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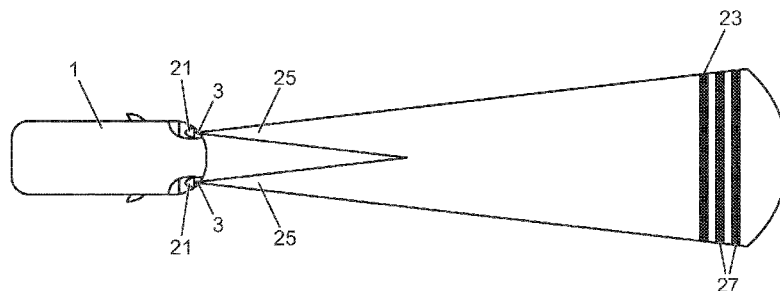


FIG. 2

(57) Abstract: An apparatus (41), system (103), method and computer program (97) for controlling lighting of a vehicle (1), the apparatus (41) comprising; means (43) for controlling a beam of light (21) to create a beam of structured light (25) comprising a projected pattern; means for detecting deformation of the projected pattern; and means for controlling the projected pattern in response to the detected deformation.

APPARATUS, SYSTEM, METHOD AND COMPUTER PROGRAM FOR PROVIDING LIGHTING OF A VEHICLE

TECHNICAL FIELD

5 The present disclosure relates to an apparatus, system, method and computer program for providing lighting of a vehicle. In particular, but not exclusively it relates to an apparatus, system, method and computer program for providing lighting of a vehicle which enables the lighting to be adapted.

10 Aspects of the invention relate to an apparatus, system, method, computer program and vehicle.

BACKGROUND

Vehicles are required to have lighting apparatus such as headlights to enable the vehicles to
15 be used at night and during periods of low lighting levels.

It is an aim of the present invention to improve lighting apparatus for vehicles.

SUMMARY OF THE INVENTION

20 Aspects and embodiments of the invention provide an apparatus, system, method computer program, and non-transitory computer readable media as claimed in the appended claims.

According to an aspect of the invention there is provided an apparatus for providing lighting of a vehicle, the apparatus comprising: means for providing a beam of light; and means for
25 controlling the beam of light to create a beam of structured light.

The embodiments of the invention provide the advantage that they provide increased visibility for users driving at night or in other reduced light conditions. The beam of structured light comprises a pattern which will deform when it is incident on an object. The deformation
30 of the pattern will increase the visibility of the object to the driver of the vehicle.

The means for providing a beam of light may comprise a plurality of light emitting diodes.

Using light emitting diodes (LEDs) for providing the beam of light provides a lightweight and
35 efficient source of light. The LEDs may be individually turned on or off. This may enable

control of the size and shape of the beam of light and/or the pattern within the beam of light. In some examples the LEDs may be tuned to provide different colour temperatures. This may enable the light source to be adapted for driving conditions and/or may enable the user to arrange the LEDs into a preferred colour setting.

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The means for providing a beam of light may comprise an optical device.

The optical device provides the advantage that it enables light from a light source to be directed onto the means for projecting a pattern. This may improve the efficiency of the apparatus as it may reduce the amount of light that is wasted within the apparatus. The optical device could be a collimator or any other suitable type of device.

10

The means for controlling the beam of light may comprise a liquid crystal display, or any other display device.

15

The liquid crystal display (LCD) enables a pattern to be provided within the beam of light by displaying an image on the LCD. The image that is displayed on the LCD may be controlled using any suitable controller and/or display driver. The image that is displayed on the LCD may be changed to change the pattern that is provided. Therefore the LCD provides the advantages of a lightweight and programmable means for creating a beam of structured light.

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The means for controlling the beam of light may comprise a mask.

The use of the mask provides the advantage that it does not require any power for operation as it simply blocks the light to create the patterns needed to create a beam of structured light.

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The means for controlling the beam of light may comprise one or more diffractive components.

30

The diffractive components provide the advantage that they enable light that is blocked to be diffracted to other parts of the beam. This provides a more efficient apparatus as it reduces the amount of light that is wasted.

35

The means for providing a beam of light may comprise a coherent light source.

5 The coherent light source provides the advantage that no additional optical components are needed. As the coherent light source provides a focussed and collimated beam of light there is no need for additional optical components such as collimators or focussing lenses. This may reduce the number of component within the apparatus.

The coherent light source may comprise a laser.

10 The laser may provide the advantage that it may reduce the size of the apparatus for providing forward lighting of a vehicle.

The coherent light source may be arranged to provide white light.

15 Providing a coherent source of white light may enable the light source to be used to provide head lights or other lights for a vehicle.

The means for controlling a beam of light to create a beam of structured light may comprise a micro-electromechanical mirror.

20

The micro-electromechanical (MEMs) mirror provides the advantage that it may reduce the size of the apparatus for providing forward lighting of a vehicle. The MEMs mirror may be rotated to control the pattern that is projected onto the beam. This may enable the pattern and the structures within the light to be changed as needed.

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The means for controlling a beam of light to create a beam of structured light may be arranged to enable the size and/or shape of the beam of light to be changed.

30 This may enable a plurality of settings to be provided for the forward lighting. In some examples this may enable the beam of light to be switched between low beam and full beam settings. This may also enable other settings to be provided, for example, a setting in between low beam and full beam could be provided.

35 The apparatus may comprise means for controlling the apparatus to change a pattern within the beam of structured light.

The means for controlling the apparatus may comprise a controller. The controller may be implemented as hardware or by using instructions that enable hardware functionality.

5 This may provide the advantage that it may enable different patterns to be provided in different conditions. In some examples the pattern may change as the vehicle approaches an object to make the detected object to be more visible to a user. In some examples the pattern may change to prevent glare for drivers of oncoming vehicles.

10 In some examples the means for controlling the apparatus enables the pattern within the beam of structured light to be changed based on the road ahead of the vehicle.

This may provide the advantage that the beam of structured light may be optimised for the road ahead of the vehicle. For instance, if the vehicle is travelling on a straight road the
15 pattern may comprise horizontal parallel lines whereas if the vehicle is travelling on a curved road the lines could be provided at an angle corresponding to the curvature of the road. This may make it easier for the driver of the vehicle to see the road ahead.

In some examples the means for controlling the apparatus may enable a user to change the
20 pattern within the beam of structured light.

Enabling a user to change the pattern provides the advantage that it enables a user to select the patterns and settings they prefer. This may enable different apparatus to be personalised for use with different users.

25

The means for controlling the apparatus may enable the pattern within the structure beam of light to be changed automatically.

Enabling the pattern to be changed automatically may enable the beam of light to be
30 adapted to improve visibility for the current lighting conditions and/or to improve visibility of objects in front of the vehicle without requiring any input from the user.

The pattern within the beam of structured light may comprise a plurality of parallel lines.

The parallel lines may provide the advantage that they deform when they are incident on an object. The deformation may be clearly visible to a user so that the visibility of the object is increased. In some examples the deformation of the parallel lines may be detected automatically by analysing images of the pattern.

5

According to an aspect of the invention there is provided a system for controlling lighting in a vehicle, the system comprising: an apparatus as described above; and means for obtaining an image of the structured light incident on the object; means for detecting deformation of a projected pattern; and means for controlling the apparatus to change the pattern within the structured beam of light in response to the detected deformation.

10

The means for controlling the apparatus may comprise a controller. The controller may be implemented as hardware or by using instructions that enable hardware functionality.

15

The controller may also provide means for detecting the deformation of the projected pattern.

The system provides the advantage that it may enable objects in front of the vehicle to be detected automatically. Once the object has been detected information relating to the object may be provided to a driver or a warning may be provided to the driver of the vehicle. The system also provides the advantage that the projected pattern and/or other settings of the forward lighting may be changed to increase the visibility of the object to the driver.

20

The means for obtaining an image may comprise a camera.

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The system provides the advantage that a camera can be used to detect objects. No other sensors would be needed to enable the objects to be detected. In some examples the objects could be identified by analysing the images obtained by the camera.

30

According to an aspect of the invention there is provided a system for controlling forward lighting of a vehicle as described above, wherein: the means for detecting deformation of the projected pattern comprises an electronic processor having an electrical input for receiving one or more signals from the means for obtaining an image; and an electronic memory device electrically coupled to the electronic processor and having instructions stored therein; and the means to control the apparatus to change the pattern comprises the processor being

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arranged to access the memory device and execute the instructions stored therein such that it is operable to detect that the pattern is deformed and command the means for projecting the pattern to change the pattern.

- 5 According to an aspect of the invention there is provided a vehicle comprising an apparatus as described above.

According to an aspect of the invention there is provided a vehicle comprising a system as described above.

10

According to an aspect of the invention there is provided a method for controlling lighting of a vehicle, the method comprising: controlling an apparatus to provide a beam of structured light; obtaining an image of the beam of structured light incident on an object; detecting deformation of a pattern within the beam of structured light; and changing the pattern in response to the detected deformation.

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According to an aspect of the invention there is provided a computer program comprising instructions that, when executed by one or more processors, cause a system to perform, at least: controlling an apparatus to provide a beam of structured light; obtaining an image of the beam of structured light incident on an object; detecting deformation of a pattern within the beam of structured light; and changing the pattern in response to the detected deformation.

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According to an aspect of the invention there is provided non-transitory computer readable media comprising a computer program as described above.

25

According to an aspect of the invention there is provided an apparatus for providing lighting of a vehicle comprising: means for providing a beam of structured light.

- 30 The means for providing a beam of structured light may comprise a light source and any one or more of; a liquid crystal display, a mask, one or more diffractive components, a microelectromechanical mirror.

According to an aspect of the invention there is provided an apparatus for providing lighting of a vehicle, the apparatus comprising: a light source arranged to provide a beam of light;

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and one or more optical components arranged to project a pattern onto the beam of light to create a beam of structured light.

According to an aspect of the invention there is provided an apparatus for providing lighting of a vehicle, the apparatus comprising: means for providing a beam of light; and means for projecting a pattern onto the beam of light wherein the means for projecting the pattern are controllable to enable, at least one of, the size and shape of the beam of light to be controlled.

The means for projecting a pattern onto the beam of light may comprise any one or more of; a liquid crystal display, a mask, one or more diffractive components, a microelectromechanical mirror.

The apparatus may be for providing forward lighting of a vehicle.

Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig 1 illustrates an example vehicle which may comprise embodiments of the invention;
Fig 2 illustrates an example forward lighting beam;
Figs 3A and 3B schematically illustrate an example forward lighting beam in use;
Fig 4 illustrates an example apparatus;
Fig 5 illustrates an example apparatus;
Figs 6A to 6D illustrate another example apparatus.

Figs 7A to 7C illustrate example forward lighting beams;

Fig 8 schematically illustrates a system for determining a type of surface;

Fig 9 illustrates a controller;

Fig 10 illustrates a controller within a system for controlling forward lighting;

5 Fig 11 illustrates an example method;

Fig 12 illustrates a controller within a system for controlling settings of a vehicle; and

Fig 13 illustrates an example method.

DETAILED DESCRIPTION

10 Examples of the present disclosure relate to apparatus and systems which enable the lighting in a vehicle 1 to be controlled. The Figures illustrate an apparatus 41 for providing forward lighting of a vehicle 1, the apparatus 41 comprising; means 43 for providing a beam of light 21; and means 45 for controlling the beam of light 21 to create a beam of structured light 25.

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Fig 1 illustrates an example vehicle 1 which may comprise apparatus 41 and systems 81, 103, according to examples of the present disclosure. The vehicle 1 comprises headlights 3 positioned on the front of the vehicle 1 and arranged to provide a forward lighting beam for the vehicle 1. The headlights 3 may comprise apparatus 41 as described below. It is to be appreciated that the vehicle 1 of Fig 1 is provided as an example and that embodiments of the invention may be provided in any suitable vehicle 1.

