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(54) **HEAD MOUNTED DISPLAY, DISPLAY DEVICE AND IMAGE DISPLAY METHOD THEREOF**

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(57) **ABSTRACT**

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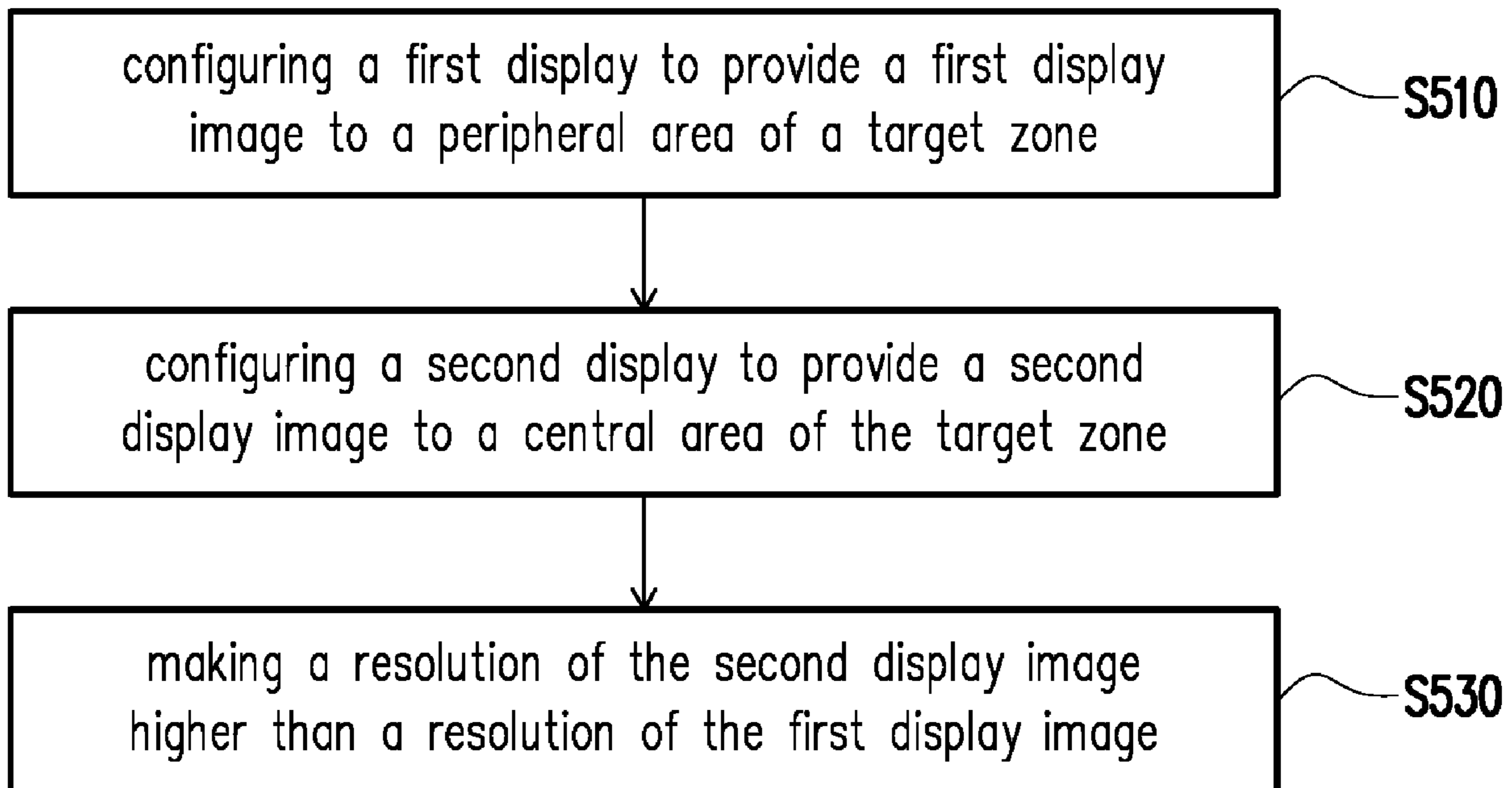
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A head mounted display, a display device and an image display method thereof are provided. The display device includes a first display and a second display. The first display is configured to provide a first display image to a peripheral area of a target zone. The second display is configured to provide a second display image to a central area of the target zone. A resolution of the second display image is higher than a resolution of the first display image.



