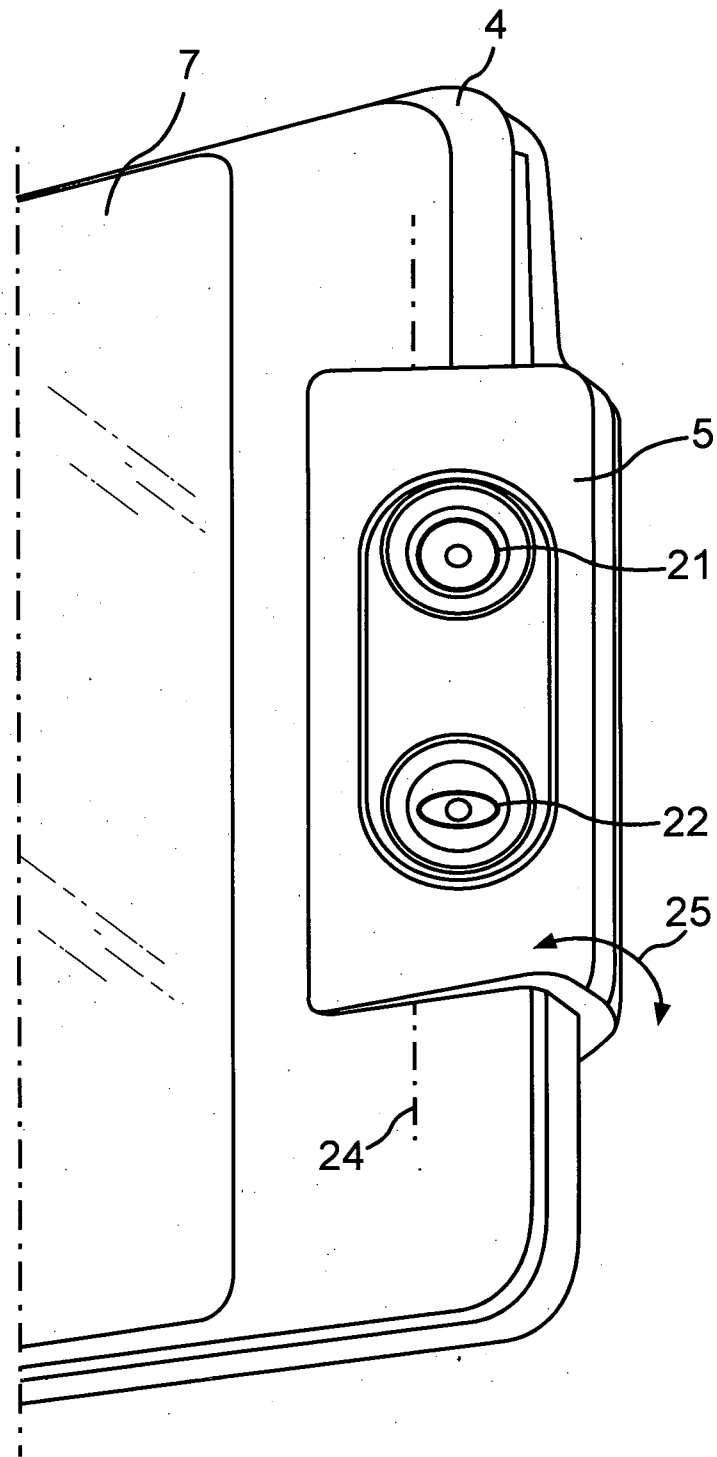


Fig.3