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Fig 2 illustrates a plan view of a vehicle 1 using an apparatus 41 to provide a beam of light 21. In the example of Fig 2 the vehicle 1 comprises two headlights 3. Each headlight 3 may comprise an apparatus 41 which provides a beam of light 21. The beams of light 21 may combine to form the forward lighting beam for the vehicle 1.

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The apparatus 41 is arranged to control the beam of light 21 to create a beam of structured light. The apparatus 41 may be arranged to project a pattern 23 on to the beams of light 21 to create a beam of structured light 25. The beam of structured light 25 may comprise any beam of light which comprises a plurality of light and dark fringes. The light and dark fringes may be formed by the pattern 23.

30

In the example of Fig 2 the pattern 23 comprises a plurality of parallel lines 27. The parallel lines 27 form dark fringes within the beam of structured light 25.

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In the example of Fig 2 the parallel lines 27 are arranged in a horizontal orientation. The parallel lines 27 are positioned within the beam of structured light 25 such that the spaces between the parallel lines 27 are not visible when the beam of structured light 25 is incident on a flat horizontal surface such as a road. The parallel lines 27 may be positioned so that when the beam of structured light 25 is incident on a flat horizontal surface such as a road they appear on the horizon for the driver and provide minimal distraction to the driver. When the parallel lines 27 are incident on an object other than the flat road surface they may deform as described below.

In the example of Fig 2 the parallel lines 27 are arranged in a regular pattern such that each parallel line 27 has the same thickness as other parallel lines 27 and the spacings between adjacent parallel lines 27 is the same for each parallel line 27 within the pattern 23. It is to be appreciated that in other examples the pattern 23 might not be regular. For example the different parallel lines 27 could have different thicknesses and there may be different spacings between different pairs of parallel lines 27.

It is to be appreciated that shapes other than parallel lines 27 could be used in patterns 23 may be used in other embodiments of the invention. For instance in other examples the pattern 23 could comprise curved lines, dots, vertical lines or any other suitable shapes or combinations of shapes.

In the example of Fig 2 the pattern 23 is projected onto the beam of light 21 so that the pattern 23 is positioned at the widest part of the beam of light 21. This may improve the effectiveness of the pattern 23 in increasing the visibility of objects. In other examples the pattern 23 may be provided at other positions within the beam of light 21. In some examples the apparatus 41 may be arranged so that the pattern 23 may be provided at different positions within the beam of light 21. In some examples the position of the pattern 23 within the beam of light 21 may be adjusted by a controller 91 to ensure that objects remain visible as the vehicle 1 approaches the object.

Figs 3A and 3B schematically illustrate how the pattern 23 improves the visibility of objects. Fig 3A illustrates a speed bump 31 which is positioned in the middle of the road. The speed bump 31 comprises a raised portion within the flat surface 33 of the road. It is useful to improve the visibility of such objects for a driver.

Fig 3B schematically illustrates the speed bump 31 being illuminated with a beam of structured light 25. In the example of Fig 3B only the pattern 23 from the beam of structured light 25 is illustrated for clarity.

5

When the pattern 23 is incident on the speed bump 31 this causes deformation of the parallel lines 27 within the pattern 23. The parallel lines 27 deform to bend around the shape of the speed bump 31. The deformation of the parallel lines 27 may be visible to the user. The pattern 23 also deforms so that the spacing between the parallel lines 27 also becomes visible to the driver. This increases the visibility of the speed bump 31.

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In the example of Fig 3B the parallel lines 27 are deformed so that a bend 35 is visible in each of the parallel lines 27 at the edges of the speed bump 31. This may increase the visibility of the edge of the speed bump 31 to a driver of the vehicle 1. In some examples the positions of the bends in the pattern 23 may enable a controller 91 to determine the shape and/or size of the speed bump or any other object. This information could be used to control settings of the vehicle.

15

The deformations of the pattern 23 which are caused by the object may depend on a plurality of factors such as the size, shape and position of the object relative to the vehicle 1. The deformations may also depend on the pattern 23 which is provided within the structured beam of light 25. In some examples the apparatus 41 may be controlled by a controller 91 so that if the beam of structure light 25 is incident on an object the pattern 23 may be changed as the vehicle 1 approaches the object to ensure that the object remains visible.

25

It is to be appreciated that although a speed bump 31 has been used in the examples of Figs 3A and 3B the deformation of the pattern 23 could be caused by any object which is positioned within the beam of structured light 25. The objects could comprise obstructions in the road, potholes, street furniture or any other suitable object.

30

Fig 4 illustrates an example apparatus 41. The example apparatus 41 may be provided within a vehicle 1 and used to provide forward lighting. The forward lighting may comprise a beam of structured light 25. The beam of structured light 25 may be as described in relation to Figs 2 to 3B. The apparatus 41 may be provided within the headlight 3 of the vehicle 1. Each of the headlights 3 may comprise an apparatus 41.

35

The apparatus 41 comprises means 43 for providing a beam of light 21 and means 45 for controlling the beam of light 21 to create a beam of structured light 25. It is to be appreciated that only components necessary for the following description are illustrated in Fig 4. The apparatus 41 may comprise other components such as optical devices and lenses which are not illustrated in Fig 4.

The means 43 for providing a beam of light 21 may comprise any suitable light source. In some examples the means 43 for providing a beam of light 21 may comprise one or more light emitting diodes (LEDs), a coherent light source, laser, a light bulb or any other suitable light source.

The means 43 for providing a beam of light 21 may provide white light. The colour temperature of the beam of light 21 may be determined by the means 43 for providing a beam of light 21. In some examples the means 43 for providing a beam of light 21 may be configurable to enable the colour temperature of the light provided to be adjusted. This may enable the user to select a shade of white light that they prefer. For instance some users may prefer white light with a high colour temperature which may appear to be blue-white. Other users may find the high colour temperature light may cause eye strain and may prefer white light with a low colour temperature. The white light may appear to be yellow-white.

In some examples the means 43 for providing a beam of light 21 may be controlled by a controller 91 to enable the colour temperature to be changed automatically, without user input. For instance, in foggy or snowy conditions white light with a high colour temperature may cause increased glare and eyestrain while white light with a low colour temperature may increase visibility and reduce eyestrain. If it is determined that the vehicle 1 is being used in foggy or snowy conditions that a setting of the means 43 for providing a beam of light 21 may be controlled to reduce the colour temperature and improve the visibility for the driver.

The apparatus 41 is arranged so that the beam of light 21 is incident on the means 45 for controlling the beam of light 21 to create a beam of structured light 25. The means 45 for controlling the beam of light 21 to create a beam of structured light 25 may comprise any means which enables one or more dark fringes to be projected onto the beam of light 21. In some examples the means 45 for controlling the beam of light 21 to create a beam of structured light 25 may comprise means for projecting a pattern 23 onto the beam of light 21.

In some examples the means 45 for controlling the beam of light 21 may comprise a display, a MEMs device such as a MEMs mirror, a mask, a diffractive filter or any other suitable means. The means 45 for controlling the beam of light 21 that is used may be dependent on the means 43 that is used to provide the beam of light 21, the pattern 23 that is to be projected onto the beam of light 21 and/or any other suitable factor.

In some examples the means 45 for controlling the beam of light 21 may also be arranged to enable the size and/or shape of the forward lighting beam to be adjusted. For instance the means 45 for controlling the beam of light 21 may enable the forward lighting beam to be switched between high beam and low beam settings. In some examples the means 45 for controlling the beam of light 21 may enable the forward lighting beam to be directed away from oncoming drivers to reduce glare for oncoming drivers.

The pattern 23 that is projected onto the beam of light 21 creates a structured beam of light 25. The structured beam of light 25 comprises the pattern 23. In the example of Fig 4 the pattern 23 comprises a plurality of parallel lines 27. Other patterns 23 may be used in other examples of the disclosure.

The structured beam of light is projected by the apparatus 41 to provide a forward lighting beam, or at least part of a forward lighting beam for the vehicle 1.

Fig 5 schematically illustrates an example apparatus 41 in more detail. The example apparatus 41 of Fig 5 also comprises means 43 for providing a beam of light 21 and means 45 for projecting a pattern 23 onto the beam of light 21 as described above. Corresponding reference numerals are used for corresponding features.

In the example apparatus 41 of Fig 5 the means 43 for providing a beam of light 21 comprises LEDs 53 and the means 45 for controlling the beam of light 21 comprises a display 59.

The apparatus 41 of Fig 5 comprises cooling means 51. The cooling means 51 may comprise any means which may be arranged to cool the LEDs 53 or other light sources. The cooling means 51 may be coupled to the LEDs 53 to enable the temperature of the LEDs 53 to be reduced. This may improve the efficiency of the apparatus 41. The cooling means 51 may comprise any suitable heat sink.

The LEDs 53 may be arranged in an array. The LEDs 53 may be arranged so that different LEDs within the array can be turned on and off. This may enable the size and/or shape of the beam light 21 to be controlled. In some examples this could also enable a pattern 23 to be provided within the beam of light 21.

The LEDs 53 may be white LEDs 53. The LEDs 53 may be controllable so that the colour temperature of the beam of light 21 may be adjusted. The colour temperature may be adjusted in response to a user input. In some examples the colour temperature may be adjusted automatically in response to conditions detected by the vehicle 1 or a controller 91 within the vehicle 1.

The LEDs 53 may be coupled to one or more optical devices 55. The optical devices 55 may comprise any means arranged to collect light from the LEDs 53 and direct the beam of light 21 onto the display 59. In some examples the optical devices 55 may collect the light into a uniform beam so that the beam of light 21 which is incident on the display 29 has a uniform intensity. The optical devices 55 may comprise any suitable means such as lenses, light guides, collimators, compound parabolic concentrators or any other suitable device or combination of devices.

The optical devices 55 that are used may depend on type of LEDs 53 and the type of display 59 used. In some examples the optical devices 55 that are used may depend on the position of the LEDs 53 relative to the display 59.

In the example of Fig 5 the apparatus 41 also comprises a polarizer 57. The polarizer 57 may be provided between the display 59 and the optical devices 55. The polarizer 57 may be arranged to polarize the beam of light 21 before it is incident on the display 59. The polarizer 57 may restrict the light that passes through to match a display 59. The polarizer 57 may improve the contrast of the pattern within the beam of light 21.

The apparatus 41 is arranged so that light that passes through the polarizer 57 is then incident on the display 59. The display 59 may comprise any means which may be used to display a pattern 23 which can then be projected onto the beam of light 21. In the example of Fig 5 the display 59 may comprise a liquid crystal display (LCD). Other types of display may be used in other embodiments of the invention.

The LCD may comprise a matrix comprising a plurality of pixels. The matrix may comprise a plurality of rows and a plurality of columns. Each of the pixels may be individually addressable. Each of the pixels may be turned on and off independently of other pixels
5 within the array. This may enable a pattern 23 to be displayed on the display 59 and projected onto the beam of light 21.

The display 59 is configurable so that different images may be displayed on the display 59. This enables different patterns 23 to be projected onto the beam of light 21. The different
10 images may be displayed by controlling different pixels within the display 59 to be turned on or off.

