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(54) Title of the Invention: **Rear view display system and method**
Abstract Title: **Rear view display system using a camera and windscreen display**

(57) A rear view display system for a motor vehicle, the rear view display system comprising; a rear view camera 4 configured to capture a rear view image; a windscreen display 6 selectively displaying the rear view image on a windscreen of the vehicle; an eye tracking camera 8 for tracking the eye of a driver of the vehicle; and a controller 10 for determining where the driver is currently looking based on data from the eye tracking camera; wherein the controller is further configured to selectively display the rear view image on the windscreen 12 when it is determined that the driver is looking at or is predicted to look at a predetermined region of the windscreen. The controller may pre-emptively display the rear view image if the driver's line of sight is moving towards the predetermined region. The display may also be activated if a hazard is detected or predicted at the rear of the vehicle, and/or if the vehicle is in one or more driving modes. The display may comprise a projector or a screen provided on or embedded into the windscreen. A deployable mirror may be provided if the system fails.

Fig. 1

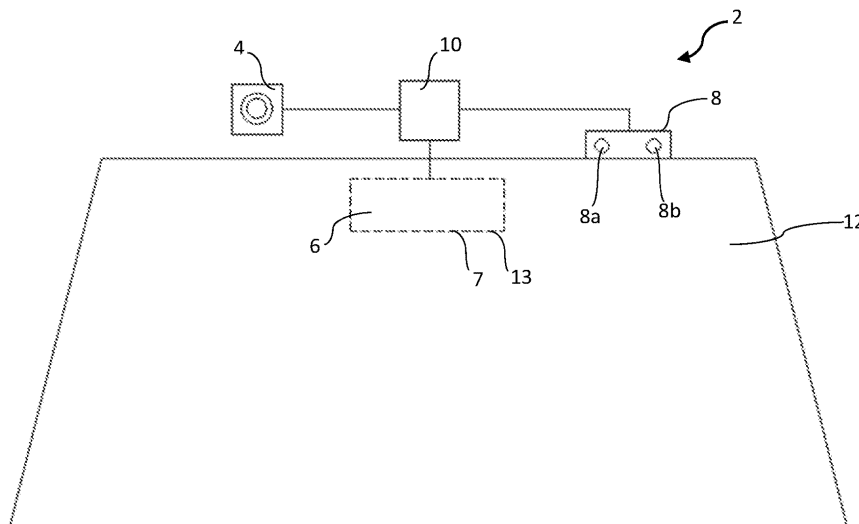


Fig. 1

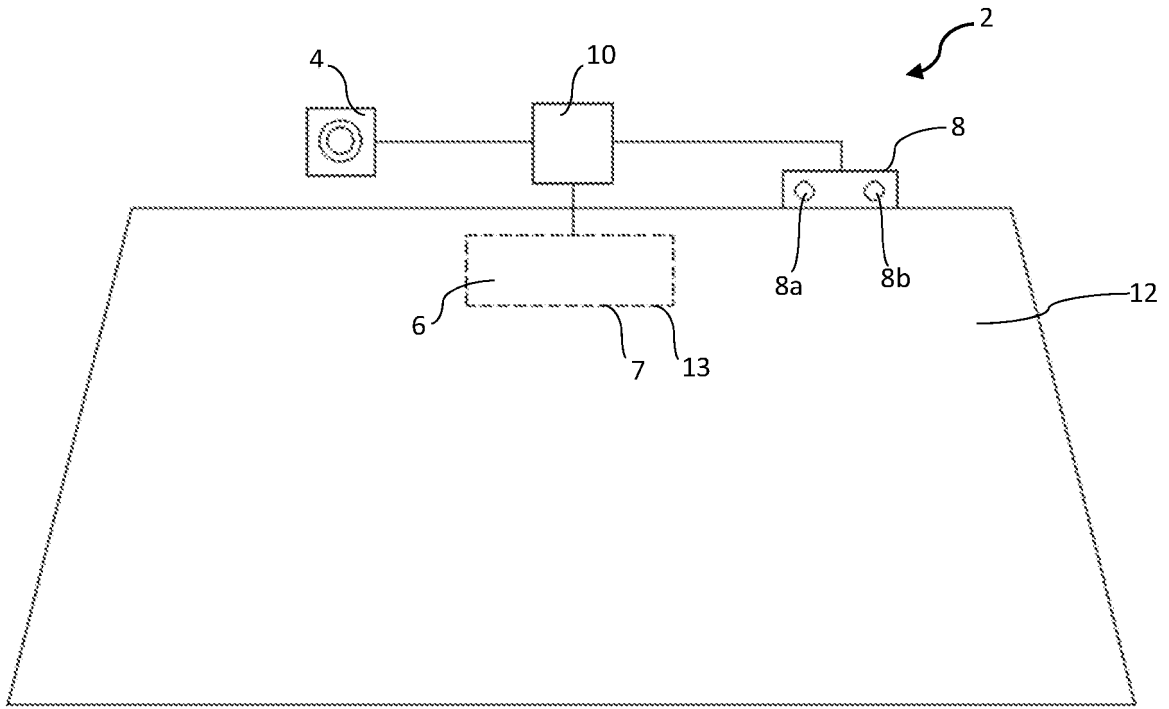


Fig. 2a

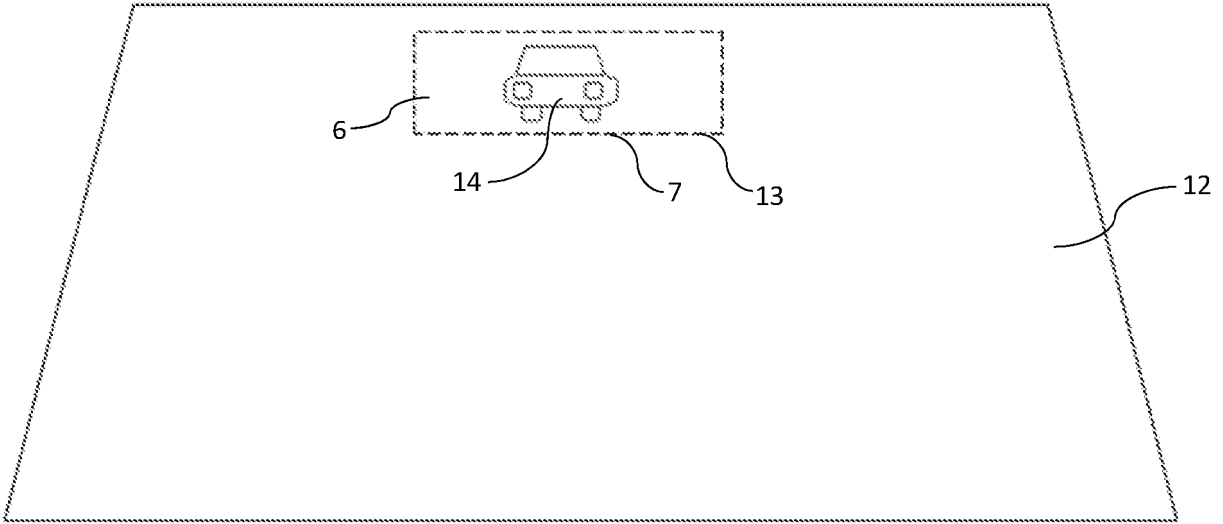


Fig. 2b

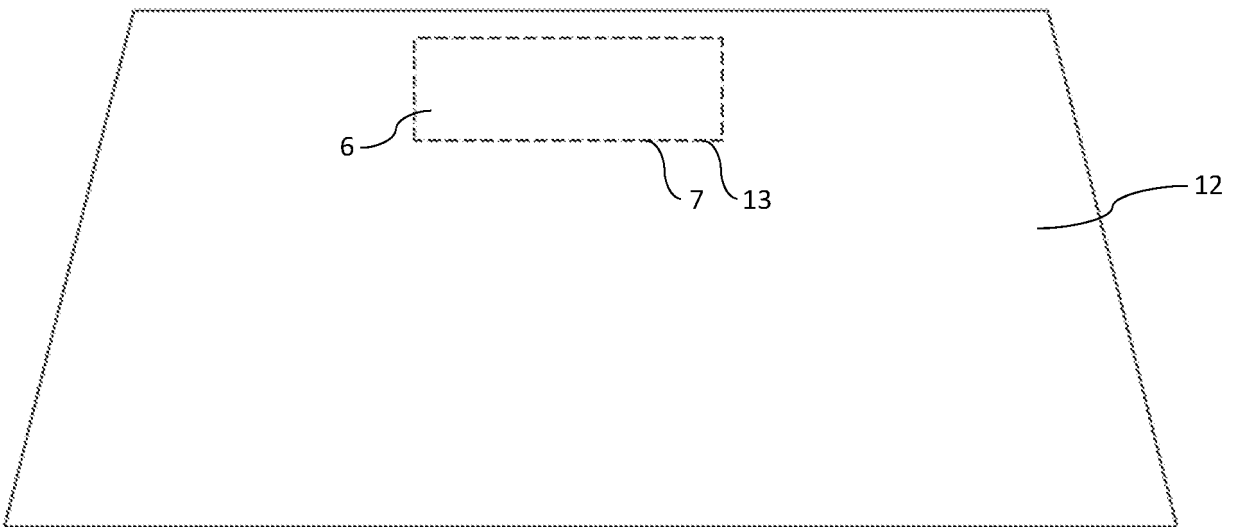
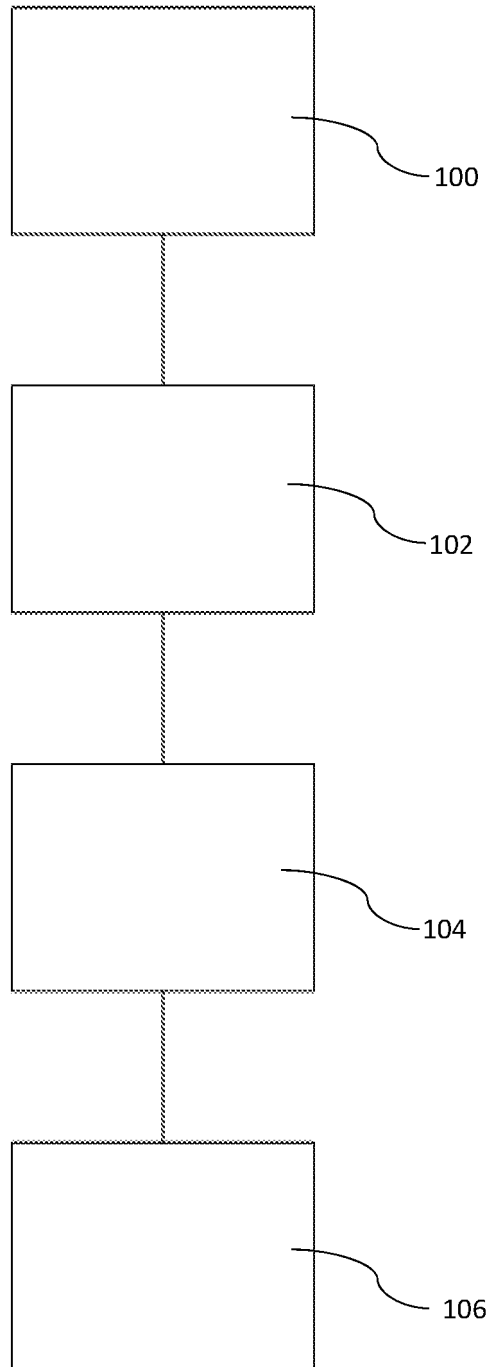


Fig. 3



REAR VIEW DISPLAY SYSTEM AND METHOD

Technical Field

5 This disclosure relates generally to a rear view display system and method for a motor vehicle and particularly, but not exclusively, relates to a rear view display system and method configured to selectively display a rear view image captured by a rear view camera when a driver's eyes are determined to be looking at a location where a rear view mirror would otherwise have been.

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Background

Conventional rear view mirrors provide a driver of a vehicle with a reflected view to the rear of the vehicle. The rear view is desirable before and during many manoeuvres, including turning, reversing and merging into traffic.

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Rear view mirrors are typically mounted onto the front windscreen of the vehicle. However, the rear view mirror and/or its mounting may partially obscure the driver's peripheral view through the windscreen.

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Rear view mirrors are also typically adjustable to accommodate different driver head positions. However, as a result of this adjustability, the rear view mirror may be knocked out of position and the driver's rear view may not be optimal.

25 Furthermore, where different drivers use the same vehicle, the mirrors have to be adjusted to suit the current driver. Drivers often forget to make such adjustments until after setting off. As a result, the rear view may at least initially be compromised and the driver may be distracted whilst adjusting the mirrors.

30 Accordingly, it is desirable to provide a rear view system that does not require adjustment or that does not obstruct the driver's peripheral view.