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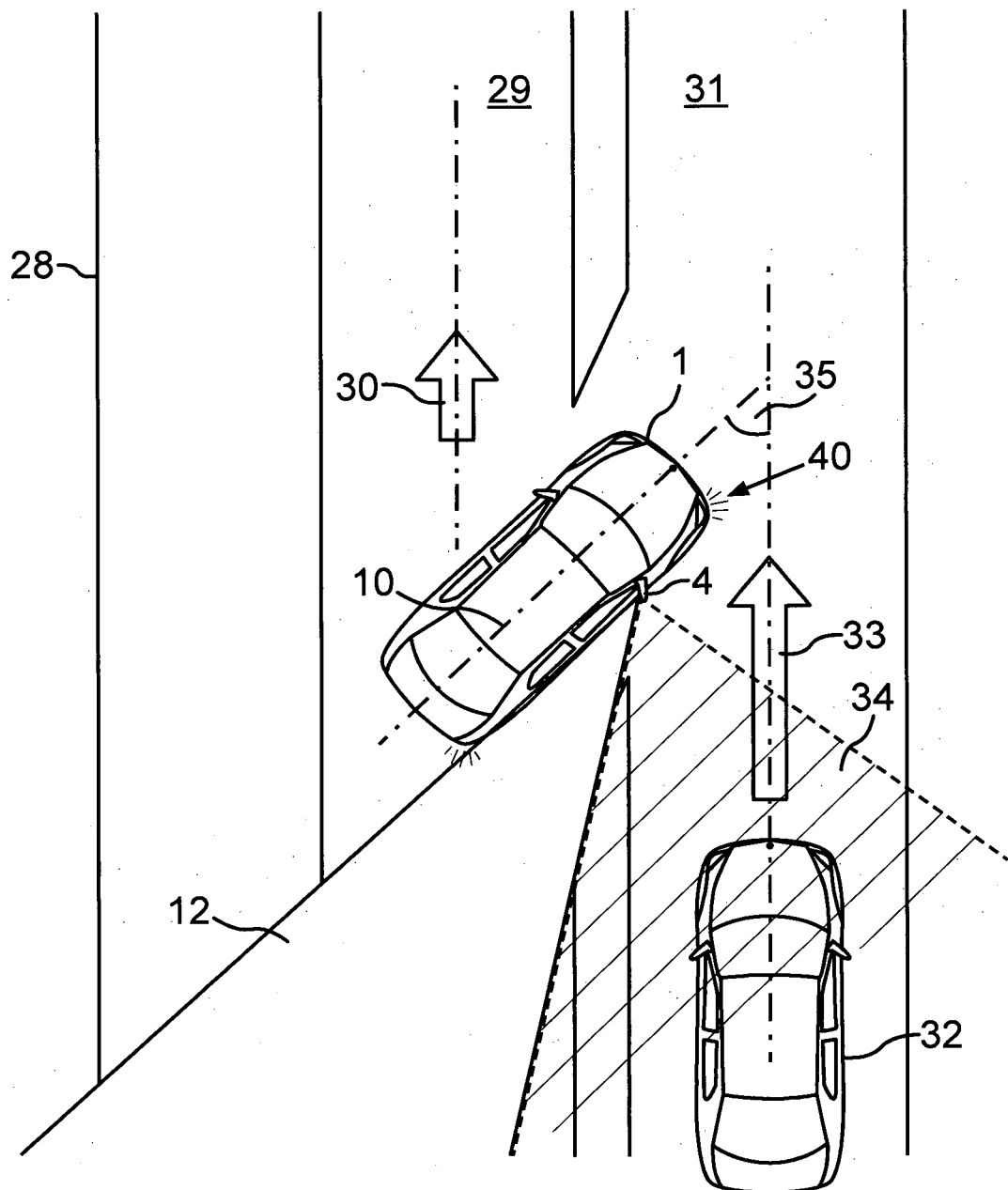