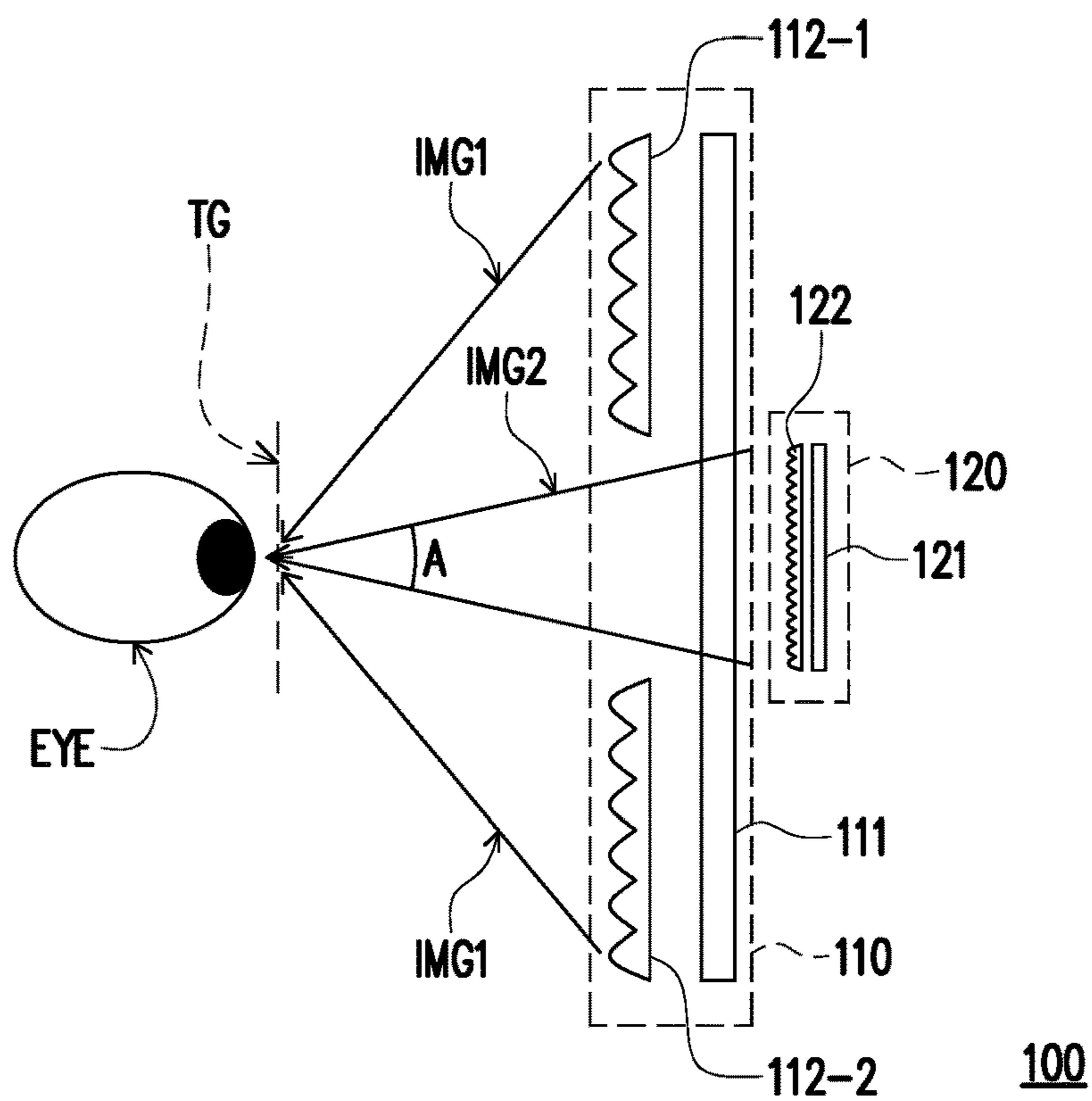


FIG. 1

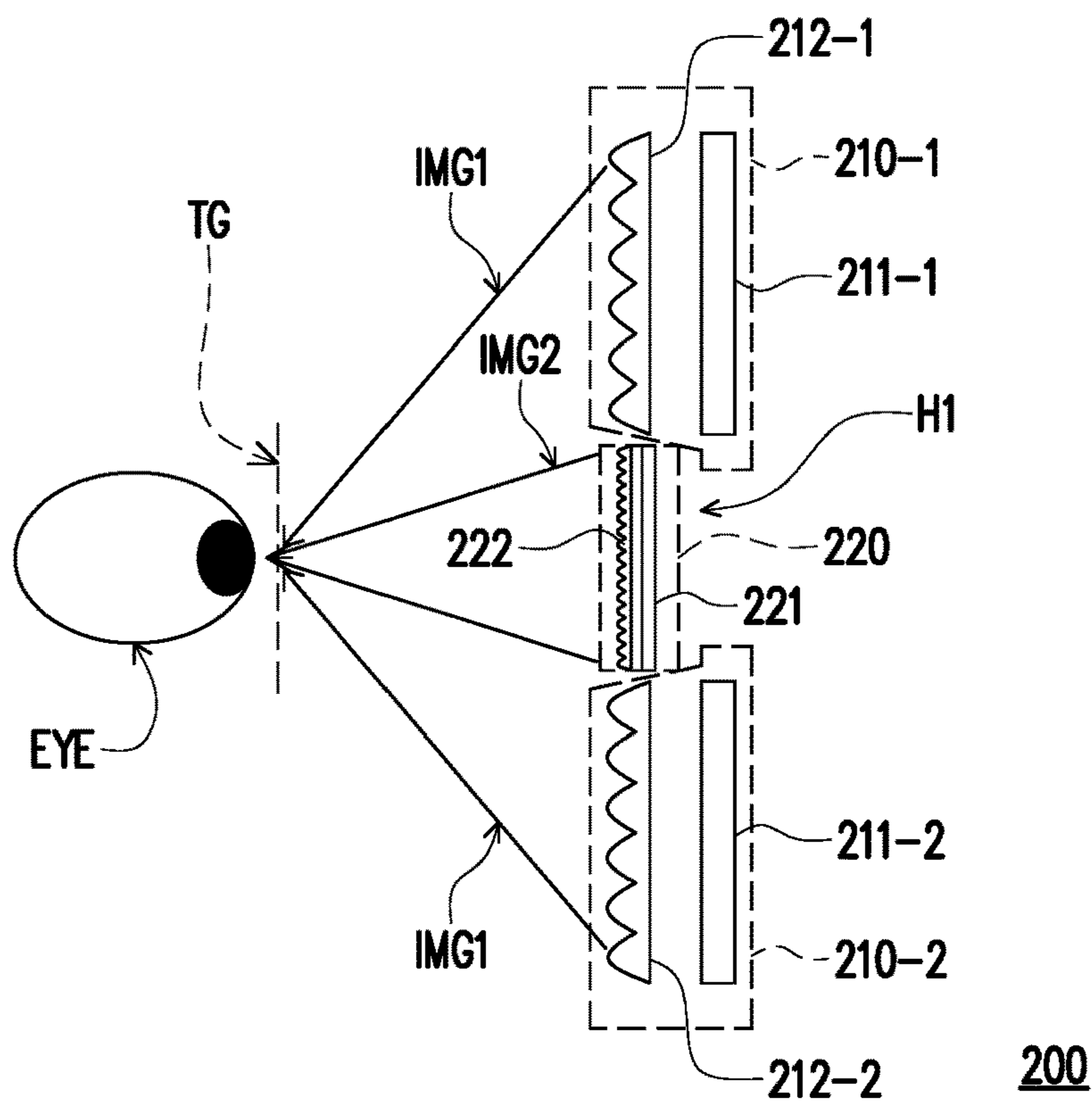


FIG. 2

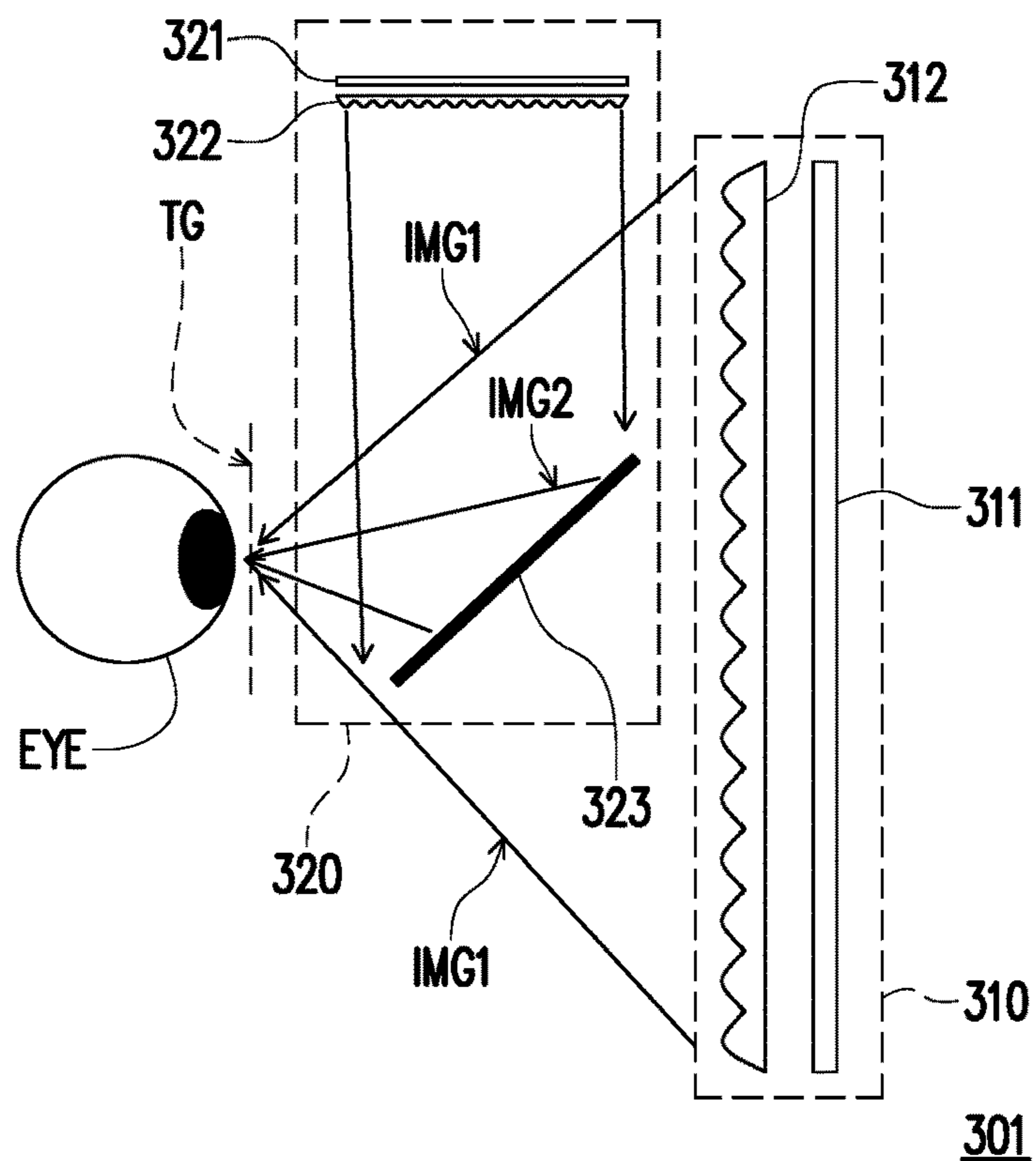


FIG. 3A

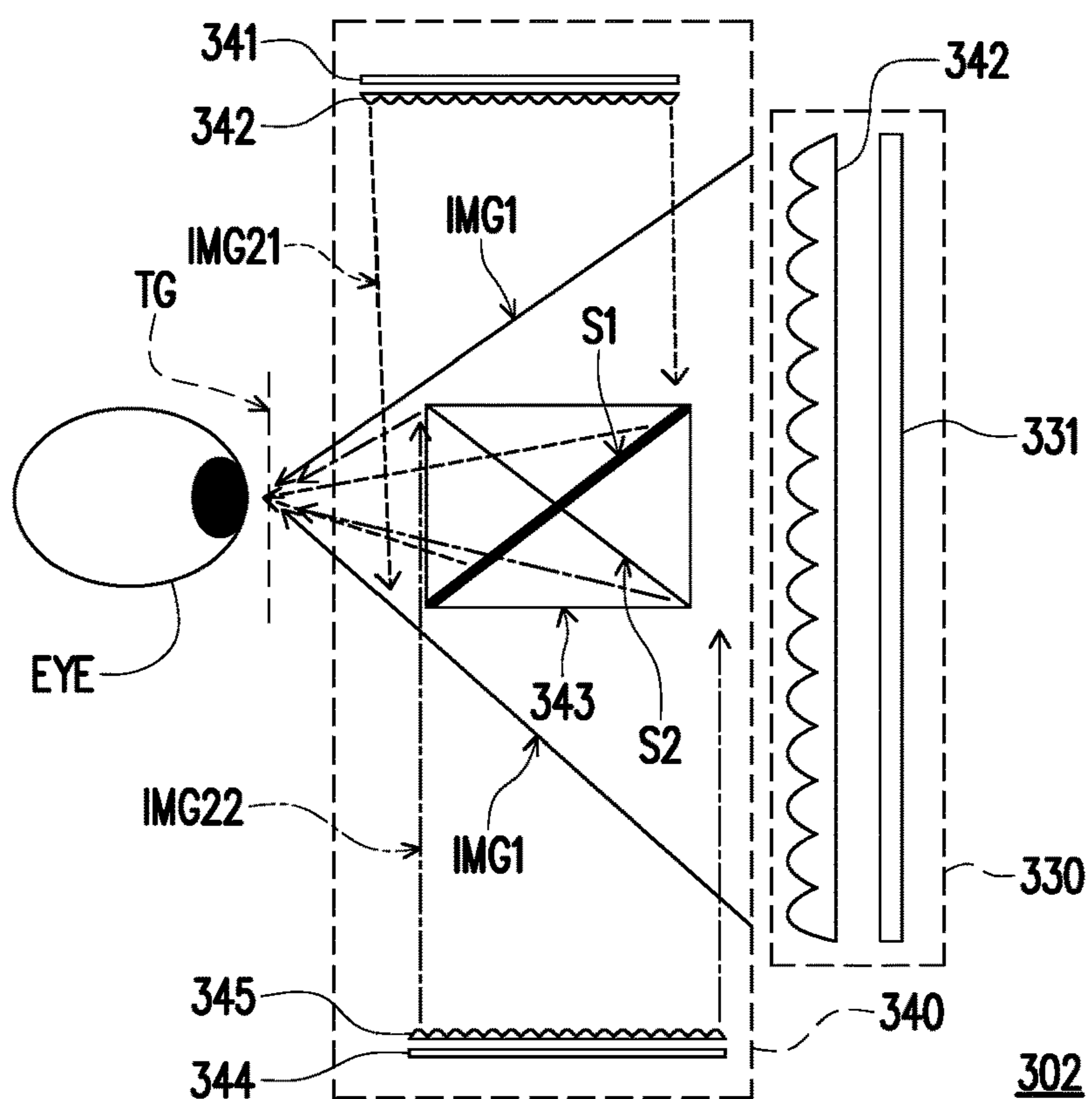


FIG. 3B

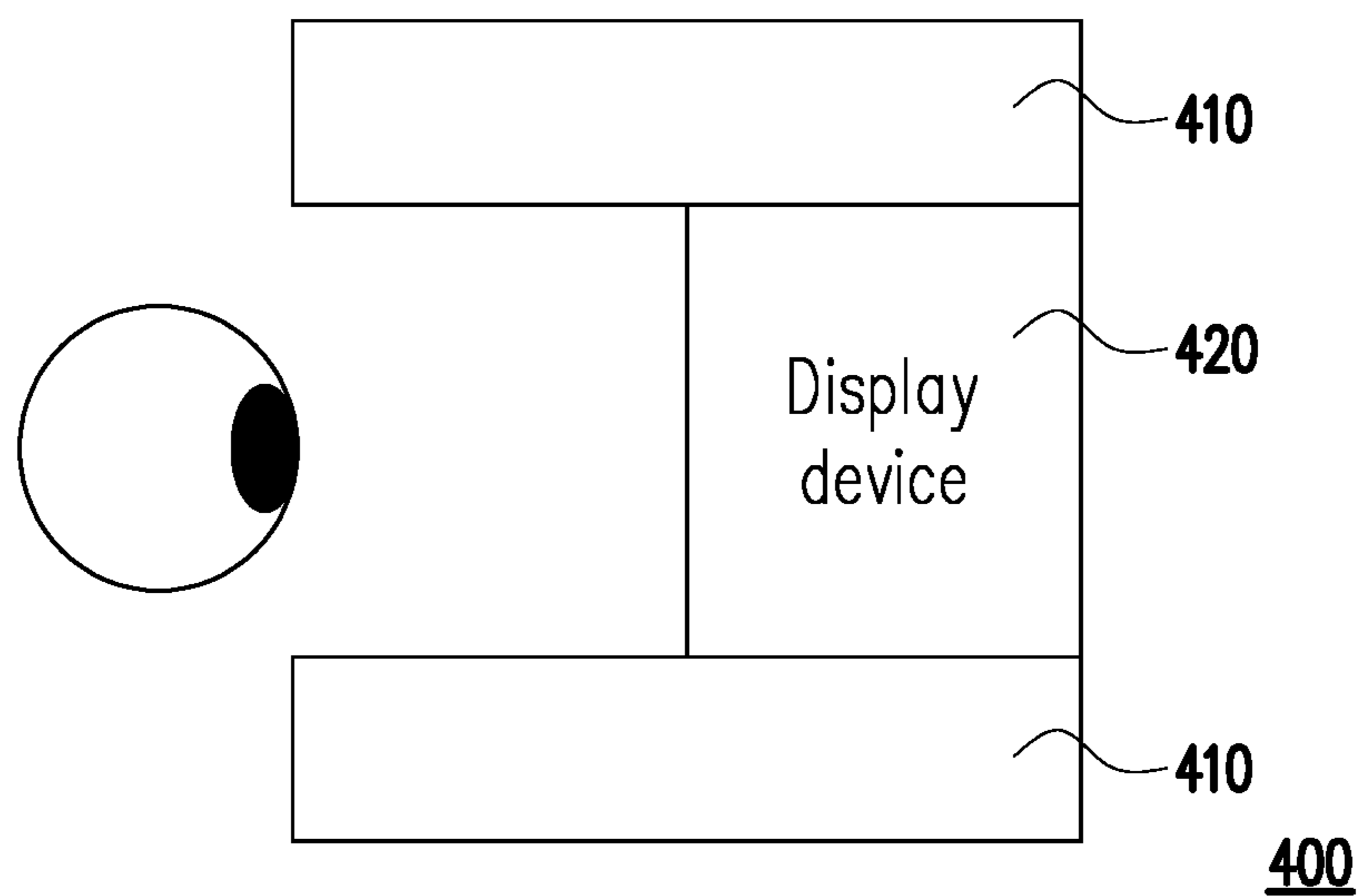


FIG. 4

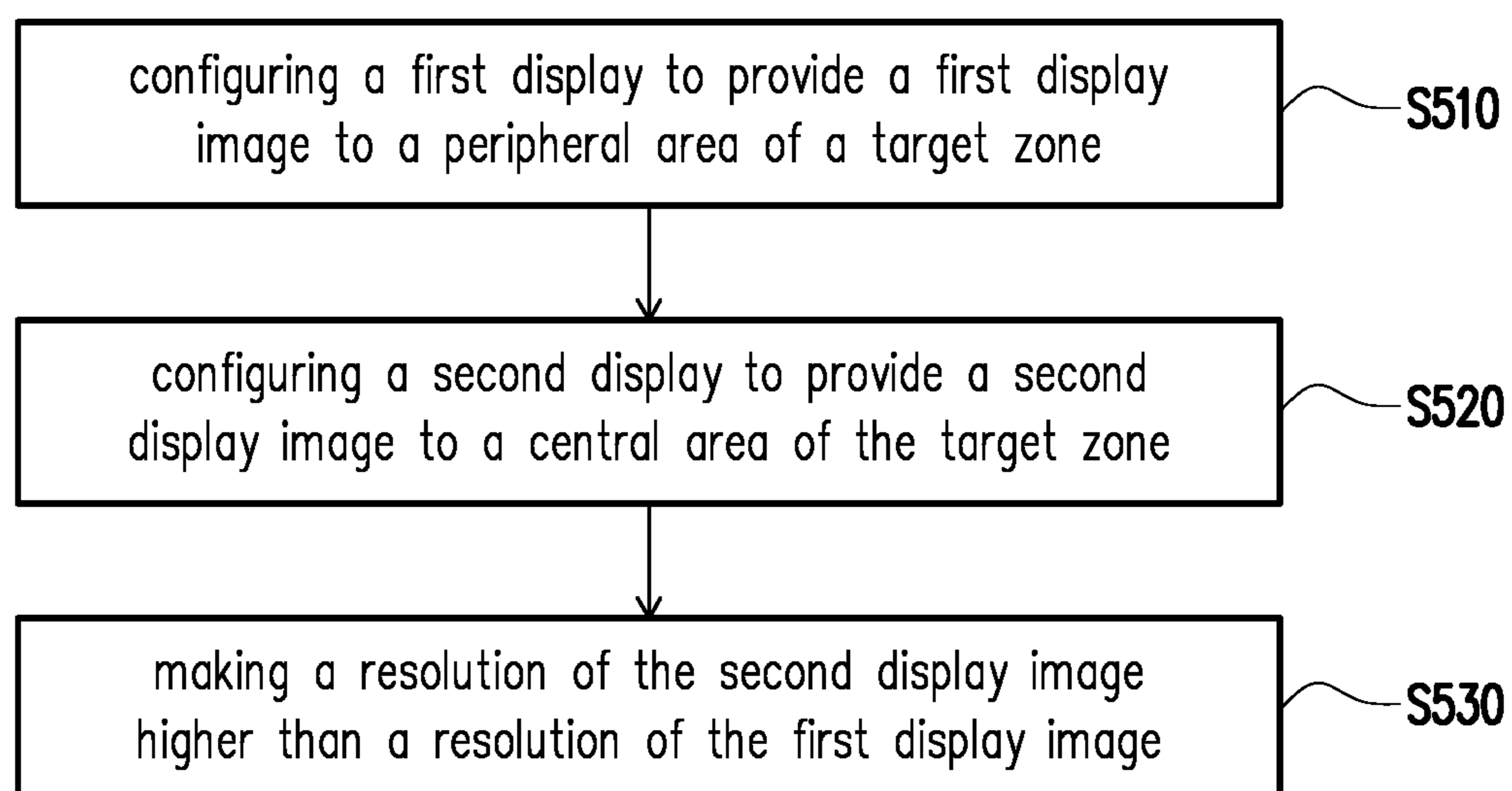


FIG. 5

**HEAD MOUNTED DISPLAY, DISPLAY
DEVICE AND IMAGE DISPLAY METHOD
THEREOF**

BACKGROUND

Technical Field

[0001] The disclosure is related to a head mounted display, a display device and an image display method thereof, and in particular to a head mounted display, a display device and an image display method thereof for a composite light field display system.

Description of Related Art

[0002] With the advancement of electronic technology, a light field display has been proposed. Common light field displays are roughly divided into five categories: high speed spin, multi-projector, directional backlight, multi layer display, and lens array.