Statements of Invention

35 According to an aspect of the present disclosure, there is provided a rear view display system for a motor vehicle, the rear view display system comprising:

a rear view camera configured to capture a rear view image;
a windscreen display configured to selectively display the rear view image on a
windscreen of the vehicle; and
a controller configured to selectively display the rear view image.

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The rear view mirror system may comprise an eye tracking camera configured to track the eye of a driver of the vehicle. The controller may be configured to determine where the driver is currently looking based on data from the eye tracking camera. The controller may be further configured to selectively display the rear view image on the windscreen when it is determined
10 that the driver is looking at or is predicted to look at a predetermined region of the windscreen.

Accordingly, a physical rear view mirror may be omitted. The driver's eyes may instead be tracked and when it may be determined that the driver is looking in the direction of where the rear view mirror may have been, an image may be displayed on the windscreen that shows the
15 rear view as captured by a rear view camera.

The controller may be further configured to pre-emptively display the rear view image if the driver's line of sight is moving towards the predetermined region. Such a pre-emptive display of the rear view image may reduce any delay in displaying the rear view image.

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The rear view display system may further comprise one or more hazard detecting systems. The controller may be further configured to selectively display the rear view image on the windscreen when a hazard is detected at the rear of the vehicle, e.g. regardless of where the driver may be looking or predicted to look.

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The rear view display system may further comprise one or more hazard prediction systems. The controller may be further configured to selectively display the rear view image on the windscreen when a hazard is predicted at the rear of the vehicle, e.g. regardless of where the driver may be looking or predicted to look. Displaying the rear view image when a hazard is
30 detected or predicted may serve to warn the driver of a particular hazard.

The controller may be further configured to selectively display the rear view image on the windscreen when the vehicle is in one or more particular driving modes, e.g. regardless of where the driver is looking or predicted to look. Such driving modes may comprise reversing,
35 merging with traffic, indicating before turning or any other driving scenario or manoeuvre.

The windscreen display may comprise a projector configured to project the rear view image onto the windscreen. The windscreen display may comprise one or more rear projection display layers disposed between the projector and the windscreen. The windscreen display may comprise a windscreen with a tinted layer on an inner surface of the windscreen. The tinted
5 layer may comprise a coating or film applied to the windscreen.

The windscreen display may comprise a display screen provided on or embedded into the windscreen. The display screen may comprise an LCD or LED panel or any other display technology. The windscreen display may be confined to or extend beyond the predetermined
10 region of the windscreen. The display screen may comprise a backless display screen through which the driver can view the road ahead.

The windscreen may comprise a border or outline marking where the predetermined region is on the windscreen. Such a border or outline may assist the driver in determining where to look
15 to obtain the rear view. The predetermined region may be provided toward the top and in the middle of the windscreen, e.g. where the rear view mirror might otherwise have been.

The rear view display system may further comprise a deployable rear view mirror that may be movable from a stowed position to a deployed position. For example, the rear view mirror may
20 be deployed upon failure of the rear view display system to selectively display the rear view image on the windscreen.

A vehicle may comprise the above-mentioned rear view display system.

25 According to a second aspect of the present disclosure there is provided a method of displaying a rear view for a motor vehicle, the method comprising:

capturing a rear view image with a rear view camera;
tracking the eye of a driver of the vehicle with an eye tracking camera;
determining where the driver is currently looking based on data from the eye tracking
30 camera; and
selectively displaying the rear view image on a windscreen when it is determined the driver is looking at or is predicted to look at a predetermined region of the windscreen.

The method may further comprise pre-emptively displaying the rear view image if the driver's
35 line of sight is moving towards the predetermined region.

The method may further comprise selectively displaying the rear view image on the windscreen when a hazard is detected at the rear of the vehicle.

5 The method may further comprise selectively displaying the rear view image on the windscreen when a hazard is predicted at the rear of the vehicle.

The method may further comprise selectively displaying the rear view image on the windscreen when the vehicle is in one or more particular driving modes.

10 The method may further comprise moving a deployable rear view mirror from a stowed position to a deployed position upon failure of the rear view display system to selectively display the rear view image on the windscreen.

15 To avoid unnecessary duplication of effort and repetition of text in the specification, certain features are described in relation to only one or several aspects or embodiments of the invention. However, it is to be understood that, where it is technically possible, features described in relation to any aspect or embodiment of the invention may also be used with any other aspect or embodiment of the invention.