The display 59 may be controlled by a controller 91 or other display driver. The controller 91 may control the pixels within the display 59 to control the image displayed on the display 59.
15 This may enable the pattern 23 within the beam of structured light 25 to be changed as needed. In some examples the controller 91 may enable a user may select a type of pattern 23 that they prefer to be used for the beam of structured light 25. In some examples the controller 91 and display 59 may also enable a user to select other settings for the forward lighting, such as switching between high beam and low beam settings. In some examples
20 the controller 91 may enable the pattern 23 to be changed to adapt to the road ahead of the vehicle 1. For instance if the vehicle 1 is travelling on a straight road the pattern 23 may comprise a plurality of horizontal parallel lines or other features optimized to highlight features in the straight road. If the vehicle 1 is travelling on a curved road the pattern 23 may comprises a plurality of lines provided at an angle corresponding to the curvature of the road
25 or other features optimized to highlight the curvature of the road.

In some examples controller 91 may enable the pattern 23 to be changed automatically without any user input. For instance if an object is detected in front of a vehicle 1 the pattern 23 may be modified to ensure that the pattern 23 is incident on the object and/or to increase
30 the visibility of the object. The visibility of the object could be increased by increasing the number of parallel lines 27 within a pattern 23 or by changing the thickness of the parallel lines 27 or by any other suitable change.

The apparatus 41 is arranged so that light that passes through the display 59 is then incident
35 on a far field lens 61. The far field lens 61 may comprise any means which may be arranged

to direct the beam of structured light 25 in front of the vehicle 1. The far field lens 61 may diverge the beam of structured light 25 to provide forward lighting for the vehicle 1.

It is to be appreciated that modifications may be made to the apparatus 41 of Fig 5. For instance in other examples other means 45 for controlling the beam of light 21 may comprise a mask or other filter. The mask may act to block light in the region of the beam of light 21 where the dark regions are required. Using masks or filter may provide the advantage that they do not require any power for use.

In some examples the means 45 for controlling the beam of light 21 may comprise one or more diffractive components. The diffractive components may be arranged to diffract light from the region of the beam of light 21 where the dark regions are intended to be and guide the diffracted light to the other regions of the beam of light 21. This may increase the efficiency of the apparatus 41 by reducing the amount of light which is wasted.

Fig 6A illustrates another example apparatus 41 and Figs 6B to 6D illustrate examples of patterns 23 that may be projected onto the beam of light 21. The example apparatus 41 of Fig 6A also comprises means 43 for providing a beam of light 21 and means 45 for controlling the beam of light 21 as described above. Corresponding reference numerals are used for corresponding features.

In the example of Fig 6A the means 43 for providing a beam of light 21 comprises a coherent light source 63. The coherent light source 63 may comprise a laser or any other suitable means.

The coherent light source 63 may provide a very small and focused beam of light 21. As the beam of light 21 is small and focused there is no requirement for any optical devices to be positioned between the coherent light source 63 and the means 45 for controlling the beam of light 21.

In the example apparatus 41 of Fig 6 the means 45 for controlling the beam of light 21 comprises a MEMs mirror 65. As the beam of light provided 21 provided by the coherent light source 63 is very narrow this allows a very small component such as a MEMs mirror 65 to be used as the means 45 for projecting a pattern 23 onto the beam of light 21. This may

enable the apparatus 41 to be very small. This may decrease the size of the head lights 3 in the front of the vehicle 1.

The MEMs mirror 65 is arranged so that the beam of light 21 from the coherent light source 63 is incident on the MEMs mirror 65. The MEMs mirror 65 is arranged to reflect, at least part of the incident beam of light 25.

The MEMs may be arranged to be rotated so that the small incident beam of light 21 is reflected to provide the forward lighting beam for the vehicle 1. The MEMs may also be arranged to enable a pattern 23 to be projected into the beam of light 21. The pattern 23 may create a structured beam of light as described above.

Figs 6B to 6C illustrate example patterns 23 that may be projected into the beam of light 21 by the MEMs mirror 65.

In Fig 6B the pattern comprises a single dark portion 67. The single dark portion 67 is provided in the upper portion of the beam of light 21. The dark portion may enable the apparatus 41 to provide low beam or dipped forward lighting.

The pattern of Fig 6C comprises an ellipse 68. Other shapes may be used in other embodiments of the invention. The ellipse 68 is provided within the central portion of the beam of light 21 and may be used to provide full beam lighting. The pattern of 6C also comprises a dark rectangle 69. The dark rectangle 69 may be positioned so as to reduce glare for oncoming drivers. In some examples the MEMs 65 may be arranged so that the position of the rectangle 69 changes as an oncoming vehicle 1 approaches the apparatus 41. In some examples the MEMs 65 may be arranged so that the size of the rectangle 69 changes as an oncoming vehicle 1 approaches the apparatus 41.

In Fig 6D the pattern 23 comprises plurality of horizontal parallel lines 27. The pattern 23 may be used to increase the visibility of objects as described above.

The means 45 for controlling the beam of light 21 may also enable settings of the forward lighting to be changed. The means 45 for controlling the beam of light 21 may enable the size and/or shape of the beam of light 21 to be changed. This may enable the forward

lighting to be switched between full beam and high beam settings and any other type of setting.

Figs 7A to 7C illustrate example forward lighting beams 21 which may be provided using the apparatus 41 in different control settings.

Fig 7A illustrates three different forward lighting settings which may be provided by the apparatus 41. The different forward lighting settings comprises a dipped beam 71, a full beam 73 and an intermediate beam 75.

The dipped beam 71 may be standard dipped beam. The dipped beam 71 may be directed towards the ground 77 and may only project a short distance in front of the vehicle 1. The full beam 73 may be a standard full beam. The full beam 73 may be directed in front of the vehicle 1 at the eye level of the driver. The full beam 73 may project for a long distance in front of the vehicle 1.

The intermediate beam 75 may provide a forward lighting setting that is between dipped beam 71 and full beam 73. The intermediate beam 75 may be projected further than the dipped beam 71. The intermediate beam 75 could be projected for a similar distance to the full beam 73. However the intermediate beam 75 is projected at a lower level than the full beam 73. The intermediate beam 75 may be projected at a level below the driver's eye level.

The intermediate beam setting may improve visibility for the driver of the vehicle 1 without causing glare for oncoming drivers. Fig 7B illustrates a full beam 73 setting in use with an oncoming vehicle 1A approaching. As the full beam 73 extends at the driver's eye level this causes the full beam 73 to be incident on the windshield on the oncoming vehicle 1A. This may cause glare and reduced visibility for the driver of the oncoming vehicle 1A.

Fig 7B illustrates an intermediate beam 75 which may be provided by apparatus 41 as described above. The intermediate beam 75 extends for the same distance as the full beam 73 in the horizontal direction and so provides improved visibility for the driver of the vehicle 1. However as the intermediate beam 75 is projected beneath the eye level of the driver the intermediate beam 75 is only incident on the lower portion of the oncoming vehicle 1A. The intermediate beam 75 it is not incident on the windshield of the oncoming vehicle 1A and so does not cause glare for the driver of the oncoming vehicle 1A.

In some examples the means 45 for controlling the beam of light 21 may enable the settings of the forward lighting to be changed automatically, without user input. For instance if it is determined that the vehicle 1 is approaching a condition where glare would cause reduced visibility the means 45 for controlling the beam of light 21 could change the shape of the beam of light 21 from the full beam 75 to an intermediate beam 75 or dipped beam 71. Conditions where glare could cause reduced visibility could be conditions such as snow, ice, fog, mist, oncoming vehicles 1A or any other suitable conditions.

- Fig 8 illustrates a vehicle 1 comprising a system 81 for determining a type of surface. In the example of Fig. 8 the vehicle 1 comprises means 83 for projecting a beam of light 85 onto ground 87 in front of the vehicle 1. The vehicle 1 may also comprise means for analyzing the light reflected by the ground 87 to identify the surface type of the ground 85 and means for controlling one or more settings of the vehicle 1 in response to the identified surface type. The means for analyzing and the means for controlling may be provided within the vehicle and so are not illustrated in Fig 8.

The means 83 for projecting a beam of light 85 onto the ground 87 in front of the vehicle 1 may comprise any suitable light source. In some examples means 83 for projecting a beam of light 85 onto ground 87 in front of the vehicle 1 may comprise a coherent light source such as a laser.

The means 83 for projecting a beam of light 85 onto ground 87 in front of the vehicle 1 may be arranged within the vehicle 1 so that the beam of light 85 is incident on the ground 87 at a point in front of the forward lighting beam 75 of the vehicle 1. In the example of Fig 8 the forward lighting beam 75 is an intermediate beam 75 as described above. Other forward lighting beams may be used in other examples of the disclosure.

In some examples the beam of light 85 could be incident on the ground 87 at a point that is far enough ahead of the vehicle 1 so that the vehicle 1 has enough time to determine the type of surface on the ground before the vehicle 1 reaches the ground 87. In some examples the beam of light 85 could be incident on the ground at a distance of the order of 400m in front of the vehicle 1.

The means 83 for projecting the beam of light 85 may be provided as a separate light source to the headlights and other forward lighting apparatus. In the example of Fig 8 the means 83 for projecting the beam of light 85 is provided on the roof of the vehicle 1. The means 83 for projecting the beam of light 85 may be provided in other positions on the vehicle 1 in other
5 embodiments of the invention.

The beam of light 85 may comprise any suitable type of light. In some examples the beam of light 85 may comprise coherent light. This may facilitate spectral analysis of any reflected light. In some examples the beam of light 85 may comprise infrared red light. The infrared
10 light would not be visible to the driver of the vehicle 1. This would prevent the driver from being distracted by the beam of light 85. In other examples the beam of light 85 may comprise light within the visible portion of the electromagnetic spectrum.

The beam of light 85 may be provided as a small narrow beam. The beam of light 85 may be
15 large enough to enable spectral analysis of reflected light but small enough to avoid glare or other problems for oncoming vehicle 1A.

The light that is incident on the ground 87 may be reflected back to the vehicle 1. The amount of light and the wavelengths of the light that is reflected by the ground 87 will depend
20 upon the surface type of the ground 87. For instance ice will have different reflective characteristics to surfaces such as gravel or sand. This will cause the beam of light 85 to be reflected in different amounts. The reflected light may be analysed by any suitable means to determine the type of surface on the ground 85.

In some examples the surface may be determined by performing spectral analysis on the reflected light. Any suitable means may be used to perform the spectral analysis on the light.
25 For instance, in some examples a spectrometer may be used.

The information obtained from the spectral analysis may then be compared to information
30 obtained from known surface types. If the spectrum of the reflected light matches the spectrum of a known surface type this may enable the surface type of the ground 87 to be identified.

In response to determining the surface type of the ground 87 one or more settings of the
35 vehicle 1 may be controlled. The settings of the vehicle 1 may be controlled to improve the

performance of the vehicle 1 when it is travelling over the ground 87 comprising the identified surface type.

In some examples the settings of the vehicle 1 that are controlled may comprise settings relating to the forward lighting of the vehicle 1. In such examples controlling the settings of the forward lighting apparatus may comprise controlling any one or more of, the brightness of the forward lighting beam, the size of the forward lighting beam, the shape of the forward lighting beam, the colour temperature of the forward lighting beam, a pattern used to create structured light within the forward lighting beam or any other suitable parameter.

The changes in settings relating to the forward lighting of the vehicle 1 may enable the forward lighting beam to be adapted as needed for the identified surface type. For instance, if the identified surface type comprises a highly reflective surface such as ice or water the forward lighting may be switched to an intermediate beam 75 to prevent the driver being dazzled by reflections from highly reflective surface. In other examples the forward lighting beam could be controlled to enable the driver to view the surface more easily.

In some examples the settings of the vehicle 1 that are controlled may comprise settings relating to traction control and/or stability control and/or anti-lock braking systems (ABS) of the vehicle 1 or any other suitable settings. For instance, if the vehicle 1 is approaching a surface with a low friction the traction control may be activated so that the traction control or other settings are activated before the user reaches the low friction surface. This may provide an improved experience for the driver of the vehicle 1 as they might not notice the change in surfaces.