Fig.4

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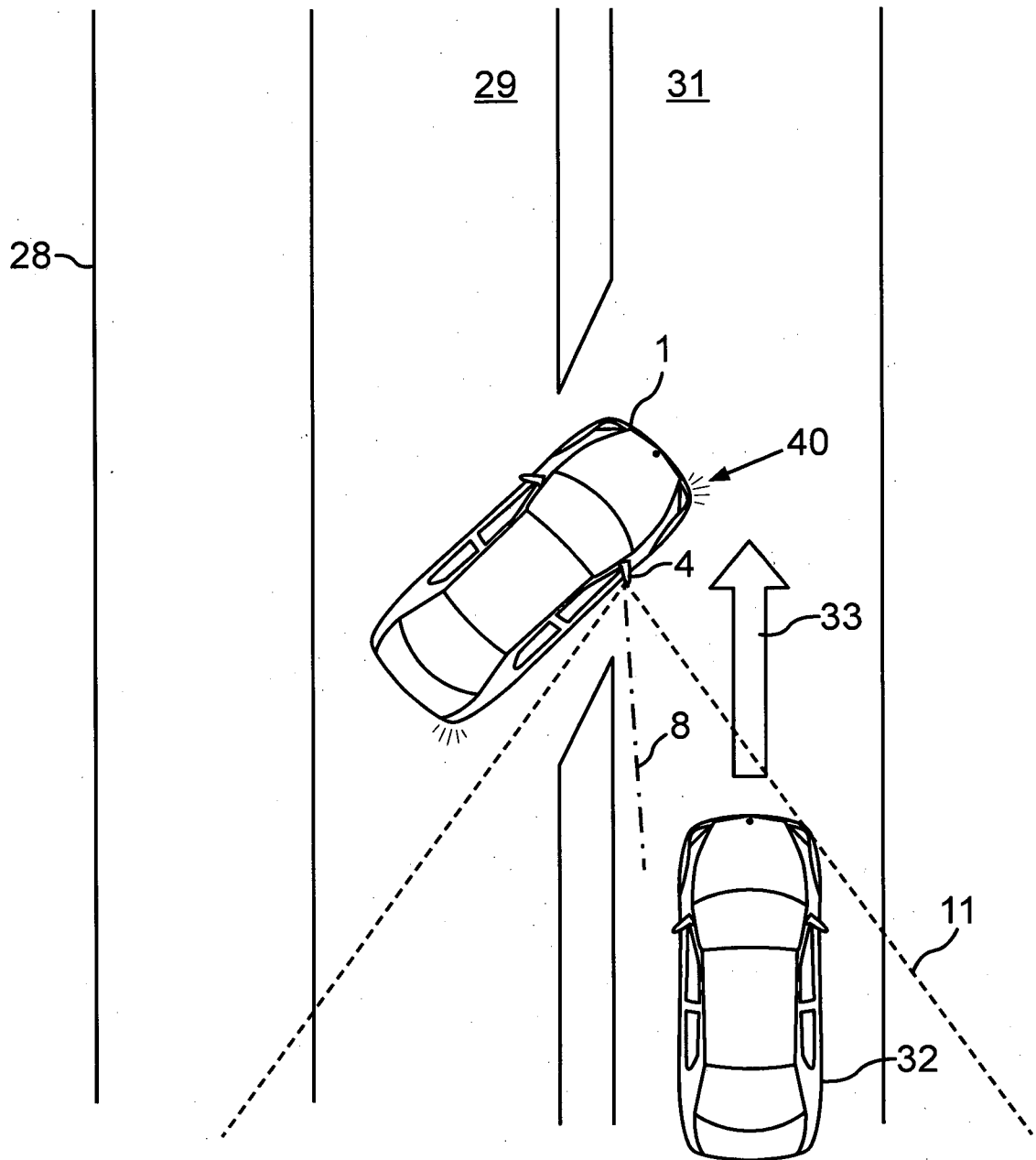


Fig.5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/001502

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60R1/02
ADD. B60W30/18

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)
B60R 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	US 2004/212484 A1 (SU WEN-WEI [TW] ET AL) 28 October 2004 (2004-10-28) paragraphs [0038] - [041,]; claim 1; figure 2 the whole document	1-4,6-13
X	EP 1 338 473 A2 (EXON SCIENCE INC [TW]) 27 August 2003 (2003-08-27) paragraphs [0009], [0014], [0022], [0029], [0035]; claim 1; figure 6 the whole document	1-4,6-13
A	US 5 971 549 A (CRUICKSHANK LESLIE [CA]) 26 October 1999 (1999-10-26) column 3, lines 55-60 column 6, lines 21-23	1,12
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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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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Date of the actual completion of the international search

23 November 2016

Date of mailing of the international search report

02/12/2016

Name and mailing address of the ISA/

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Plenk, Rupert

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2016/001502

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 10 2009 006475 A1 (ADC AUTOMOTIVE DIST CONTROL [DE]) 29 July 2010 (2010-07-29) paragraphs [0023], [0024] -----	1,12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/001502

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