20 **Brief Description of the Drawings**

For a better understanding of the present invention, and to shown more clearly how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

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Figure 1 is a schematic diagram depicting a rear view display system according to an arrangement of the present disclosure;

30 Figures 2a and 2b are schematic front views showing the windscreen with and without the rear view image being displayed respectively; and

Figure 3 is a flow diagram depicting a method for display a rear view according to the present disclosure.

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Detailed Description

With reference to Figures 1 and 2 a rear view display system 2 for a motor vehicle comprises a rear view camera 4, a windscreen display 6, an eye tracking camera 8 and a controller 10. The rear view camera 4 may capture a rear facing view 14 from the vehicle. Accordingly, the rear view camera 4 may face rearwards. The rear view camera 4 may be provided at the rear of the vehicle or at any other location where it can capture the rear view image 14.

The windscreen display 6 is configured to selectively display the rear view image 14 captured by the rear view camera 4 on a windscreen 12 of the vehicle. The windscreen display 6 may extend over substantially all of the windscreen 12 or the windscreen display may be confined to a predetermined region 7 of the windscreen. The predetermined region 7 may be provided towards the top and in the middle of the windscreen, for example where the rear view mirror might otherwise have been. Accordingly, the rear view mirror may be omitted.

The windscreen display 6 may comprise a projector configured to project the rear view image 14 onto the windscreen. In the case of the windscreen display comprising the projector the windscreen display may further comprise a rear projection display layer disposed between the projector and the windscreen. The rear projection display layer may disperse the specular light emitted from the projector. The windscreen 12 may comprise a tinted layer on an inner surface of the windscreen. The tinted layer may comprise a coating or film applied to the windscreen 12. The tinted layer may reduce the amount of light from the projector that passes through the windscreen and reflects on an outer surface of the windscreen. The tinted layer may thus reduce the likelihood of double reflections from occurring. Light from the projector may thus preferably reflect from the inner surface of the windscreen 12.

The windscreen display 6 may otherwise comprise a display screen provided on or embedded into the windscreen 12. The display screen may comprise an LCD or LED panel or any other display technology. Such a display screen may be confined to or extend beyond the predetermined region 7 of the windscreen. The display screen may comprise a backless display screen through which the driver can view the road ahead when an image is not being displayed on the windscreen display.

The windscreen 12 may comprise a border marking 13 that outlines where the predetermined region 7 is on the windscreen. The border marking 13 may be permanently provided on the windscreen 12 or the border marking 13 may be displayed by the windscreen display 6. The

border marking 13 may assist the driver in determining where to look to obtain the rear view as will be described in more detail below.

5 However the rear view image is displayed on the windscreen, the rear view image 14 may be distorted by the controller to account for the fact the windscreen is at an angle. For example, the bottom of the image 14 may be stretched laterally so that the image appears as if it had been displayed on a horizontal surface.

10 The eye tracking camera 8 may be provided within or on the vehicle at any location where the eyes of the driver are visible to the eye tracking camera 8. The eye tracking camera 8 may be provided substantially centrally or to one side of the vehicle, for example in front of the driver. The eye tracking camera 8 may be provided above the windscreen 12 or on a dashboard of the vehicle.

15 The eye tracking camera 8 may be configured to determine a 3D position of an eye or eyes of the driver. For example, the eye tracking camera 8 may comprise two or more cameras 8a, 8b, such as digital cameras, which may be arranged in offset positions relative to one another. In other words, the cameras may be spaced apart from one another. The cameras may have an overlapping field of view. Using data from the two cameras, 3D information can be extracted
20 by combining the relative positions of objects or parts of objects in the two images. Alternatively, one of the cameras may comprise a depth sensor, e.g. an infrared laser projector and sensor.

25 The eye tracking camera 8 may also be configured to track the movement of the eye or eyes of the driver of the vehicle. The eye tracking camera 8 may be configured to determine the direction in which the eye or eyes of the driver are looking, e.g. by determining the position of the pupil and/or iris relative to the rest of the face.

30 Accordingly, the eye tracking camera 8 and/or controller 10 may calculate the 3D position of the driver's eye and may determine the direction in which the eye is looking. From knowing where the eyes currently are in 3D space and which direction the eyes are looking, the eye tracking camera 8 and/or controller 10 can then determine the driver's line of sight and where on the windscreen the driver is currently looking.