Apparatus 41 and systems 81 as described above may be controlled by one or more controllers 91. An example controller 91 is illustrated in Fig 9 and described below. The controller 91 may be a chip or a chip set. The controller 91 may form part of one or more systems comprised in the vehicle 1. The controller 91 may be arranged to control the forward lighting of the vehicle 1 or any other control settings of the vehicle 1.

Implementation of a controller 91 may be as controller circuitry. The controller 91 may be implemented in hardware alone, have certain aspects in software including firmware alone or can be a combination of hardware and software (including firmware).

As illustrated in Fig 9 the controller 91 may be implemented using instructions that enable hardware functionality, for example, by using executable instructions of a computer program 97 in a general-purpose or special-purpose processor 93 that may be stored on a computer readable storage medium (disk, memory etc.) to be executed by such a processor 93.

5

The processor 93 is arranged to read from and write to the memory 95. The processor 93 may also comprise an output interface via which data and/or commands are output by the processor 93 and an input interface via which data and/or commands are input to the processor 93.

10

The memory 95 stores a computer program 97 comprising computer program instructions 99 (computer program code) that controls the operation of the controller 91 when loaded into the processor 93. The computer program instructions 97, of the computer program 97, provide the logic and routines that enables the controller 91 to control the forward lighting of the vehicle 1 and any other control settings of the vehicle 1. The processor 93 by reading the memory 95 is able to load and execute the computer program 97.

15

As illustrated in Fig 9, the computer program 97 may arrive at the controller 91 via any suitable delivery mechanism 101. The delivery mechanism 101 may be, for example, a non-transitory computer-readable storage medium, a computer program product, a memory device, a record medium such as a compact disc read-only memory (CD-ROM) or digital versatile disc (DVD), an article of manufacture that tangibly embodies the computer program 97. The delivery mechanism may be a signal arranged to reliably transfer the computer program 97. The controller 91 may propagate or transmit the computer program 97 as a computer data signal.

20

25

Although the memory 95 is illustrated as a single component/circuitry it may be implemented as one or more separate components/circuitry some or all of which may be integrated/removable and/or may provide permanent/semi-permanent/ dynamic/cached storage.

30

Although the processor 93 is illustrated as a single component/circuitry it may be implemented as one or more separate components/circuitry some or all of which may be integrated/removable. The processor 93 may be a single core or multi-core processor.

35

Fig 10 illustrates a controller 91 within a system 103 for controlling forward lighting. The system comprises a controller 91 which may be as described above in relation to Fig 9. The system 103 also comprises an apparatus 41 for providing forward lighting which may be as described in relation to any of Figs 2 to 8.

5

In such examples the controller 91 may be arranged to provide control signals to the apparatus 41. The controller 91 may be arranged to provide control signals to control the means 45 for projecting a pattern 23 onto the beam of light 21. This may enable the controller 91 to control the patterns 21 within the structured beam of light 25. This may also enable the controller 91 to control other settings of the forwarding lighting such as the size and/or shape of the beam, the colour temperature and any other suitable parameter.

10

In some examples the controller 91 may be arranged to control the apparatus 41 in response to a user input. For instance the driver of the vehicle 1 may be able to select a preferred pattern 23 for providing the beam of structured light 25. In some examples the controller 91 may enable a driver to select other settings of the forward lighting such as the size and/or shape of the forward lighting beam, the colour temperature and any other parameter.

15

In some examples the controller 91 may be arranged to enable the apparatus 41 automatically without any user input. For instance, it may enable the parameters of the forward lighting in response to an input from a sensor.

20

In the example of Fig 10 the system 103 comprises an imaging device 105. The imaging device 105 may comprise a camera or any other suitable device which may be arranged to capture images. The imaging device 105 may be arranged to capture images of the region illuminated by the beam of structured light 25. This may enable the imaging device 105 to be arranged to capture images which may comprise the pattern 23 within the structured beam of light 25.

25

The image device 105 may be coupled to the controller 91 so that signals indicative of the images captured by the imaging device 105 are provided to the controller 91. The controller 91 may then enable the images obtained by the imaging device 105 to be analysed. In the example of Fig 10 the controller 91 may be arranged to analyse the image to identify any deformation of the patterns 23. Any suitable image processing technique may be used to identify such deformations.

30

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The identified deformations of the pattern 23 may be used to detect an object in front of the vehicle 1. The deformations of the pattern 23 may be used to identify the size and shape of the object in front of the vehicle 1.

5

In response to the detected deformation the pattern 23 may be changed. The pattern 23 may be changed to enhance the visibility of the object for the driver of the vehicle 1. The pattern may be changed by increasing the number of lines in the pattern or by changing the thickness of lines in the pattern 23 or by any other suitable means.

10

In some examples, once an object has been identified information relating to the object may be provided to the driver of the vehicle 1. For instance a warning notice could be displayed on a head up display (HUD) or any other means could be used to notify the driver of the object.

15

The controller 91 therefore comprises: at least one processor 93; and at least one memory 95 including computer program code 99 the at least one memory 95 and the computer program code 99 arranged to, with the at least one processor 93, cause the controller 91 at least to perform: controlling an apparatus to provide a beam of light; controlling an apparatus 41 to project a pattern 23 onto the beam of light 21 to create a beam of structured light 25; obtaining an image of the beam of structured light 25 incident on an object; detecting deformation of the projected pattern 23 in the beam of structured light 25; and changing the projected pattern 23 in response to the detected deformation.

20

It is to be appreciated that in other examples the system 103 may comprise components that are not illustrated in Fig 10. For instance the system 103 could comprise other sensors which may be used to identify objects and other conditions that may be affect the settings selected for the forward lighting of the vehicle 1.

25

Fig 11 illustrates an example method. The method may be performed by the system of Fig. 10. The method comprises at block 111 controlling an apparatus 41 to provide a beam of light. At block 113 the method comprises controlling the apparatus 41 to project a pattern 23 onto the beam of light 21 to create a beam of structured light 25. The method also comprises, at block 115 obtaining an image of the beam of structured light 25 incident on an object and, at block 117 detecting deformation of the projected pattern 23 within the beam of

30

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structured light 25. At block 119 the method comprises changing the projected pattern 23 in response to the detected deformation.

Fig 12 illustrates a controller 91 within a system 81 for controlling settings of a vehicle 1. The system 81 comprises means 83 for projecting a beam of light 85 onto ground 87 in front of the vehicle 1. The system 81 also comprises means 121 for analysing the reflected light and means 123 for controlling the settings of the vehicle 1.

The means 83 for projecting a beam of light 85 onto ground 87 may be a light source as described above in relation to Fig 8. The means 83 for projecting a beam of light 85 onto ground 87 may be controlled by the controller 91.

The means 83 for projecting a beam of light 85 onto ground 87 and the controller 91 may be provided at different locations within the vehicle 1. For example means 83 for projecting a beam of light 85 onto ground 87 may be provided at the front of the vehicle 1 to enable the light to be projected in front of the vehicle 1. The controller 91 may be part of a control system which could be provided at any suitable location within the vehicle 1.

The controller 91 may be as described above in relation to Fig 9.

The means 121 for analysing the reflected light may comprise any suitable means which enables information to be obtained from the reflected light. In some examples the means 121 for analysing the reflected light may be arranged to perform spectral analysis on the reflected light. The means 121 for analysing the reflected light may be arranged to identify the wavelengths and/or the intensity of the reflected light. In some examples the means 121 for analysing the reflected light may comprise a spectrometer or any other suitable means.

The information obtained from the reflected light may be analysed to identify a surface type of the ground. The surface type of the ground 87 may be identified by comparing characteristics of the obtained spectrum of reflected light with characteristics of spectrums for reflection from known surface types. In some examples the comparison between the obtained spectrum and the known spectrums may be performed by a module of the controller 91.

The means 121 for analysing the reflected light may be coupled to the controller 91 to enable information indicative of the identified surface type to be provided to the controller 91. The controller 91 may comprise one or more modules which may provide means 123 for controlling one or more settings of the vehicle 1. The settings of the vehicle 1 which may be controlled could comprise forward lighting settings, traction control settings, braking system settings or any other suitable settings.

The controller 91 therefore comprises: at least one processor 93; and at least one memory 95 including computer program code 99 the at least one memory 95 and the computer program code 99 arranged to, with the at least one processor 93, cause the controller 91 at least to perform: controlling a light source to project a beam of light onto ground in front of the vehicle; analysing light reflected by the ground to identify a surface type of the ground; and controlling one or more settings of the vehicle in response to identified surface type.

Fig 13 illustrates an example method. The method may be implemented using the system of Fig 12.

The method comprises, at block 131, projecting a beam of light 85 onto ground 87 in front of the vehicle 1. At block 133 the method comprises analysing light reflected by the ground 87 to identify a surface type of the ground 87 and, at block 135 controlling one or more settings of the vehicle 1 in response to the identified surface type.

For purposes of this disclosure, it is to be understood that the controller(s) described herein can each comprise a control unit or computational device having one or more electronic processors. A vehicle and/or a system thereof may comprise a single control unit or electronic controller or alternatively different functions of the controller(s) may be embodied in, or hosted in, different control units or controllers. A set of instructions could be provided which, when executed, cause said controller(s) or control unit(s) to implement the control techniques described herein (including the described method(s)). The set of instructions may be embedded in one or more electronic processors, or alternatively, the set of instructions could be provided as software to be executed by one or more electronic processor(s). For example, a first controller may be implemented in software run on one or more electronic processors, and one or more other controllers may also be implemented in software run on one or more electronic processors, optionally the same one or more processors as the first controller. It will be appreciated, however, that other arrangements are also useful, and

therefore, the present disclosure is not intended to be limited to any particular arrangement. In any event, the set of instructions described above may be embedded in a computer-readable storage medium (e.g., a non-transitory storage medium) that may comprise any mechanism for storing information in a form readable by a machine or electronic
5 processors/computational device, including, without limitation: a magnetic storage medium (e.g., floppy diskette); optical storage medium (e.g., CD-ROM); magneto optical storage medium; read only memory (ROM); random access memory (RAM); erasable programmable memory (e.g., EPROM and EEPROM); flash memory; or electrical or other types of medium for storing such information/instructions.

10 The blocks illustrated in Figs 11 and 13 may represent steps in a method and/or sections of code in the computer program 97. The illustration of a particular order to the blocks does not necessarily imply that there is a required or preferred order for the blocks and the order and arrangement of the block may be varied. Furthermore, it may be possible for some steps to
15 be omitted.

Although embodiments of the present invention have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the invention as
20 claimed.

Features described in the preceding description may be used in combinations other than the combinations explicitly described.

25 Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not.

Although features have been described with reference to certain embodiments, those features may also be present in other embodiments whether described or not.

30 Whilst endeavoring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis
35 has been placed thereon.

CLAIMS

1. An apparatus for controlling lighting of a vehicle, the apparatus comprising:
means for controlling a beam of light to create a beam of structured light comprising
5 a projected pattern;
means for detecting deformation of the projected pattern; and
means for controlling the projected pattern in response to the detected deformation.
2. An apparatus as claimed in any preceding claim wherein the means for providing a
10 beam of light comprises a plurality of light emitting diodes.
3. An apparatus as claimed in any preceding claim wherein the means for providing a
beam of light comprises an optical device.
- 15 4. An apparatus as claimed in any preceding claim wherein the means for controlling
the beam of light comprises a liquid crystal display.
5. An apparatus as claimed in any of claims 1 to 3 wherein the means for controlling the
beam of light comprises a mask.
20
6. An apparatus as claimed in any of claims 1 to 3 wherein the means for controlling the
beam of light comprises one or more diffractive components.
7. An apparatus as claimed in claim 1 wherein the means for providing a beam of light
25 comprises a coherent light source.
8. An apparatus as claimed in claim 7 wherein the coherent light source comprises a
laser.
- 30 9. An apparatus as claimed in any of claims 7 to 8 wherein the coherent light source is
arranged to provide white light.
10. An apparatus as claimed in any of claims 7 to 9 wherein the means for controlling the
beam of light to create a structured beam of light comprises a microelectromechanical
35 mirror.