[0003] In the related art, especially in the lens array type light field display, the main problem is that the resolution is not effectively improved. Therefore, how to improve the resolution of the light field display, so as to improve the user's image experience is an important issue for those skilled in the art.

SUMMARY

[0004] The disclosure provides a head mounted display, a display device and an image display method thereof, which improves the display effect of images.

[0005] The display device of the disclosure includes a first display and a second display. The first display is configured to provide a first display image to a peripheral area of a target zone. The second display is configured to provide a second display image to a central area of the target zone. A resolution of the second display image is higher than a resolution of the first display image.

[0006] The head mounted display device of the disclosure includes a main body portion and a display device as described above. The display device is disposed in the main body portion.

[0007] The image display method of the disclosure includes: configuring the first display to provide a first display image to a peripheral area of a target zone; configuring the second display to provide a second display image to a central area of the target zone; making a resolution of the second display image higher than a resolution of the first display image.

[0008] Based on the above, the disclosure uses the second display to provide a second display image with relatively high resolution to the central area of the target zone where the attention of human's eye is relatively concentrated. In the peripheral area of the target zone, the first display image with relatively low resolution is provided through the first display. In this way, in the light field display system, the display device of the disclosure effectively improves the display quality of the image. The display performance of virtual image in the application of head mounted display is also improved effectively.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a schematic view of a display device according to an embodiment of the disclosure.

[0010] FIG. 2 is a schematic view of a display device according to another embodiment of the disclosure.

