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### DISPLAY DEVICE FOR VEHICLE

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#### Abstract

A head-up display device for a vehicle includes an image generating device configured to output a light projection image toward a windshield of the vehicle, and a mirror configured to reflect a projection image reflected from a first area of the windshield, toward a second area of the windshield, and the projection image from the mirror is reflected from the second area of the windshield and output towards a third area that is separated from the windshield. Accordingly, it is possible to reduce a size of the display device for the vehicle while implementing a projection image on a large screen.

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## Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a bypass continuation application of PCT/KR2023/010343 filed on Jul. 19, 2023, which claims benefit of priority to Korean Patent Application No. 10-2022-0146158, filed on Nov. 4, 2022, both of which are incorporated herein by reference in their entireties.

### BACKGROUND

#### 1. Technical Field

[0002] The present disclosure relates to a display device for a vehicle, and more particularly, to a head-up display device for a vehicle capable of reducing the size of the display device for the vehicle while implementing a projection image on a large screen.

#### 2. Description of the Related Art

[0003] A vehicle is an apparatus that moves in the direction desired by a user riding in it. A representative example is an automobile.

[0004] Meanwhile, a display device for a vehicle is installed inside the vehicle, for the convenience of a user using the vehicle.

[0005] For example, a display is placed on a cluster, etc., to display various types of information. Meanwhile, in order to display vehicle driving information, etc., separately from the cluster, various displays, such as an Audio Video Navigation (AVN) display and a head-up display configured to output a projection image on a windshield, have been installed in a vehicle.

[0006] Meanwhile, the information displayed through a head-up display is increasing. For example, in order to realize an augmented reality-based head-up display, information on a road, an automobile, and a surrounding object in a street must be displayed, so the screen of the head-up display must be larger, and ultimately, the size of the head-up display must be increased.

[0007] Meanwhile, Japanese Registered Patent Publication No. 4474711, which is a prior art document 1, relates to a head-up display, and discloses a head-up display (HUD) optical structure.

[0008] Meanwhile, prior art document 2, US Patent Publication No. US20120224062 relates to a head-up display, and discloses a HUD optical structure.

[0009] However, according to prior art documents 1 and 2, since the optical path after a concave mirror must be configured internally in a head-up display, there is a disadvantage that the size of a head-up display must be increased in order to realize an augmented reality-based head-up display.

[0010] Meanwhile, if the size of a head-up display is increased, there is a problem that there is a restriction on mounting it inside a vehicle.

### SUMMARY

[0011] The problem of the present disclosure is to provide a display device for a vehicle capable of reducing the size of the display device for the vehicle while implementing a projection image on a large screen.

[0012] Meanwhile, another problem of the present disclosure is to provide a display device for a vehicle capable of reducing the size while securing an optical path.

[0013] According to an embodiment of the present disclosure, there is provided a display device for a vehicle including: an image generating device configured to output a projection image toward a windshield; and a mirror configured to reflect a projection image reflected from a first area of the windshield, toward the windshield, wherein the projection image from the mirror is reflected from a second area of the windshield and output to a third area.

[0014] Meanwhile, the second area of the windshield is closer to the third area than the first area of the windshield.

[0015] Meanwhile, an incident angle of the projection image incident on the first area of the windshield is greater than an incident angle of the projection image incident on the second area of the windshield.

[0016] Meanwhile, the image generating device is closer to the third area than the mirror.

[0017] Meanwhile, the position of the image generating device is disposed at a higher position than the position of the mirror.

[0018] Meanwhile, the mirror is closer to the third area than the image generating device.

[0019] Meanwhile, the position of the mirror can be disposed at a higher position than the position of the image generating device.

[0020] Meanwhile, the display device for a vehicle according to an embodiment of the present disclosure further includes a transparent cover disposed between the image generating device and the windshield.

[0021] Meanwhile, the image generating device includes a digital mirror device or a liquid crystal display panel.

[0022] Meanwhile, in the windshield, the reflectivity of S polarized light can be greater than the reflectivity of P polarized light.

[0023] Meanwhile, the image generating device is configured to output a projection image to the first area of the windshield to which a P polarized light reflection film is attached, wherein the mirror is configured to reflect the projection image to the second area of the windshield to which the P polarized light reflection film is attached.

[0024] Meanwhile, the first area of the windshield corresponds to a black masking area or a frit area.

[0025] Meanwhile, the display device for a vehicle according to an embodiment of the present disclosure further includes a transparent cover disposed between the image generating device and the windshield; and a phase delay film attached to the transparent cover, wherein the image generating device includes a liquid crystal display panel, wherein the liquid crystal display panel is configured to output a projection image of P polarized light, wherein the transparent cover is configured to output a projection image of right circular polarized light to the first area of the windshield based on the projection image of P polarized light, wherein the mirror outputs a projection image of S polarized light based on a projection image of left circular polarized light from the first area of the windshield, wherein the transparent cover is configured to output a projection image of left circular polarized light to the second area of the windshield based on the projection image of S polarized light.