35 Having determined where the driver is currently looking based on data from the eye tracking camera 8, the controller 10 determines whether the driver is looking at the predetermined region

7 of the windscreen. If it is determined that the driver is looking at the predetermined region, the controller 10 instructs the windscreen display 6 to display the rear view image 14 captured by the rear view camera 4 as depicted in Figure 2a. The controller 10 may also predict whether the driver is about to look at the predetermined region 7. If it is determined that the driver is about to look at the predetermined region, the controller may instruct the windscreen display 6 to display the rear view image in advance of the driver actually looking at the predetermined region 7. The controller 10 may monitor the driver's line of sight and if the line of sight is moving in a direction towards the predetermined region 7, the controller 10 may predict that the driver is about to look at the predetermined region.

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The rear view display system 2 may further comprise one or more hazard detecting systems. The hazard detecting systems may comprise sensors configured to detect potential hazards around the vehicle. The controller 10 may be operatively coupled to the hazard detecting systems and the controller 10 may instruct the windscreen display 6 to display the rear view image 14 when a hazard is detected, e.g. at the rear of the vehicle. In this case the rear view image 14 may be displayed regardless of where the driver is currently looking or is predicted to look.

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The rear view display system 2 may further comprise one or more hazard prediction systems.

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The hazard prediction systems may comprise one or more sensors and a processor configured to predict the occurrence of a hazard to the vehicle. The controller 10 may be operatively coupled to the hazard prediction systems and the controller 10 may instruct the windscreen display 6 to display the rear view image when a hazard is predicted at the rear of the vehicle. In this case the rear view image may be displayed regardless of where the driver is currently looking or is predicted to look.

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The controller 10 may also be configured to selectively display the rear view image 14 on the windscreen when the vehicle is in one or more particular driving modes. For example, such driving modes may comprise reversing, merging with traffic, indicating before turning or any other driving scenario. The controller 10 may also receive data from a navigation system and the controller 10 may display the rear view image 14 when the navigation system indicates the vehicle is about to perform a manoeuvre.

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The controller 10 may not otherwise display the rear view image in the predetermined region as depicted in Figure 2b. The driver's peripheral view may therefore be unobscured. The windscreen display 6 may display the rear view image at a location similar to where a rear view

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mirror may have been provided. It will be appreciated that the rear view mirror may thus be omitted. However, the rear view display system may further comprise a deployable rear view mirror that may be moveable from a stowed position to a deployed position. Such a rear view mirror may be deployed upon failure of the rear view display system to selectively display the rear view image on the windscreen. The deployable rear view mirror may be deployed
5 automatically if a fault with the rear view display system is detected and/or manually if the driver prefers to use the rear view mirror. The driver may also indicate to the controller 10 that the rear view image 14 is to be permanently displayed on the windscreen.

10 With reference to Figure 2, a method of displaying a rear view for a motor vehicle will now be described. The method comprises a first step 100 in which the rear view image 14 is captured with the rear view camera 4. The method comprises a second step 102 in which the eye of the driver is tracked with the eye tracking camera 8. The method comprises a third step in which it is determined where the driver is currently looking based on data from the eye tracking camera.
15 The method comprises a fourth step 106 in which the rear view image is selectively displayed on one windscreen 12 when it is determined the driver is looking at or is predicted to look at the predetermined region 7 of the windscreen.

The method may further comprise pre-emptively displaying the rear view image 14 if the
20 driver's line of sight is moving towards the predetermined region. The rear view image 14 may be displayed on the windscreen when a hazard is detected or predicted at the rear of the vehicle. The rear view image on the windscreen may be displayed when the vehicle is between one or more particular driving modes. The rear view image may not otherwise be displayed.

25 In an alternative arrangement the eye-tracking camera may be omitted. The controller may instead determine when the driver needs to view the rear view image, e.g. if a potential hazard is detected or predicted at the rear.

It will be appreciated by those skilled in the art that although the invention has been described
30 by way of example, with reference to one or more examples, it is not limited to the disclosed examples and alternative examples may be constructed without departing from the scope of the invention as defined by the appended claims.