[0011] FIG. 3A and FIG. 3B are schematic views of different implementation manners of a display device according to another embodiment of the disclosure.

[0012] FIG. 4 is a schematic view of ahead mounted display of an embodiment of the disclosure.

[0013] FIG. 5 is a flowchart of an image display method of an embodiment of the disclosure.

DESCRIPTION OF THE EMBODIMENTS

[0014] Please refer to FIG. 1. FIG. 1 is a schematic view of a display device according to an embodiment of the disclosure. The display device 100 includes a first display 110 and a second display 120. The first display 110 and the second display 120 overlap each other. The first display 110 is configured to project a first display image IMG1 toward a peripheral area of a target zone TG. The second display 120 is configured to provide a second display image IMG2 to a central area of the target zone TG. The target zone TG may be the area where the user's eyeball EYE is located. In this embodiment, the resolution of the second display image IMG2 projected by the second display 120 may be greater than the resolution of the first display image IMG1 projected by the first display 110.

[0015] The disposition of the first display 110 and the second display 120 is described in detail below. The first display 110 includes a display panel 111, a lens array 112-1, and a lens array 112-2. The lens array 112-1 and the lens array 112-2 overlaps the upper half area and the lower half area of the display panel 111, respectively. The central area of the display panel 111 does not overlap the lens arrays 112-1 and 112-2. The second display 120 is disposed corresponding to the central area of the display panel 111, and the display panel 111 is disposed between the target zone and the second display 120. That is, the second display 120 may be disposed behind the display panel 111.

[0016] In this embodiment, the second display 120 includes a display panel 121 and a lens array 122. The display panel 121 and the lens array 122 overlaps each other. The lens array 122 is disposed in front of the display panel 121.