[0026] Meanwhile, the display device for a vehicle according to an embodiment of the present disclosure further includes a transparent cover disposed between the image generating device and the windshield, wherein a phase delay film is attached to the first area of the windshield, wherein the image generating device includes a liquid crystal display panel, wherein the liquid crystal display panel is configured to output a projection image of P polarized light, wherein the mirror reflects a projection image of S polarized light from the first area of the windshield, wherein the transparent cover is configured to output the projection image of S polarized light to the second area of the windshield.

[0027] Meanwhile, the mirror includes: a base; and a mirror coating member formed on the base.

[0028] Meanwhile, the mirror includes: a base; a photoadhesive film formed on the base; and a reflection film on the photoadhesive film.

[0029] Meanwhile, an optical path before a first reflection of the projection image output from the image generating device is longer than an optical path from after the first reflection to before a second reflection.

[0030] According to another embodiment of the present disclosure, there is provided a display

device for a vehicle including: an image generating device configured to output a projection image toward a windshield; and a mirror configured to reflect a projection image reflected first from the windshield toward the windshield, wherein the projection image from the mirror is reflected secondarily from the windshield, and wherein an optical path before a first reflection of the projection image output from the image generating device is longer than an optical path from after the first reflection to before a second reflection.

#### Effects of the Disclosure

[0031] According to an embodiment of the present disclosure, there is provided a display device for a vehicle including: an image generating device configured to output a projection image toward a windshield; and a mirror configured to reflect a projection image reflected from a first area of the windshield, toward the windshield, wherein the projection image from the mirror is reflected from a second area of the windshield and output to a third area. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen. In particular, it is possible to reduce the size while securing an optical path.

[0032] Meanwhile, the second area of the windshield is closer to the third area than the first area of the windshield. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen.

[0033] Meanwhile, an incident angle of the projection image incident on the first area of the windshield is greater than an incident angle of the projection image incident on the second area of the windshield. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen.

[0034] Meanwhile, the image generating device is closer to the third area than the mirror. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen.

[0035] Meanwhile, the position of the image generating device is disposed at a higher position than the position of the mirror. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen.

[0036] Meanwhile, the mirror is closer to the third area than the image generating device. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen.

[0037] Meanwhile, the position of the mirror can be disposed at a higher position than the position of the image generating device. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen.

[0038] Meanwhile, the display device for a vehicle according to an embodiment of the present disclosure further includes a transparent cover disposed between the image generating device and the windshield. Accordingly, it is possible to output the projection image to the outside of the image generating device while protecting the inside of the image generating device.

[0039] Meanwhile, the image generating device includes a digital mirror device or a liquid crystal display panel. Accordingly, it is possible to output the projection image to the outside of the image generating device.

[0040] Meanwhile, in the windshield, the reflectivity of S polarized light can be greater than the reflectivity of P polarized light. Accordingly, the brightness of the projection image based on S polarized light can be higher.

[0041] Meanwhile, the image generating device is configured to output a projection image to the first area of the windshield to which a P polarized light reflection film is attached, wherein the mirror is configured to reflect the projection image to the second area of the windshield to which the P polarized light reflection film is attached. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen.

[0042] Meanwhile, the first area of the windshield corresponds to a black masking area or a frit area. Accordingly, the brightness of the projection image can be improved.

[0043] Meanwhile, the display device for a vehicle according to an embodiment of the present disclosure further includes a transparent cover disposed between the image generating device and the windshield; and a phase delay film attached to the transparent cover, wherein the image generating device includes a liquid crystal display panel, wherein the liquid crystal display panel is configured to output a projection image of P polarized light, wherein the transparent cover is configured to output a projection image of right circular polarized light to the first area of the windshield based on the projection image of P polarized light, wherein the mirror outputs a projection image of S polarized light based on a projection image of left circular polarized light from the first area of the windshield, wherein the transparent cover is configured to output a projection image of left circular polarized light to the second area of the windshield based on the projection image of S polarized light. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image of left circular polarized light on a large screen.

[0044] Meanwhile, the display device for a vehicle according to an embodiment of the present disclosure further includes a transparent cover disposed between the image generating device and the windshield, wherein a phase delay film is attached to the first area of the windshield, wherein the image generating device includes a liquid crystal display panel, wherein the liquid crystal display panel is configured to output a projection image of P polarized light, wherein the mirror reflects a projection image of S polarized light from the first area of the windshield, wherein the transparent cover is configured to output the projection image of S polarized light to the second area of the windshield. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image of S polarized light on a large screen.