11. An apparatus as claimed in any preceding claim wherein the means for controlling the beam of light is arranged to enable the size and/or shape of the beam of light to be changed.

5

12. An apparatus as claimed in any preceding claim, wherein the means for controlling the projected pattern enables the pattern within the beam of structured light to be changed based on the road ahead of the vehicle.

10 13. An apparatus as claimed in claim 12, wherein the means for controlling the projected pattern enables a user to change the pattern within the beam of structured light.

14. An apparatus as claimed in any of claims 12 or 13, wherein the means for controlling the projected pattern enables the pattern within the beam of structured light to be changed
15 automatically.

15. An apparatus as claimed in any of claims 12 to 14 wherein the pattern comprises a plurality of parallel lines.

20 16. An apparatus as claimed in any preceding claim, comprising:
means for obtaining an image of the structured light incident on the object.

17. An apparatus as claimed in claim 16, wherein the means for obtaining an image comprises a camera.

25

18. A vehicle comprising an apparatus as claimed in any of claims 1 to 17.

19. A method for controlling lighting of a vehicle, the method comprising:
controlling an apparatus to provide a beam of structured light comprising a projected
30 pattern;
detecting deformation of the projected pattern; and
controlling the pattern in response to the detected deformation.

20. A method for controlling lighting of a vehicle as claimed in claim 19, the method
35 comprising:

obtaining an image of the beam of structured light incident on an object.

21. A computer program comprising instructions that, when executed by one or more processors, cause a system to perform, at least:

5 controlling an apparatus to provide a beam of structured light comprising a projected pattern;

detecting deformation of the projected pattern; and

controlling the pattern in response to the detected deformation.

10 22. A computer program comprising instructions that, when executed by one or more processors, cause a system to perform:

obtaining an image of the beam of structured light incident on an object.

15 23. A non-transitory computer readable media comprising a computer program as claimed in claim 21 or claim 22.