[0017] The second display image IMG2 projected by the display panel 121 of the second display 120 penetrates the display panel 111 of the first display 110 to the central area of the target zone TG. In this embodiment, the first display 110 may be a transmissive display, that is, the display panel 111 of the first display 110 is a transmissive display panel. The transmittance of the first display 110 may be 80%. The first display 110 is configured to project the first display image IMG1 to the peripheral area of the target zone TG. It should be noted that in the target zone TG, a viewing angle A of a user to the second display image IMG2 may be between 20 and 60 degrees.

[0018] It should be noted that the second display 120 may be a micro-display, which provides the second display image IMG2 of the light field display image to the central area of a user's eyeball EYE. In this embodiment, the second display 120 provides the second display image IMG2 with relatively high resolution to the central area of the user's eyeball EYE, which enhances the display quality of the display device 100.

[0019] Please refer to FIG. 2. FIG. 2 is a schematic view of a display device according to another embodiment of the

disclosure. The display device **200** includes a first display **210** and a second display **220**. The central area of the first display **210** may have an opening area **H1**, and the second display **220** may be disposed in the opening area **H1**. The first display **210** includes a display panel **211-1**, a display panel **211-2**, a lens array **212-1**, and a lens array **212-2**. The display panels **211-1** and **211-2** and the lens arrays **212-1** and **212-2** overlaps each other respectively. The second display **220** includes a display panel **221** and a lens array **222**. The display panel **221** and the lens array **222** overlaps each other.

[0020] In this embodiment, in the first display **210**, the lens array **212-1** and the lens array **212-2** are respectively disposed in front of the display panel **211-1** and the display panel **211-2**. The display panel **211-1** and the display panel **211-2** provide the first display image **IMG1** to the peripheral area of the target zone **TG**. The target zone **TG** corresponds to the position of the user's eyeball. In the second display **220**, the lens array **222** are disposed in front of the display panel **221**. The display panel **221** provides the second display image **IMG2** to the central area of the target zone **TG**.

[0021] By disposing the second display **220** in the opening area **H1** in the central area of the first display **210**, the second display **220** effectively provide the second display image **IMG2** for the central area of the target zone **TG**. And by making the resolution of the second display image **IMG2** higher than that of the first display image **IMG1**, the user may directly see the second display image **IMG2** with high resolution, which effectively enhance the visual effect of the user.

[0022] Incidentally, in this embodiment, the shape of the opening area **H1** may be disposed according to the shape of the second display **220**. The shape of the opening area **H1** may be, for example, a circle, an ellipse, a rectangle, a rhombus, an arbitrary regular polygon, etc., and are not limited thereto.

[0023] Please refer to FIG. 3A and FIG. 3B. FIG. 3A and FIG. 3B are schematic views of different implementation manners of a display device according to another embodiment of the disclosure. In FIG. 3A, the display device **301** includes a first display **310** and a second display **320**. The second display **320** is disposed between the target zone **TG** and the first display **310**. The first display **310** faces the target zone **TG**, where target zone **TG** corresponds to the position of the user's eyeball **EYE**.

[0024] In detail, the second display **320** includes a display panel **311** and a lens array **312**. The lens array **312** is disposed in front of the display panel **311** and overlaps with the display panel **311**. The display panel **311** is configured to project the first display image **IMG1**. The second display **320** includes a display panel **321**, a lens array **322**, and a semi-transparent reflector **323**. The semi-transparent reflector **323** may be disposed at the position corresponding to a position of the central area of the display panel **311**. The display panel **321** and the lens array **322** overlap each other and are disposed outside the image projection area of the display panel **311**. The display panel **321** is configured to project the second display image **IMG2** to the semi-transparent reflector **323**. In addition, the semi-transparent reflector **323** reflects the second display image **IMG2**, and the second display image **IMG2** is reflected to the central area of the target zone.

[0025] In addition, the first display image **IMG1** projected by the display panel **311** penetrates the semi-transparent reflector **323** and is transmitted to the peripheral area of the target zone **TG**.

[0026] Similar to the aforementioned embodiment, the second display **320** of this embodiment effectively enhance the user's experience of the display image of the display device **301** by projecting the second display image **IMG2** with relatively high resolution to the central area of the target zone **TG**.

[0027] Incidentally, in this embodiment, image projection directions of the first display **310** and the second display **320** do not have to be perpendicular to each other. As long as the image projection directions of the first display **310** and the second display **320** are not parallel to each other, they may have any included angle without any specific limitation.

[0028] In FIG. 3B, the display device **302** includes a first display **330** and a second display **340**. The second display **340** is disposed between the target zone **TG** and the first display **330**. The first display **330** faces the target zone **TG**, where target zone **TG** corresponds to the position of the user's eyeball **EYE**. The first display **330** includes a display panel **331** and a lens array **342** overlapping each other. The display panel **331** is configured to project the first display image **IMG1**, and the first display image **IMG1** penetrates a beam splitter **343** to project to the peripheral area of the target zone **TG**.

[0029] Different from the embodiment in FIG. 3A, in this embodiment, the second display **340** includes a display panel **341**, a display panel **344**, a lens array **342**, a lens array **345**, and the beam splitter **343**. The beam splitter **343** may be disposed in front of the first display **330** corresponding to a position of the central area of the display panel **331**. The display panel **341** and the lens array **342** overlap each other and are disposed outside a first side of the beam splitter **343**. The display panel **344** and the lens array **345** overlap each other and are disposed outside a second side of the beam splitter **343**. The first side is opposite to the second side.