[0045] Meanwhile, the mirror includes: a base; and a mirror coating member formed on the base. Accordingly, the reflectivity of the mirror can be improved.

[0046] Meanwhile, the mirror includes: a base; a photoadhesive film formed on the base; and a reflection film on the photoadhesive film. Accordingly, the reflectivity of the mirror can be improved.

[0047] Meanwhile, an optical path before a first reflection of the projection image output from the image generating device is longer than an optical path from after the first reflection to before a second reflection. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen.

[0048] According to another embodiment of the present disclosure, there is provided a display device for a vehicle including: an image generating device configured to output a projection image toward a windshield; and a mirror configured to reflect a projection image reflected first from the windshield toward the windshield, wherein the projection image from the mirror is reflected secondarily from the windshield, and wherein an optical path before a first reflection of the projection image output from the image generating device is longer than an optical path from after the first reflection to before a second reflection. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen. In particular, it is possible to reduce the size while securing an optical path.

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## Description

### BRIEF DESCRIPTION OF THE DRAWINGS

[0049] FIG. 1 is a drawing illustrating an example of the exterior and interior of a vehicle.

[0050] FIGS. 2A and 2B are drawings illustrating various examples of the internal configuration of a display device for a vehicle related to the present disclosure.

[0051] FIG. 3 is a drawing illustrating an example of the internal configuration of a display device for a vehicle according to an embodiment of the present disclosure.

[0052] FIG. 4 is a drawing for explaining FIG. 3.

[0053] FIG. 5 is a drawing illustrating an example of the internal configuration of a display device for a vehicle according to another embodiment of the present disclosure.

[0054] FIG. 6 is a drawing illustrating an example of the internal configuration of a display device for a vehicle according to another embodiment of the present disclosure.

[0055] FIG. 7 is a drawing illustrating an example of the internal configuration of a display device for a vehicle according to another embodiment of the present disclosure.

[0056] FIGS. 8A and 8B are drawings illustrating various examples of a mirror of FIGS. 3 to 7.

[0057] FIGS. 9A to 10B are drawings for explaining FIGS. 3 to 7.

#### DETAILED DESCRIPTION

[0058] Hereinafter, the present disclosure will be described in more detail with reference to the drawings.

[0059] The suffixes “module” and “part” used for components in the following description are merely intended to facilitate description of the specification, and the suffixes do not have any special meaning or function. Accordingly, the “module” and “part” can be used interchangeably.

[0060] FIG. 1 is a drawing showing an example of the exterior and interior of a vehicle.

[0061] Referring to the drawing, a vehicle **200** is operated by a plurality of wheels **103FR**, **103FL**, **103RL**, . . . that rotate by a power source and a steering wheel **150** for controlling the moving direction of the vehicle **200**.

[0062] Meanwhile, the vehicle **200** can further include a camera **195** for obtaining images in front of the vehicle.

[0063] Meanwhile, the vehicle **200** can include a plurality of displays **180a**, **180b**, **180h**, which display images, information, etc., that are provided therein.

[0064] For example, among the plurality of displays **180a**, **180b**, **180h**, a first display **180a** can be a cluster display, a second display **180b** can be an Audio Video Navigation (AVN) display, and a third display **180h** can be a HUD display which is a head-up display (HUD) that projects an image onto a certain separated area Ara on a windshield WS.

[0065] Meanwhile, a display device for a vehicle (**100** of FIG. 3) according to an embodiment of the present disclosure is a device for the HUD display **180h**.

[0066] Meanwhile, a black masking area or a frit area Fz can be formed in the lower area of the windshield WS, as shown in the drawing.

[0067] Meanwhile, the vehicle **200** described in this specification can be a concept that includes all of a vehicle equipped with an engine as a power source, a hybrid vehicle equipped with an engine and an electric motor as power sources, and an electric vehicle equipped with an electric motor as a power source.

[0068] FIGS. 2A to 2B are drawings illustrating various examples of the internal configuration of a display device for a vehicle related to the present disclosure.

[0069] FIG. 2A illustrates an example of a display device for a vehicle related to the present disclosure.

[0070] Referring to the drawing, a display device **100x** for a vehicle related to the present disclosure includes a liquid crystal display panel **300x** configured to output a projection image, a fold mirror **315x** configured to reflect the projection image from the liquid crystal display panel **300x**, and a concave mirror **325x** configured to reflect the projection image from the fold mirror **315x** to a windshield WS.

[0071] The projection image reflected from a certain area Arx of the windshield WS is output to a driver's viewing area Ara.

[0072] The concave mirror **325x** in the display device **100x** for a vehicle is disposed between the liquid crystal display panel **300x** and the driver's viewing area Ara.

[0073] Meanwhile, the concave mirror **325x** in the display device **100x** for a vehicle determines the arrangement of the projection image and the position of the light source.