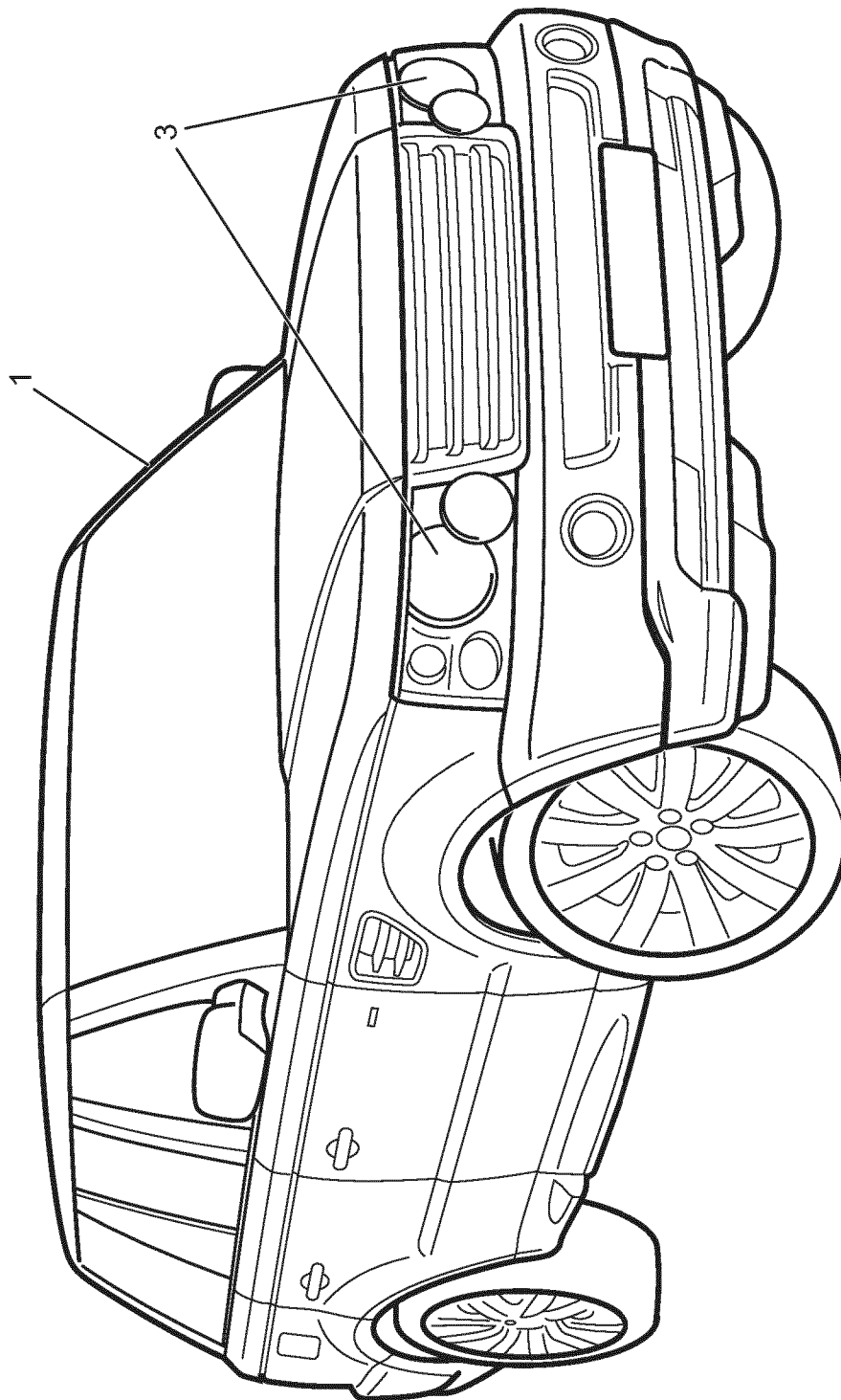


FIG. 1

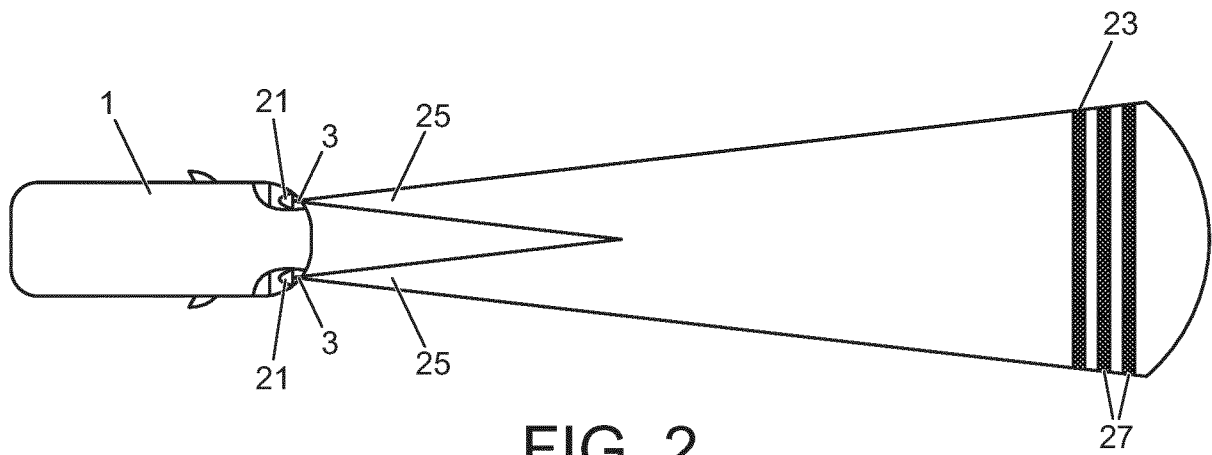


FIG. 2

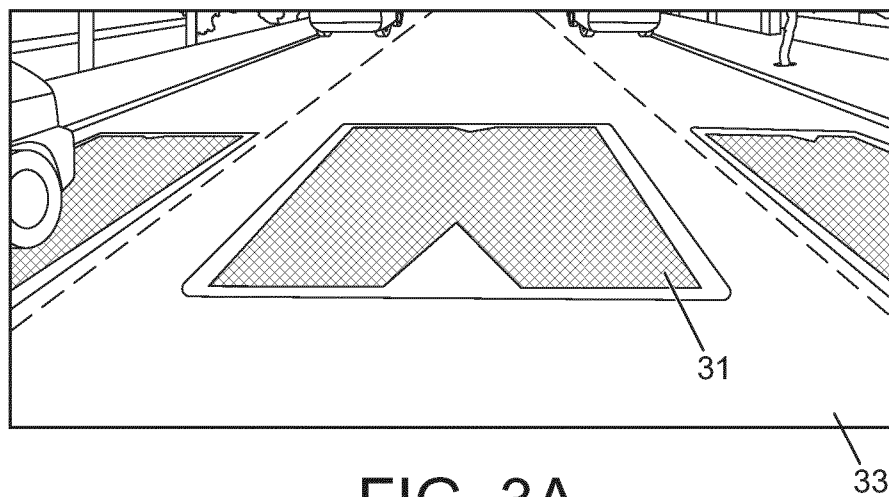


FIG. 3A

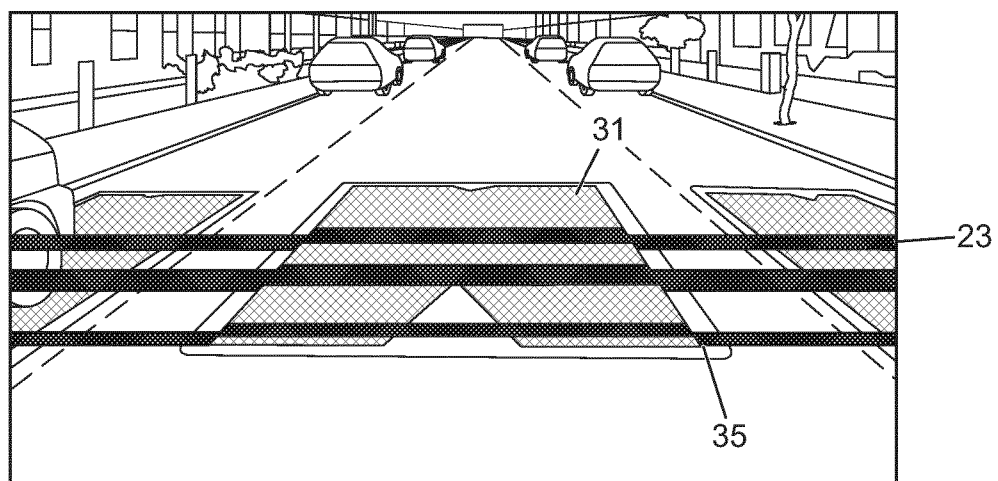


FIG. 3B

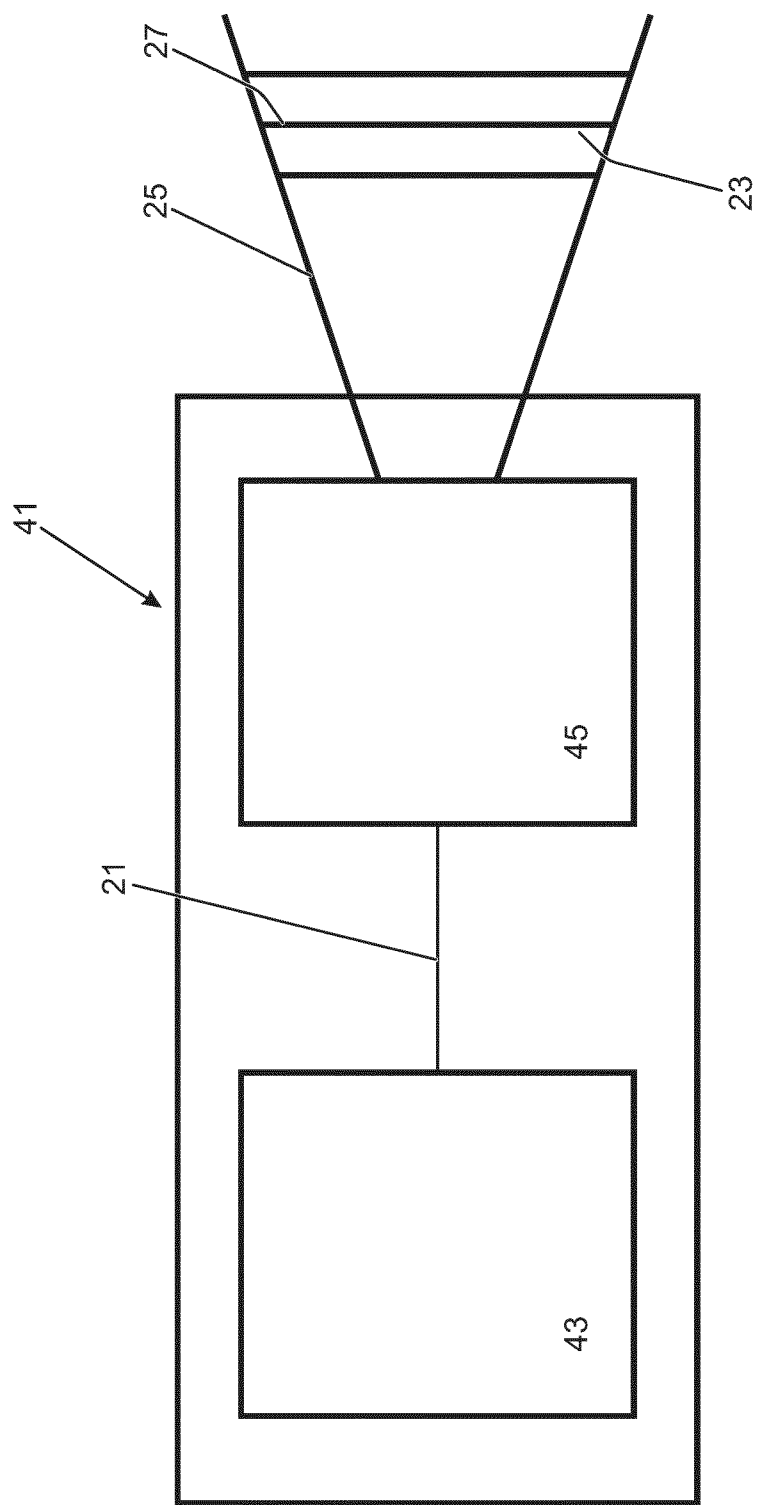


FIG. 4

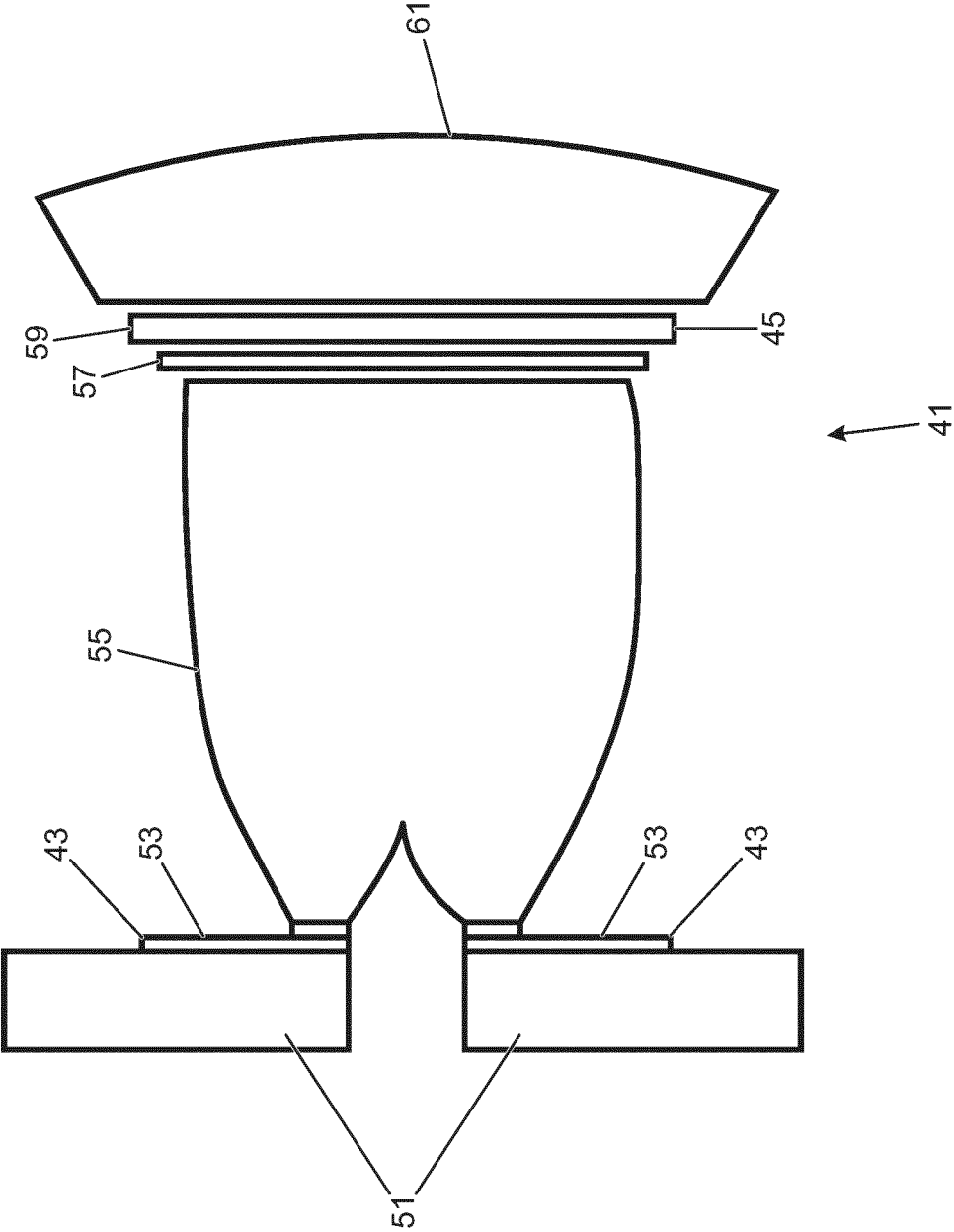


FIG. 5

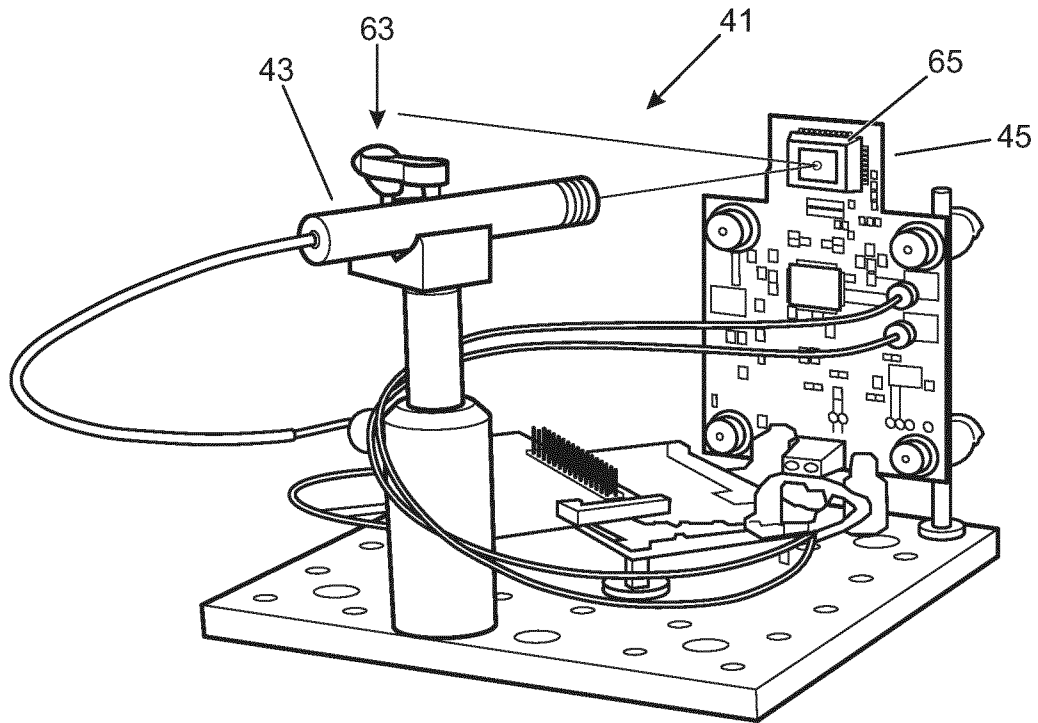


FIG. 6A

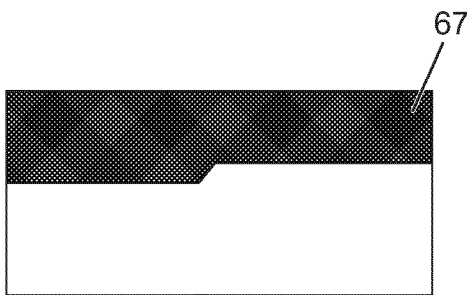


FIG. 6B