Claims

1. A rear view display system for a motor vehicle, the rear view display system comprising:
a rear view camera configured to capture a rear view image;
5 a windscreen display configured to selectively display the rear view image on a
windscreen of the vehicle;
an eye tracking camera configured to track the eye of a driver of the vehicle; and
a controller configured to determine where the driver is currently looking based on data
from the eye tracking camera; wherein the controller is further configured to selectively display
10 the rear view image on the windscreen when it is determined that the driver is looking at or is
predicted to look at a predetermined region of the windscreen.
2. The rear view display system of claim 1, wherein the controller is further configured to
pre-emptively display the rear view image if the driver's line of sight is moving towards the
15 predetermined region.
3. The rear view display system of claim 1 or 2, wherein the rear view display system
further comprises one or more hazard detecting systems, wherein the controller is further
configured to selectively display the rear view image on the windscreen when a hazard is
20 detected at the rear of the vehicle.
4. The rear view display system of any of the preceding claims, wherein the rear view
display system further comprises one or more hazard prediction systems, wherein the controller
is further configured to selectively display the rear view image on the windscreen when a hazard
25 is predicted at the rear of the vehicle.
5. The rear view display system of any of the preceding claims, wherein the controller is
further configured to selectively display the rear view image on the windscreen when the
vehicle is in one or more particular driving modes.
30
6. The rear view display system of any of the preceding claims, wherein the windscreen
display comprises a projector configured to project the rear view image onto the windscreen.
7. The rear view display system of claim 6, wherein the windscreen display comprises one
35 or more rear projection display layers disposed between the projector and the windscreen.

8. The rear view display system of claim 6 or 7, wherein the windscreen display comprises a windscreen with a tinted layer on an inner surface of the windscreen.
9. The rear view display system of any of claims 1 to 5, wherein the windscreen display
5 comprises a display screen provided on or embedded into the windscreen.
10. The rear view display system of any of the preceding claims, wherein the windscreen comprises a border marking where the predetermined region is on the windscreen.
- 10 11. The rear view display system of any of the preceding claims, wherein the predetermined region is provided toward the top and in the middle of the windscreen.
12. The rear view display system of any of the preceding claims, wherein the rear view display system further comprises a deployable rear view mirror that is movable from a stowed
15 position to a deployed position upon failure of the rear view display system to selectively display the rear view image on the windscreen.
13. A vehicle comprising the rear view display system of any of the preceding claims.
- 20 14. A method of displaying a rear view for a motor vehicle, the method comprising:
capturing a rear view image with a rear view camera;
tracking the eye of a driver of the vehicle with an eye tracking camera;
determining where the driver is currently looking based on data from the eye tracking
camera; and
25 selectively displaying the rear view image on a windscreen when it is determined the driver is looking at or is predicted to look at a predetermined region of the windscreen.
15. The method of claim 14, wherein the method further comprises:
pre-emptively displaying the rear view image if the driver's line of sight is moving
30 towards the predetermined region.
16. The method of claim 14 or 15, wherein the method further comprises:
selectively displaying the rear view image on the windscreen when a hazard is detected at
the rear of the vehicle.
35
17. The method of any of claims 14 to 16, wherein the method further comprises:

selectively displaying the rear view image on the windscreen when a hazard is predicted at the rear of the vehicle.

18. The method of any of claims 14 to 17, wherein the method further comprises:
5 selectively displaying the rear view image on the windscreen when the vehicle is in one or more particular driving modes.
19. The method of any of claims 14 to 18, wherein the method further comprises:
10 moving a deployable rear view mirror from a stowed position to a deployed position upon failure of the rear view display system to selectively display the rear view image on the windscreen.
20. A rear view display system or vehicle substantially as described herein, with reference to and as shown in the accompanying drawings.
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21. A method of displaying a rear view for a motor vehicle substantially as described herein, with reference to and as shown in the accompanying drawings.

Amendments to the claims have been filed as follows:

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Claims

1. A rear view display system for a motor vehicle, the rear view display system comprising:
a rear view camera configured to capture a rear view image;
5 a windscreen display configured to selectively display the rear view image on a
windscreen of the vehicle;
an eye tracking camera configured to track the eye of a driver of the vehicle; and
a controller configured to determine where the driver is currently looking based on data
10 from the eye tracking camera; wherein the controller is further configured to selectively display
the rear view image on the windscreen when it is determined that the driver is looking at or is
predicted to look at a predetermined region of the windscreen, wherein the controller is further
configured to distort the rear view image displayed on the windscreen to account for the
windscreen being at an angle.
- 15 2. The rear view display system of claim 1, wherein the controller is further configured to
pre-emptively display the rear view image if the driver's line of sight is moving towards the
predetermined region.
3. The rear view display system of claim 1 or 2, wherein the rear view display system
20 further comprises one or more hazard detecting systems, wherein the controller is further
configured to selectively display the rear view image on the windscreen when a hazard is
detected at the rear of the vehicle.
4. The rear view display system of any of the preceding claims, wherein the rear view
25 display system further comprises one or more hazard prediction systems, wherein the controller
is further configured to selectively display the rear view image on the windscreen when a hazard
is predicted at the rear of the vehicle.
5. The rear view display system of any of the preceding claims, wherein the controller is
30 further configured to selectively display the rear view image on the windscreen when the
vehicle is in one or more particular driving modes.
6. The rear view display system of any of the preceding claims, wherein the windscreen
display comprises a projector configured to project the rear view image onto the windscreen.