[0074] For example, by increasing the magnification of the concave mirror **325x** in the display device **100x** for a vehicle and reducing the focal length, the size SZx of the display device **100x** for a vehicle can be reduced.

[0075] However, when reducing the size in this way, it becomes difficult to realize a projection image on a large screen, which includes the disadvantage of making it difficult to realize an augmented reality head-up display (AR HUD).

[0076] FIG. 2B illustrates another example of a display device for a vehicle related to the present disclosure.

[0077] Referring to the drawing, a display device **100y** for a vehicle related to the present disclosure includes a liquid crystal display panel **300y** configured to output a projection image, a fold mirror **315y** configured to reflect the projection image from the liquid crystal display panel **300y**, a concave mirror **325y** configured to reflect the projection image from the fold mirror **315y**, and a transparent cover **335y** configured to output the projection image from the concave mirror **325y** to a windshield WS.

[0078] A projection image reflected from a certain area Ary of the windshield WS is output to a driver's viewing area Ara.

[0079] Unlike FIG. 2A, the concave mirror **325y** in the display device **100y** for a vehicle is disposed in front of the liquid crystal display panel **300y** and the driver's viewing area Ara.

[0080] That is, the liquid crystal display panel **300y** in the display device **100y** for a vehicle is disposed between the concave mirror **325y** and the driver's viewing area Ara.

[0081] Meanwhile, the concave mirror **325y** in the display device **100y** for a vehicle determines the arrangement of the projection image and the position of the light source.

[0082] For example, by increasing the magnification of the concave mirror **325y** in the display device **100y** for a vehicle and reducing the focal length, the size SZy of the display device **100y** for a vehicle can be reduced.

[0083] However, when reducing the size in this way, it becomes difficult to realize a projection image on a large screen, which includes the disadvantage of making it difficult to realize an AR HUD.

[0084] Therefore, this disclosure proposes a method for reducing the size of a display device for a vehicle while realizing a projection image on a large screen.

[0085] In particular, unlike FIGS. 2A and 2B, a display device **100** for a vehicle utilizing two reflections on a windshield WS is proposed. This is described with reference to FIG. 3 and below.

[0086] FIG. 3 is a drawing showing an example of the internal configuration of a display device for a vehicle according to an embodiment of the present disclosure.

[0087] Referring to the drawing, a display device **100** for a vehicle according to an embodiment of the present disclosure includes an image generating device **300** configured to output a projection image in the direction of a windshield WS, and a mirror **325** configured to reflect a projection image reflected from a first area Ra of the windshield WS in the direction of the windshield WS.

[0088] The projection image from the mirror **325** is reflected from a second area Rb of the windshield WS and output to a third area Ara. At this time, the third area Ara can correspond to the driver's viewing area.

[0089] Meanwhile, since the display device **100** for a vehicle according to an embodiment of the present disclosure utilizes two reflections from the windshield WS, it is possible to reduce the size while sufficiently securing an optical path.

[0090] That is, the size of the display device **100** for a vehicle according to an embodiment of the present disclosure is Sza that is smaller than the size SZx of the display device **100x** for a vehicle of FIG. 2A or the size SZy of the display device **100y** for a vehicle of FIG. 2B.

[0091] Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen. In particular, it is possible to reduce the size while securing an optical path.

[0092] Meanwhile, the second area Rb of the windshield WS can be closer to the third area Ara than the first area Ra of the windshield WS.

[0093] Meanwhile, the incident angle of the projection image incident on the first area Ra of the windshield WS can be greater than the incident angle of the projection image incident on the second area Rb of the windshield WS. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large screen. The first area Ra of the windshield WS and the second area Rb of the windshield WS can be separated by a first distance that is less than a second distance between the second area Rb and the third area Ara.

[0094] Meanwhile, the image generating device **300** can be closer to the third area Ara than the mirror **325**.

[0095] Meanwhile, the position of the image generating device **300** can be disposed at a higher position than the position of the mirror **325**. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large screen.

[0096] Meanwhile, the image generating device **300** can be equipped with a digital mirror device or a liquid crystal display panel. Accordingly, the projection image can be output to the outside of the image generating device **300**.

[0097] For example, the image generating device **300** can include a light source and a digital mirror device configured to reflect light output from the light source.

[0098] The light source can include an LED diode or a laser diode, etc.

[0099] Meanwhile, the digital mirror device can have a plurality of digital mirrors. For example, it can have a digital micromirror device (DMD).

[0100] As another example, the image generating device **300** can include a light source and a liquid crystal display panel configured to output a projection image based on light output from the light source.

[0101] Meanwhile, the liquid crystal display panel can output a projection image of P polarized light.

[0102] Meanwhile, the first area Ra of the windshield WS can correspond to the black masking area or the frit area FZ of FIG. **1**. Accordingly, the brightness of the projection image can be improved.