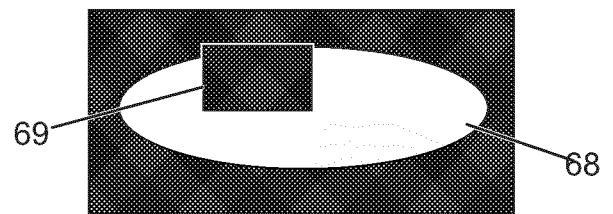


FIG. 6C

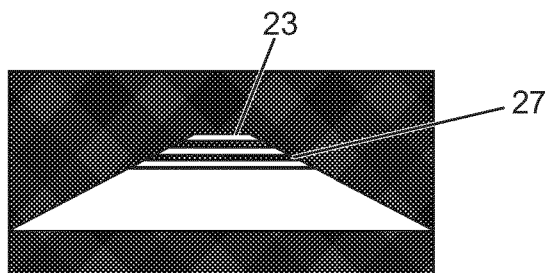


FIG. 6D

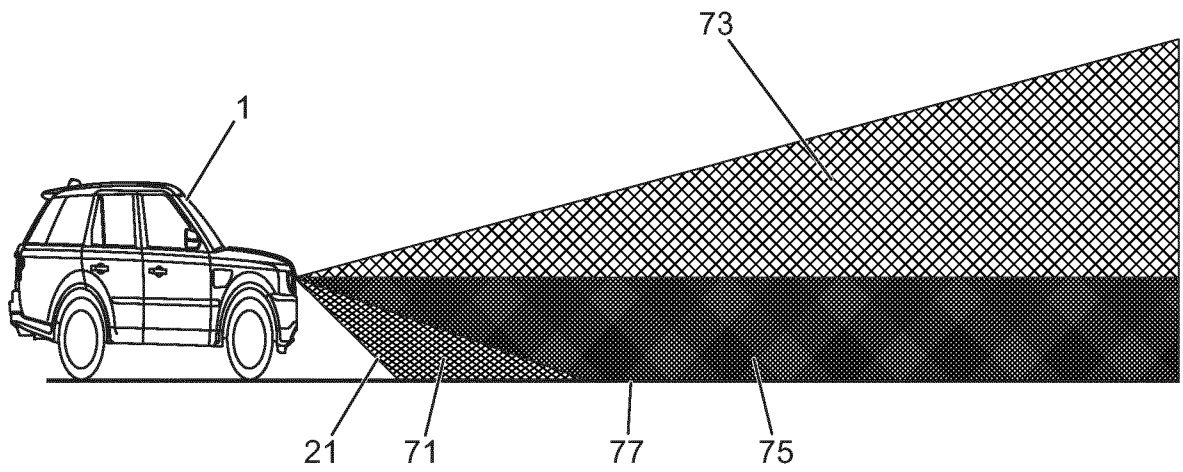


FIG. 7A

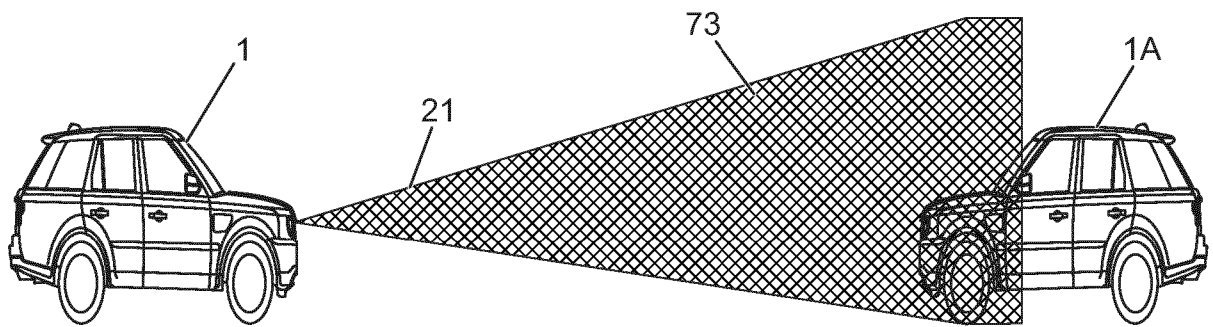


FIG. 7B

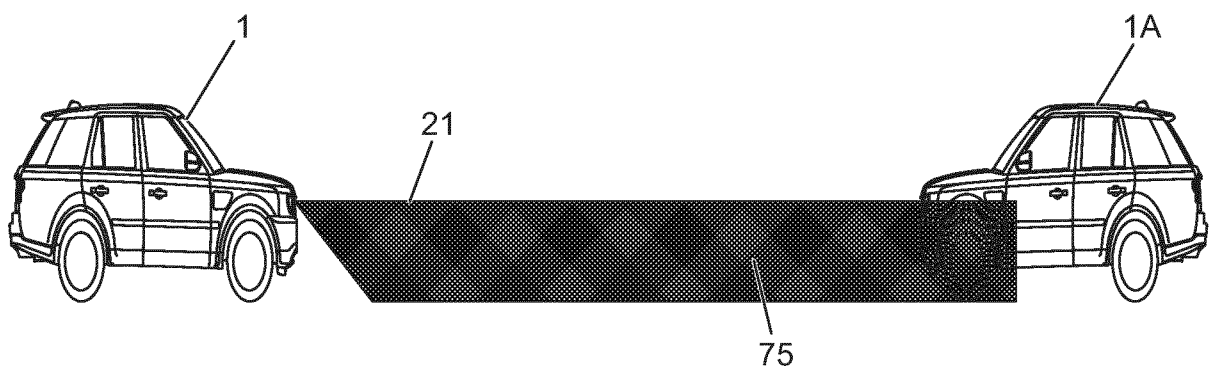
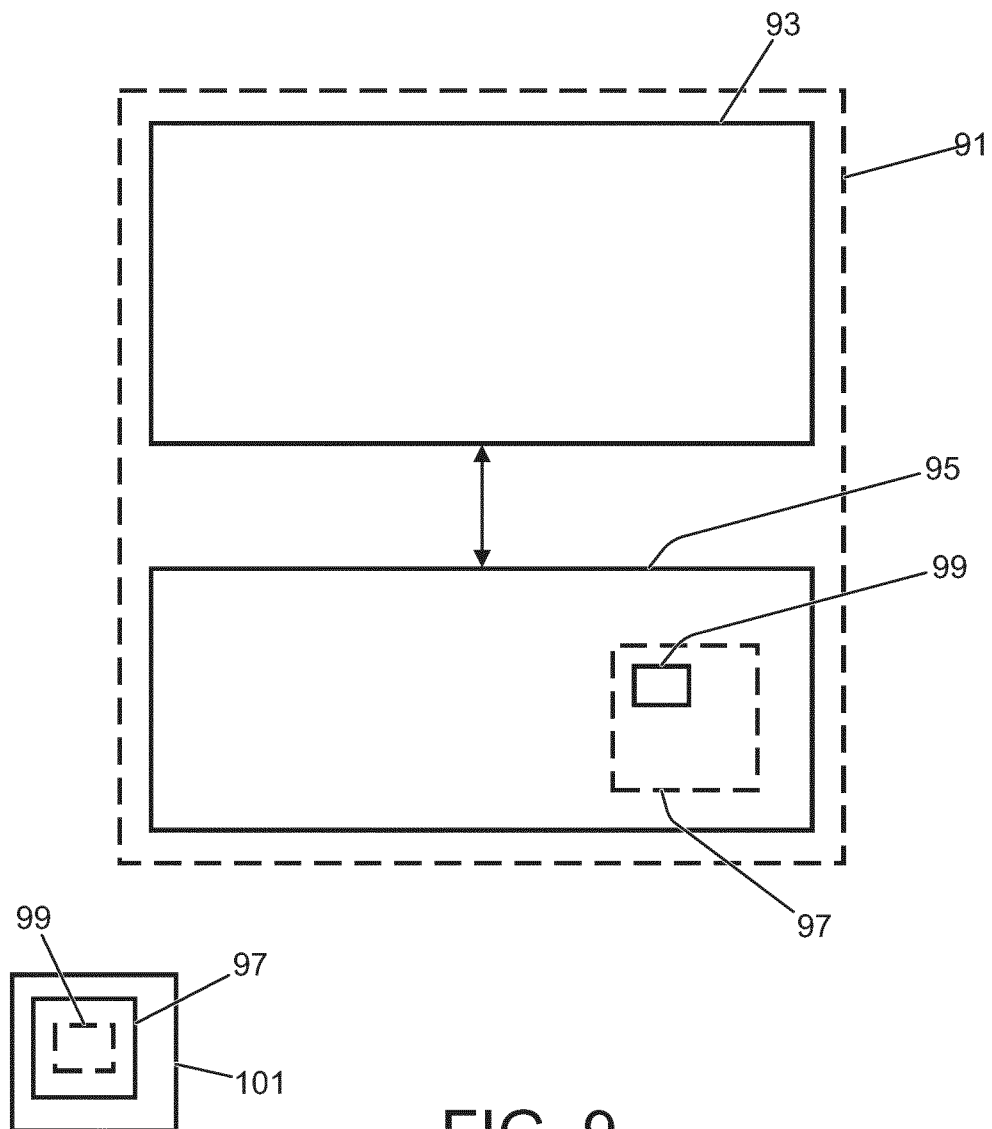
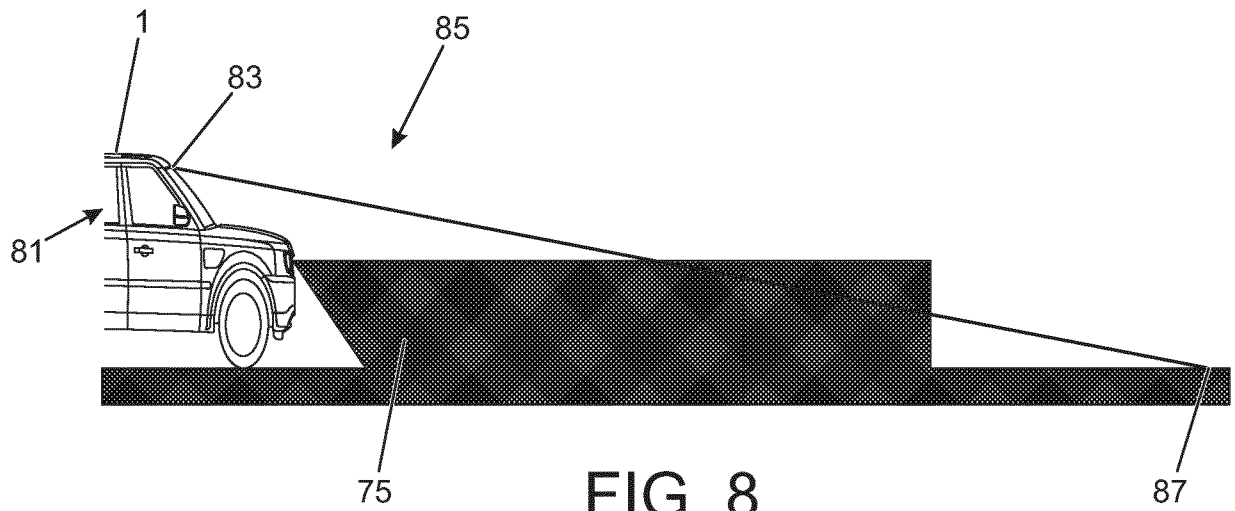
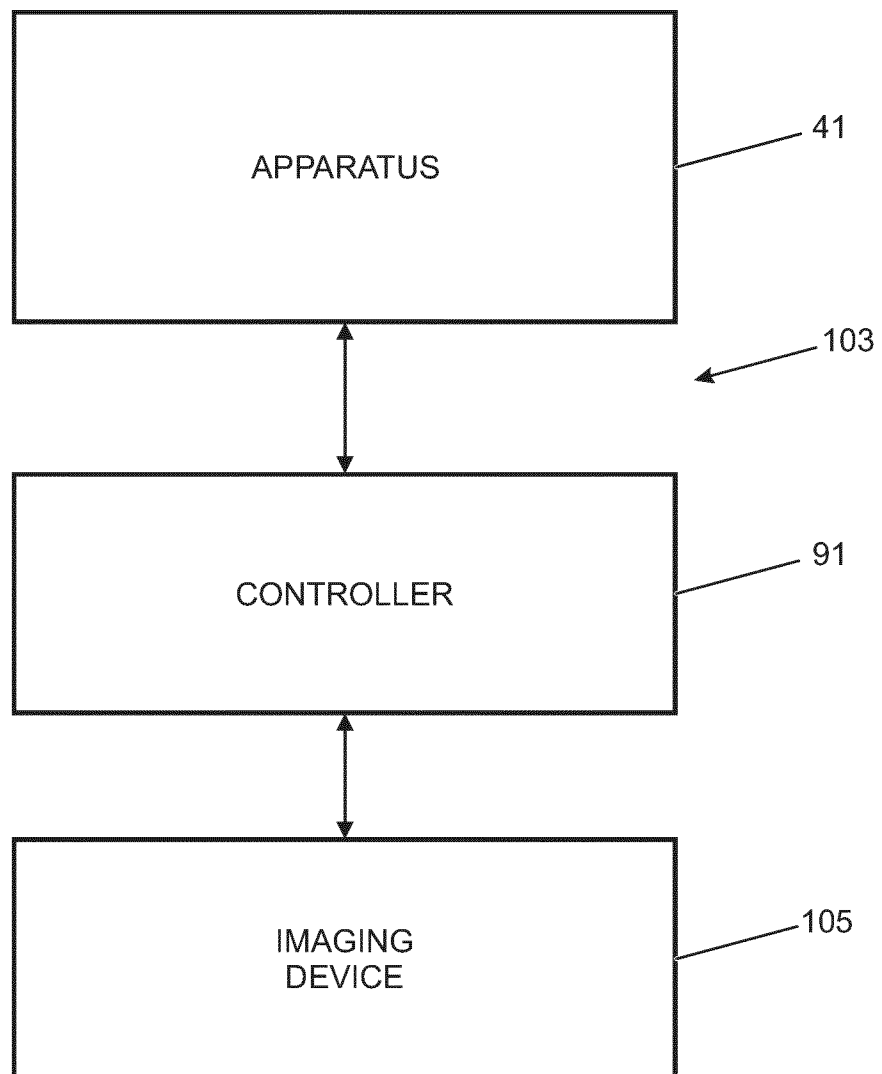
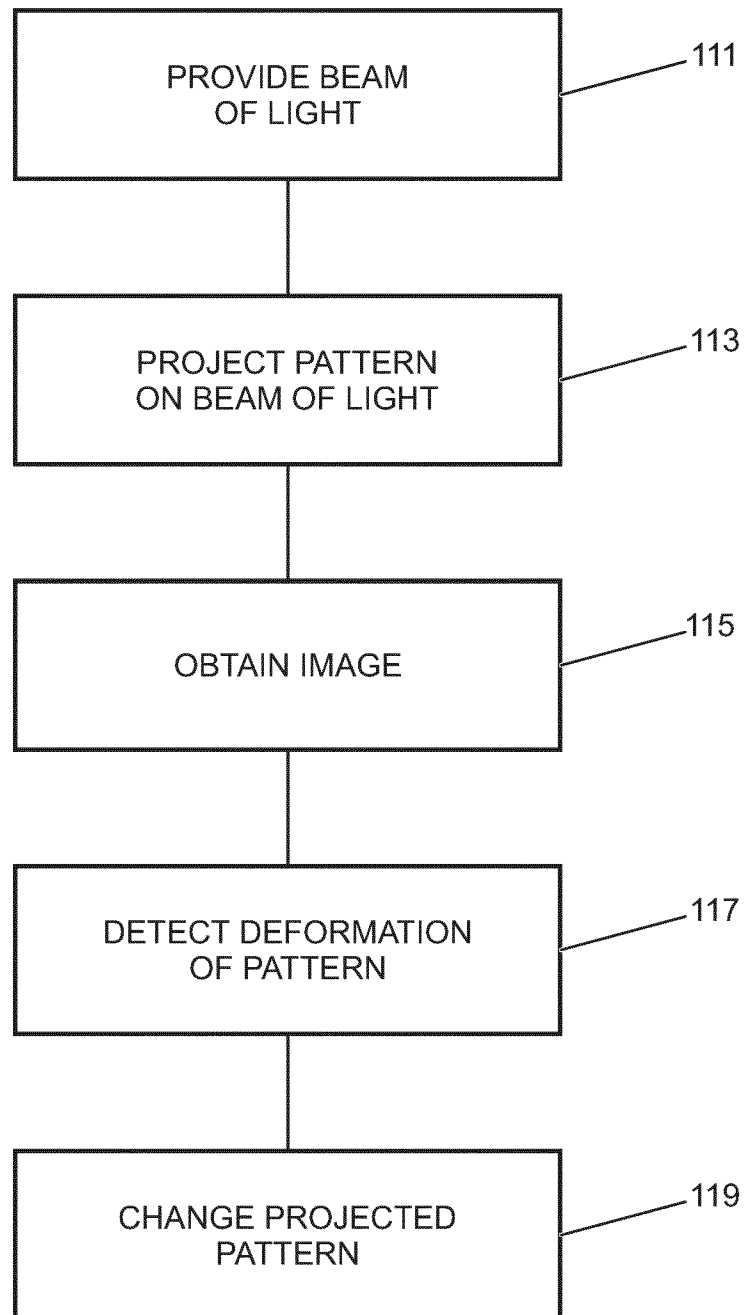