[0030] The beam splitter **343** has two reflecting surfaces **S1** and **S2**. The display panel **341** is configured to project a first sub display image **IMG21** to the reflecting surface **S1** of the beam splitter **343**. The reflecting surface **S1** of the beam splitter **343** is configured to reflect the first sub display image **IMG21** to the central area of the target zone **TG**. The display panel **344** is configured to project a second sub display image **IMG22** to the reflecting surface **S1** of the beam splitter **343**. The reflecting surface **S1** of the beam splitter **343** is configured to reflect the second sub display image **IMG22** to the central area of the target zone **TG**. The first sub display image **IMG21** and the second sub display image **IMG22** may be combined into the second display image with relatively high resolution.

[0031] It should be noted that a first distance between geometric centers of the display panel **341** and the beam splitter **343** may be the same as or different from a second distance between geometric centers of the display panel **344** and the beam splitter **343**, and are not limited thereto.

[0032] It is worth mentioning that in this embodiment, by making the first distance and the second distance the same, a display image with high resolution may be obtained by overlapping the first sub display image **IMG21** and the second sub display image **IMG22**. By making the first distance and the second distance different, the first sub

display image IMG21 and the second sub display image IMG22 become two images with parallax, which generate a stereoscopic image.

[0033] Please refer to FIG. 4. FIG. 4 is a schematic view of a head mounted display of an embodiment of the disclosure. The head mounted display device 400 includes a main body portion 410 and a display device 420. The display device 420 may be disposed in the main body portion 410. The display device 420 may be implemented by using any one of the display devices 100, 200, 301, and 302 of the aforementioned embodiment, and is configured to provide image display effect of virtual reality.

[0034] Please refer to FIG. 5. FIG. 5 is a flowchart of an image display method of an embodiment of the disclosure. In step S510, the first display is configured to provide a first display image to a peripheral area of a target zone. In step S520, the second display is configured to provide a second display image to a central area of the target zone. In addition, in step S530, a resolution of the second display image is made to be higher than a resolution of the first display image.

[0035] The implementation details of the above steps have been described in detail in the aforementioned embodiments, and will not be repeated here.

[0036] To sum up, the display device of the disclosure provides a second display to project the second display image with relatively high resolution to the central area of the target zone. By displaying the second display image within a certain viewing angle range of the user, the quality of the display image generated by the display device is effectively improved. The user's experience of the display image is also enhanced.

1. A display device, comprising:
 - a first display, configured to provide a first display image to a peripheral area of a target zone; and
 - a second display, configured to provide a second display image to a central area of the target zone, wherein the second display comprises:
 - a beam splitter, having a first reflecting surface and a second reflecting surface;
 - a first display panel, configured to project a first sub display image to the first reflecting surface; and
 - a second display panel, configured to project a second sub display image to the second reflecting surface, wherein the beam splitter reflects the first sub display image and the second sub display image to the central area of the target zone to form the second display image, and
 - wherein a resolution of the second display image is higher than a resolution of the first display image.
2. The display device according to claim 1, wherein the first display and the second display overlap each other.
3. The display device according to claim 2, wherein the first display is a transmissive display.
4. The display device according to claim 3, wherein a transmittance of the first display is 80%.
5. (canceled)
6. (canceled)
7. (canceled)
8. (canceled)
9. The display device according to claim 1, wherein the first display comprises:

- a display panel; and
- a lens array, overlapping the display panel, wherein the lens array is disposed between the display panel and the target zone.

10. The display device according to claim 1, wherein a viewing angle of a user to the second display image in the target zone is between 20 and 60 degrees.

11. A head mounted display, comprising:

- a main body portion; and
- the display device according to claim 1, disposed in the main body portion.

12. An image display method, comprising

- configuring a first display to provide a first display image to a peripheral area of a target zone;
- configuring a second display to provide a second display image to a central area of the target zone, comprising:
 - disposing a beam splitter, wherein the beam splitter has a first reflecting surface and a second reflecting surface;

- disposing a first display panel, wherein the first display panel is configured to project a first sub display image to the first reflecting surface; and

- disposing a second display panel, wherein the second display is configured to project a second sub display image to the second reflecting surface, wherein the beam splitter reflects the first sub display image and the second sub display image to the central area of the target zone to form the second display image; and
- making a resolution of the second display image higher than a resolution of the first display image.

13. The image display method according to claim 12, further comprising:

- making a viewing angle of a user to the second display image in the target zone between and 60 degrees.

14. The image display method according to claim 12, further comprising:

- overlapping the first display and the second display, wherein the first display is a transmissive display.

15. (canceled)

16. (canceled)

17. A display device, comprising:

- a first display, configured to provide a first display image to a peripheral area of a target zone; and

- a second display, configured to provide a second display image to a central area of the target zone, wherein the second display comprises:

- a semi-transparent reflector, disposed between the first display and the target zone;

- a display panel, configured to project the second display image to the semi-transparent reflector; and

- a lens array, disposed between the display panel and the semi-transparent reflector,

- wherein the semi-transparent reflector reflects the second display image to the central area of the target zone, and

- wherein a resolution of the second display image is higher than a resolution of the first display image.

18. The display device according to claim 17, wherein a first distance between geometric centers of the first display panel and the beam splitter are the same as or different from a second distance between geometric centers of the second display panel and the beam splitter.