[0103] Meanwhile, the display device **100** for a vehicle according to an embodiment of the present disclosure can further include a transparent cover **335** disposed between the image generating device **300** and the windshield WS. Accordingly, the interior of the image generating device **300** can be protected while the projection image can be output to the outside of the image generating device **300**. In this regard, an optical path of the projection image from the image generating device **300** to the first area Ra of the windshield WS may intersect an optical path of the projection image reflected from the mirror **325** at an intersection location. The intersection location may be located between the transparent cover **335** and the windshield WS.

[0104] Meanwhile, in the display device **100x** for a vehicle of FIG. **2A**, an optical path before a first reflection of the projection image output from the liquid crystal display panel **300x** is formed smaller than an optical path ranging from after the first reflection to before a second reflection.

[0105] At this time, the optical path before the first reflection of the projection image output from the liquid crystal display panel **300x** corresponds to between the liquid crystal display panel **300x** and the fold mirror **315x**, and the optical path from after the first reflection to before the second reflection corresponds to between the fold mirror **315x** and the concave mirror **325x**.

[0106] In particular, in the display device **100x** for a vehicle of FIG. **2A**, the optical path before the first reflection of the projection image output from the liquid crystal display panel **300x** is significantly smaller than the optical path from after the first reflection to before the second reflection.

[0107] Meanwhile, the optical path before the first reflection of the projection image output from the image generating device **300** in the display device **100** for a vehicle according to an



embodiment of the present disclosure is longer than the optical path from after the first reflection to before the second reflection.

[0108] The optical path before the first reflection of the projection image output from the image generating device **300** in the display device **100** for a vehicle in FIG. **3** corresponds to between the image generating device **300** and the first area Ra of the windshield WS.

[0109] Meanwhile, the optical path after the first reflection to before the second reflection in the display device **100** for a vehicle corresponds to between the first area Ra of the windshield WS and the mirror **325**.

[0110] As shown in the drawing, the optical path before the first reflection of the projection image output from the image generating device **300** is formed longer than the optical path from after the first reflection to before the second reflection, so that a sufficient optical path can be secured within the display device **100** for a vehicle of a small size SZ.

[0111] FIG. **4** is a drawing for explaining FIG. **3**.

[0112] Referring to the drawing, the size of the display device **100** for a vehicle according to an embodiment of the present disclosure is SZa that is smaller than the size SZx of the display device **100x** for a vehicle of FIG. **2A**.

[0113] Furthermore, the size of the display device **100** for a vehicle according to an embodiment of the present disclosure is SZa that is smaller than the size SZy of the display device **100y** for a vehicle of FIG. **2B**.

[0114] Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large screen. In particular, it is possible to reduce the size while securing an optical path.

[0115] FIG. **5** is a drawing showing an example of the internal configuration of a display device for a vehicle according to another embodiment of the present disclosure.

[0116] Meanwhile, in the windshield WS, the reflectivity of S polarized light is higher than that of P polarized light. Accordingly, the brightness of the projection image based on S polarized light can be higher.

[0117] Accordingly, in order to improve the reflectivity of P polarized light, it is preferable that a P polarized light reflection film **415** is attached to the windshield WS.

[0118] Referring to the drawing, a display device **100b** for a vehicle according to another embodiment of the present disclosure includes an image generating device **300** configured to output a projection image to a first area Ra of a windshield WS to which the P polarized light reflection film **415** is attached, and a mirror **325** configured to reflect the projection image reflected from the first area Ra of the windshield WS to a second area Rb of the windshield WS to which the P polarized light reflection film **415** is attached.

[0119] The projection image from the mirror **325** is reflected from the second area Rb of the windshield WS and output to the third area Ara. At this time, the third area Ara can correspond to the driver's viewing area. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large screen.

[0120] Meanwhile, the display device **100b** for a vehicle according to another embodiment of the present disclosure can further include a transparent cover **335** disposed between the image generating device **300** and the windshield WS. Accordingly, the interior of the image generating device **300** can be protected while the projection image can be output to the outside of the image generating device **300**.

[0121] FIG. **6** is a drawing illustrating an example of the internal configuration of the display device for a vehicle according to another embodiment of the present disclosure.

[0122] Referring to the drawing, a display device **100c** for a vehicle according to another embodiment of the present disclosure includes an image generating device **300** configured to output a projection image in the direction of a windshield WS, and a mirror **325** configured to reflect a projection image reflected from a first area Ra of the windshield WS in the direction of the

windshield WS.

[0123] Meanwhile, the display device **100c** for a vehicle of FIG. **6** is similar to the display device **100** for a vehicle of FIG. **3**, but differs in the position of the disposition of the image generating device **300** and the mirror **325**.