FIG. 7C



**FIG. 10**

**FIG. 11**

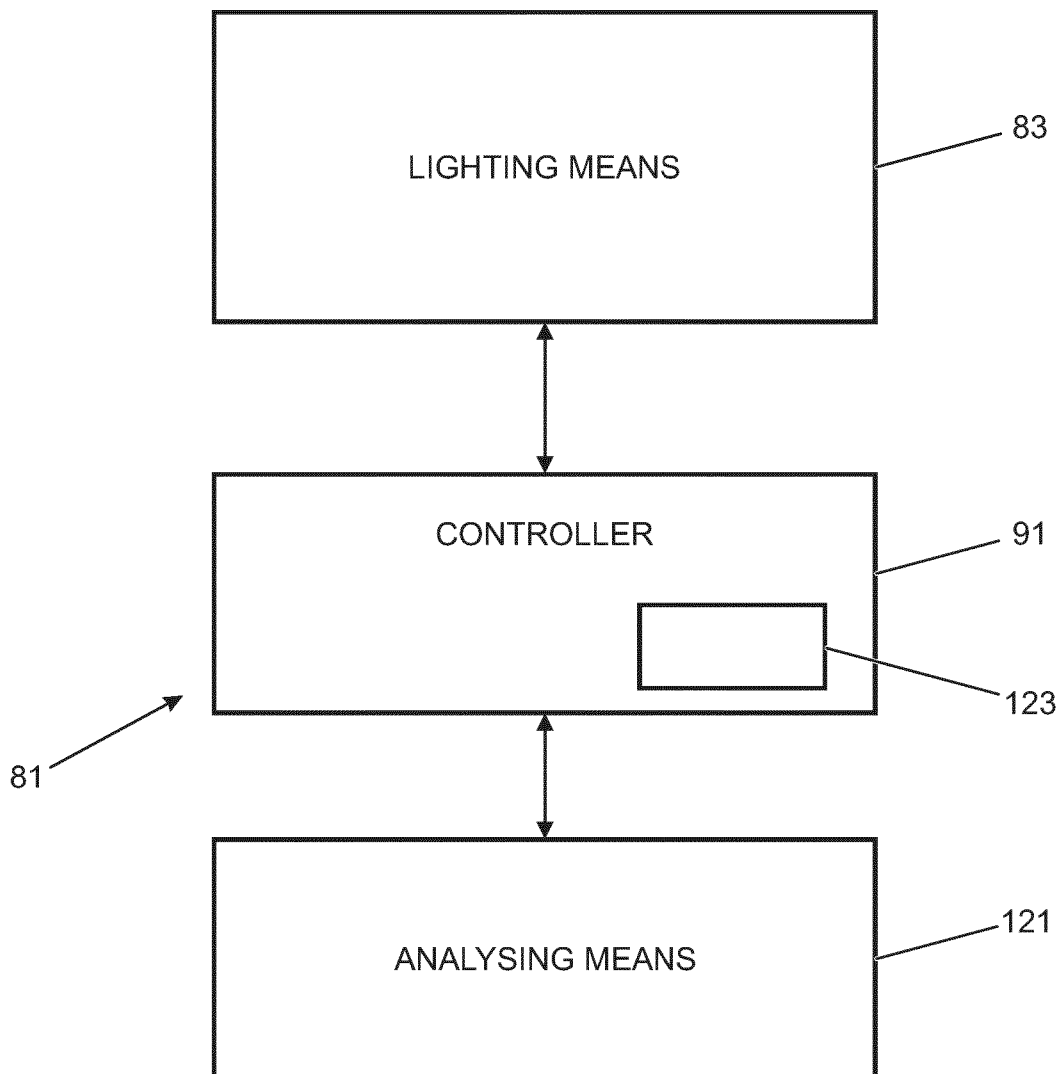


FIG. 12

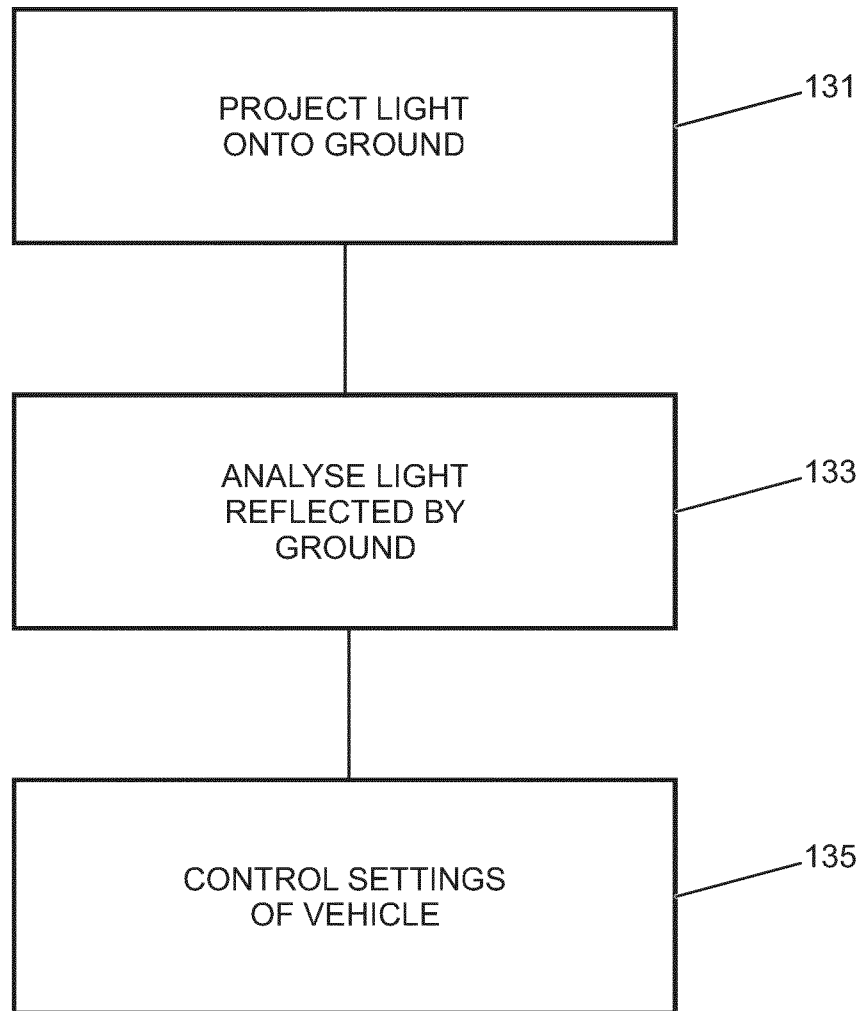


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/056653

A. CLASSIFICATION OF SUBJECT MATTER

INV. B60Q1/00 B60Q1/08 B60Q1/14 B60Q1/24 G06K9/00
B60Q9/00 B60Q1/50

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)

B60Q G06K

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	WO 2015/193714 A1 (TOYOTA MOTOR CO LTD [JP]) 23 December 2015 (2015-12-23) the whole document	1-23
A	DE 197 30 414 A1 (OPEL ADAM AG [DE]) 21 January 1999 (1999-01-21) the whole document	1-23
A	US 2009/097038 A1 (HIGGINS-LUTTMAN MICHAEL J [US] ET AL) 16 April 2009 (2009-04-16) abstract; figures	1-23
A	WO 2015/125301 A1 (NISSAN MOTOR [JP]) 27 August 2015 (2015-08-27) abstract; figures & EP 3 113 150 A1 (NISSAN MOTOR [JP]) 4 January 2017 (2017-01-04) ----- -/-	1-23



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

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No
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