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7. The rear view display system of claim 6, wherein the windscreen display comprises one or more rear projection display layers disposed between the projector and the windscreen.

8. The rear view display system of claim 6 or 7, wherein the windscreen display comprises a
5 windscreen with a tinted layer on an inner surface of the windscreen.

9. The rear view display system of any of claims 1 to 5, wherein the windscreen display comprises a display screen provided on or embedded into the windscreen.

10 10. The rear view display system of any of the preceding claims, wherein the windscreen comprises a border marking where the predetermined region is on the windscreen.

11. The rear view display system of claim 10, wherein the border marking is displayed by the
windscreen display.

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12. The rear view display system of any of the preceding claims, wherein the predetermined region is provided toward the top and in the middle of the windscreen.

13. The rear view display system of any of the preceding claims, wherein the rear view
20 display system further comprises a deployable rear view mirror that is movable from a stowed position to a deployed position upon failure of the rear view display system to selectively display the rear view image on the windscreen.

14. A vehicle comprising the rear view display system of any of the preceding claims.
25

15. A method of displaying a rear view for a motor vehicle, the method comprising:
capturing a rear view image with a rear view camera;
tracking the eye of a driver of the vehicle with an eye tracking camera;
determining where the driver is currently looking based on data from the eye tracking
30 camera;
selectively displaying the rear view image on a windscreen when it is determined the driver is looking at or is predicted to look at a predetermined region of the windscreen; and
distorting the rear view image displayed on the windscreen to account for the windscreen
being at an angle.

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16. The method of claim 15, wherein the method further comprises:

pre-emptively displaying the rear view image if the driver's line of sight is moving towards the predetermined region.

17. The method of claim 15 or 16, wherein the method further comprises:

5 selectively displaying the rear view image on the windscreen when a hazard is detected at the rear of the vehicle.

18. The method of any of claims 15 to 17, wherein the method further comprises:

10 selectively displaying the rear view image on the windscreen when a hazard is predicted at the rear of the vehicle.

19. The method of any of claims 15 to 18, wherein the method further comprises:

15 selectively displaying the rear view image on the windscreen when the vehicle is in one or more particular driving modes.

20. The method of any of claims 15 to 19, wherein the method further comprises:

20 moving a deployable rear view mirror from a stowed position to a deployed position upon failure of the rear view display system to selectively display the rear view image on the windscreen.

21. The method of any of claims 15 to 20, wherein the method further comprises:

displaying a border marking where the predetermined region is on the windscreen, the border marking being displayed by the windscreen display.

25 22. A rear view display system or vehicle substantially as described herein, with reference to and as shown in the accompanying drawings.

23. A method of displaying a rear view for a motor vehicle substantially as described herein, with reference to and as shown in the accompanying drawings.

30



Application No: GB1516567.3

Examiner: Peter Gardiner

Claims searched: 1 to 21

Date of search: 17 March 2016

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X,Y	X: 1-11,13-18; Y: 12,19	US 2015/0232030 A1 (MAGNA ELECTRONICS) See the whole document.
X	1,2,9,13,14,15	KR 1020120062541 A (HYUNDAI) See the abstract and figures, in particular the tracking of the driver's eye line towards the display region.
Y	12,19	US 5121200 A (CHOI) See the emergency deployable mirror in figure 8.
A	-	DE 102012020170 A1 (VW) See the whole document, in particular the display which can be selectively dimmed and brightened depending upon the driver's line of sight.

Categories:

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

Field of Search:

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

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

B60R; G02B

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

WPI, EPODOC

International Classification:

Subclass	Subgroup	Valid From
B60R	0001/02	01/01/2006