[0124] The projection image from the mirror **325** is reflected from the second area Rb of the windshield WS and output to the third area Ara. At this time, the third area Ara can correspond to the driver's viewing area.

[0125] Meanwhile, the display device **100c** for a vehicle according to another embodiment of the present disclosure utilizes two reflections from the windshield WS, thereby reducing the size while sufficiently securing an optical path.

[0126] That is, the size of the display device **100c** for a vehicle according to another embodiment of the present disclosure is SZb which is smaller than the size SZx of the display device **100x** for a vehicle of FIG. **2A** or the size SZy of the display device **100y** for a vehicle of FIG. **2B**.

[0127] Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen. In particular, it is possible to reduce the size while securing an optical path.

[0128] Meanwhile, the second area Rb of the windshield WS can be closer to the third area Ara than the first area Ra of the windshield WS.

[0129] Meanwhile, the incident angle of the projection image incident on the first area Ra of the windshield WS can be greater than the incident angle of the projection image incident on the second area Rb of the windshield WS. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large screen.

[0130] Meanwhile, the mirror **325** can be closer to the third area Ara than the image generating device **300**.

[0131] Meanwhile, the position of the mirror **325** can be disposed at a higher position than the position of the image generating device **300**. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large screen.

[0132] Meanwhile, the image generating device **300** can include a digital mirror device or a liquid crystal display panel. Accordingly, the projection image can be output to the outside of the image generating device **300**.

[0133] Meanwhile, the first area Ra of the windshield WS can correspond to the black masking area or the frit area FZ of FIG. **1**. Accordingly, the brightness of the projection image can be improved.

[0134] Meanwhile, the display device **100c** for a vehicle according to another embodiment of the present disclosure can further include a transparent cover **335** disposed between the image generating device **300** and the windshield WS. Accordingly, the interior of the image generating device **300** can be protected while the projection image can be output to the outside of the image generating device **300**. Also, a first normal line to a surface of the mirror **300** and a second normal line to a surface of the image generating device **325** may diverge from each other. Such may be different from that of FIG. **3**, where the first normal line to the surface of the mirror **300** and the second normal line to the surface of the image generating device **300** may converge towards each other.

[0135] FIG. **7** is a drawing illustrating an example of the internal configuration of a display device for a vehicle according to another embodiment of the present disclosure.

[0136] Accordingly, in order to improve the reflectivity of P polarized light, it is preferable that the P polarized light reflection film **415** of the windshield WS is attached.

[0137] Referring to the drawing, a display device **100d** for a vehicle according to another embodiment of the present disclosure includes an image generating device **300** configured to output a projection image to a first area Ra of a windshield WS to which the P polarized light reflection film **415** is attached, and a mirror **325** configured to reflect the projection image reflected

from the first area Ra of the windshield WS to a second area Rb of the windshield WS to which the P polarized light reflection film **415** is attached.

[0138] The projection image from the mirror **325** is reflected from the second area Rb of the windshield WS and output to a third area Ara. At this time, the third area Ara can correspond to the driver's viewing area. Accordingly, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large screen.

[0139] Meanwhile, the display device **100d** for a vehicle of FIG. 7 is similar to the display device **100b** for a vehicle of FIG. 5, but includes a difference in the disposition position of the image generating device **300** and the mirror **325**.

[0140] Meanwhile, the display device **100d** for a vehicle according to another embodiment of the present disclosure can further include a transparent cover **335** disposed between the image generating device **300** and the windshield WS. Accordingly, the interior of the image generating device **300** can be protected while the projection image can be output to the outside of the image generating device **300**.

[0141] FIGS. **8A** and **8B** are drawings illustrating various examples of the mirror of FIGS. **3** to **7**.

[0142] FIG. **8A** is a drawing illustrating an example of a mirror.

[0143] Referring to the drawing, the mirror **325a** of FIGS. **3** to **7** can be a concave mirror.

[0144] Meanwhile, the mirror **325a** of FIGS. **3** to **7** can include a base **710** and a mirror coating member **720** formed on the base **710**. Accordingly, the reflectivity of the mirror **325a** can be improved.

[0145] The base **710** can face an interior of the display device while the mirror coating layer **720** can face the windshield WS.

[0146] The base **710** can be a depositable substrate, such as glass and plastic.

[0147] Meanwhile, the mirror coating member **720** can be a reflection coating member through deposition such as metal and dielectric.

[0148] FIG. **8B** is a drawing illustrating another example of a mirror.

[0149] Referring to the drawing, the mirror **325b** of FIGS. **3** to **7** can be a concave mirror.

[0150] Meanwhile, the mirror **325b** of FIGS. **3** to **7** can include a base **710**, an optical adhesive film **715** formed on the base **710**, and a reflection film **725** on the optical adhesive film **715**. Accordingly, the reflectivity of the mirror **325b** can be improved.

[0151] The base **710** can be a depositable substrate such as glass and plastic. The optical adhesive film **715** can include an Optically Clear Adhesive (OCA).

[0152] Meanwhile, the reflection film **725** can be an optical film that can be attached through lamination, etc.

[0153] FIG. **9A** to FIG. **10B** are drawings for explaining FIG. **3** to FIG. **7**.

[0154] FIG. **9A** illustrates an example of an optical path of a projection image of P polarized light.

[0155] Referring to the drawing, the image generating device **300** in the display device **100**, **100b**, **100c**, **100d** for a vehicle of FIG. **3** to FIG. **7** includes a liquid crystal display panel, and the liquid crystal display panel can output a projection image of P polarized light.

[0156] Meanwhile, the image generating device **300** in the display device **100**, **100b**, **100c**, **100d** for a vehicle of FIG. **3** to FIG. **7** can further include a transparent cover **335** disposed between the image generating device **300** and the windshield WS, and a phase delay film **333** attached to the transparent cover **335**.

[0157] Meanwhile, the phase delay film **333** can include a quarter wave plate (QWP).

[0158] Meanwhile, the transparent cover **335** outputs a projection image of right circular polarized light  $\Rightarrow$  based on a projection image of P polarized light to the first area Ra of the windshield WS, the mirror **325** outputs a projection image of S polarized light based on a projection image of left-handed polarized light  $\Leftarrow$  from the first area Ra of the windshield WS, and the transparent cover **335** can output a projection image of left-handed polarized light  $\Leftarrow$  based on a projection image of S polarized light to the second area Rb of the windshield WS. Accordingly, it is possible to reduce the

size of the display device for the vehicle while implementing a projection image of left-handed polarized light on a large screen.

[0159] FIG. 9B illustrates another example of the optical path of the projection image of P polarized light.

[0160] Referring to the drawing, the image generating device **300** in the display device **100**, **100b**, **100c**, **100d** for a vehicle of FIGS. 3 to 7 includes a liquid crystal display panel, and the liquid crystal display panel can output a projection image of P polarized light.

[0161] Meanwhile, the image generating device **300** in the display device **100**, **100b**, **100c**, **100d** for a vehicle of FIGS. 3 to 7 can further include a transparent cover **335** disposed between the image generating device **300** and the windshield WS.

[0162] Meanwhile, a phase delay film **333** can be attached to the first area Ra of the windshield WS.

[0163] Meanwhile, the phase delay film **333** can include a quarter wave plate (QWP).

[0164] Meanwhile, the mirror **325** reflects the projection image of S polarized light from the first area Ra of the windshield WS, and the transparent cover **335** can output the projection image of S polarized light to the second area Rb of the windshield WS. Accordingly, the projection image of S polarized light on a large screen can be realized while reducing the size.

[0165] FIG. 10A is a drawing exemplifying an optical path in the display device **100** for a vehicle of FIG. 3.

[0166] Referring to the drawing, the image generating device **300** closer to the third area Ara than the mirror **325** outputs a plurality of lights to the first area Ra of the windshield WS.

[0167] The mirror **325** reflects a plurality of lights that are first reflected from the first area Ra of the windshield WS, and outputs them to the second area Rb of the windshield WS that is higher than the first area Ra of the windshield WS.

[0168] Meanwhile, a plurality of lights that are secondarily reflected from the second area Rb of the windshield WS are incident on the third area Ara corresponding to the user's viewing area.

[0169] Accordingly, a driver recognizes a virtual image in the opposite direction of the windshield WS.

[0170] As a result, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large-screen. In particular, it is possible to reduce the size while securing the optical path.

[0171] FIG. 10B is a drawing illustrating an optical path in the display device **100c** for a vehicle of FIG. 6.

[0172] Referring to the drawing, the image generating device **300** disposed further from the third area Ara than the mirror **325** outputs a plurality of lights to the first area Ra of the windshield WS.

[0173] The mirror **325** reflects a plurality of lights that are first reflected from the first area Ra of the windshield WS, and outputs them to the second area Rb of the windshield WS that is higher than the first area Ra of the windshield WS.

[0174] Meanwhile, a plurality of lights that are secondarily reflected from the second area Rb of the windshield WS are incident on the third area Ara corresponding to a user's viewing area.

[0175] Accordingly, a driver recognizes a virtual image in the opposite direction of the windshield WS.

[0176] As a result, it is possible to reduce the size of the display device for the vehicle while implementing a projection image on a large screen. In particular, it is possible to reduce the size while securing an optical path.

[0177] Meanwhile, although the present disclosure includes been described with reference to specific embodiments shown in the drawings, it is apparent to those skilled in the art that the present description is not limited to those exemplary embodiments and is embodied in many forms without departing from the scope of the present disclosure, which is described in the following

claims. These modifications should not be individually understood from the technical spirit or scope of the present disclosure.

## Claims

1. A head-up display device for a vehicle, the head-up display device comprising: an image generating device configured to output a projection image toward a windshield of the vehicle; and a mirror configured to reflect a projection image reflected from a first area of the windshield, toward a second area of the windshield, wherein the projection image from the mirror is reflected from the second area of the windshield and output towards a third area that is separated from the windshield.
2. The head-up display device of claim 1, wherein the second area of the windshield is located closer to the third area than the first area of the windshield.
3. The head-up display device of claim 1, wherein an incident angle of the projection image incident on the first area of the windshield based on a first tangent line to the windshield at the first area is greater than an incident angle of the projection image incident on the second area of the windshield based on a second tangent line of the windshield at the second area.
4. The head-up display device of claim 1, wherein the image generating device is configured to output the projection image to the first area of the windshield to which a P polarized light reflection film is attached, and wherein the mirror is configured to reflect the projection image to the second area of the windshield to which the P polarized light reflection film is attached.
5. The head-up display device of claim 1, wherein the first area of the windshield corresponds to a black masking area or a first area.
6. The head-up display device of claim 5, further comprising: a transparent cover disposed between the image generating device and the windshield; and a phase delay film attached to the transparent cover, wherein the image generating device comprises a liquid crystal display panel, wherein the liquid crystal display panel is configured to output the projection image of a P polarized light, wherein the transparent cover is configured to output the projection image of a right circular polarized light to the first area of the windshield based on the projection image of the P polarized light, wherein the mirror outputs the projection image of a S polarized light based on the projection image of a left circular polarized light from the first area of the windshield, and wherein the transparent cover is configured to output the projection image of the left circular polarized light to the second area of the windshield based on the projection image of the S polarized light.
7. The head-up display device of claim 1, further comprising a transparent cover disposed between the image generating device and the windshield, wherein a phase delay film is attached to the first area of the windshield, wherein the image generating device comprises a liquid crystal display panel, wherein the liquid crystal display panel is configured to output the projection image of a P polarized light, wherein the mirror reflects the projection image of a S polarized light from the first area of the windshield, and wherein the transparent cover is configured to output the projection image of the S polarized light to the second area of the windshield.
8. The head-up display device of claim 1, wherein the mirror comprises: a base; and a mirror coating member formed on the base.
9. The head-up display device of claim 1, wherein the mirror comprises: a base; a photoadhesive film formed on the base; and a reflection film on the photoadhesive film.
10. The head-up display device of claim 1, wherein an optical path before a first reflection of the projection image at the mirror and output from the image generating device is longer than an optical path from after the first reflection at the mirror to before a second reflection at the windshield.
11. The head-up display device of claim 1, wherein an optical path of the projection image from the image generating device to the first area of the windshield intersects an optical path of the projection image reflected from the mirror at an intersection location.

- 12.** The head-up display device of claim 11, further comprising a transparent cover disposed between the image generating device and the windshield, wherein the intersection location is located between the transparent cover and the windshield.
- 13.** The head-up display device of claim 1, wherein a first normal line to a surface of the mirror and a second normal line to a surface of the image generating device diverge from each other.
- 14.** The head-up display device of claim 1, wherein a first normal line to a surface of the mirror and a second normal line to a surface of the image generating device converge toward each other.
- 15.** A head-up display device for a vehicle, the head-up display device comprising: an image generating device configured to output a projection image toward a windshield; and a mirror configured to reflect the projection image reflected first from the windshield toward the windshield, wherein the projection image from the mirror is reflected secondarily from the windshield, and wherein an optical path before a first reflection of the projection image at the mirror and output from the image generating device is longer than an optical path from after the first reflection at the mirror to before a second reflection at the windshield.
- 16.** The head-up display device of claim 15, wherein an optical path of the projection image from the image generating device to the first area of the windshield intersects an optical path of the projection image reflected from the mirror at an intersection location.
- 17.** The head-up display device of claim 14, further comprising a transparent cover disposed between the image generating device and the windshield, wherein the intersection location is located between the transparent cover and the windshield.
- 18.** A head-up display device for a vehicle, the head-up display device comprising: an image generating device configured to output a projection image toward a first area of a windshield of the vehicle; and a mirror configured to reflect the projection image reflected from the first area of the windshield, toward a second area of the windshield, wherein an optical path of the projection image from the image generating device to the first area of the windshield intersects an optical path of the projection image reflected from the mirror and extending towards the second area at an intersection location.
- 19.** The head-up display device of claim 18, further comprising a transparent cover disposed between the image generating device and the windshield, wherein the intersection location is located between the transparent cover and the windshield.
- 20.** A vehicle, comprising: a windshield; and the head-up display device according to claim 1.
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