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

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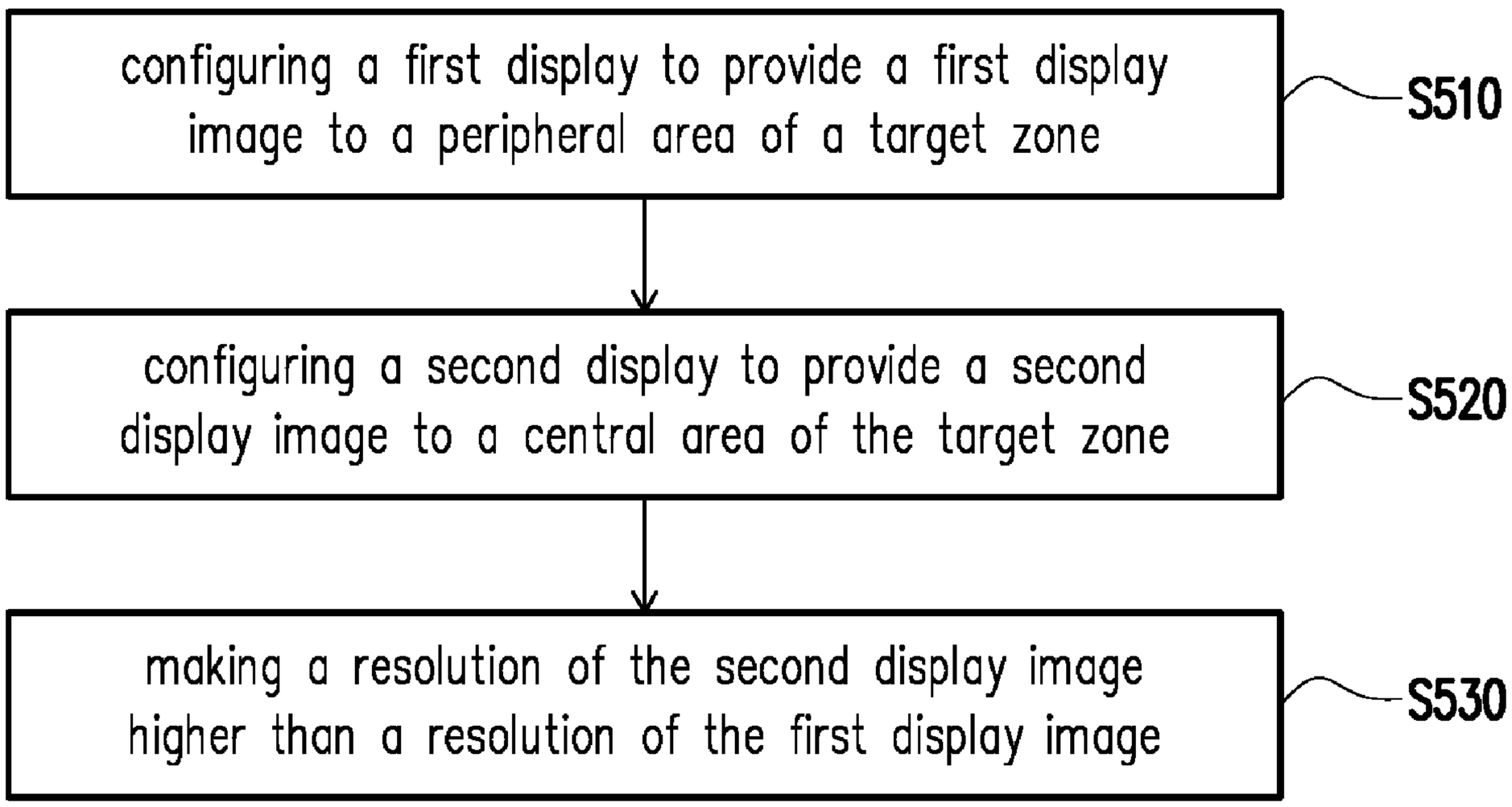
(57) **ABSTRACT**

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.



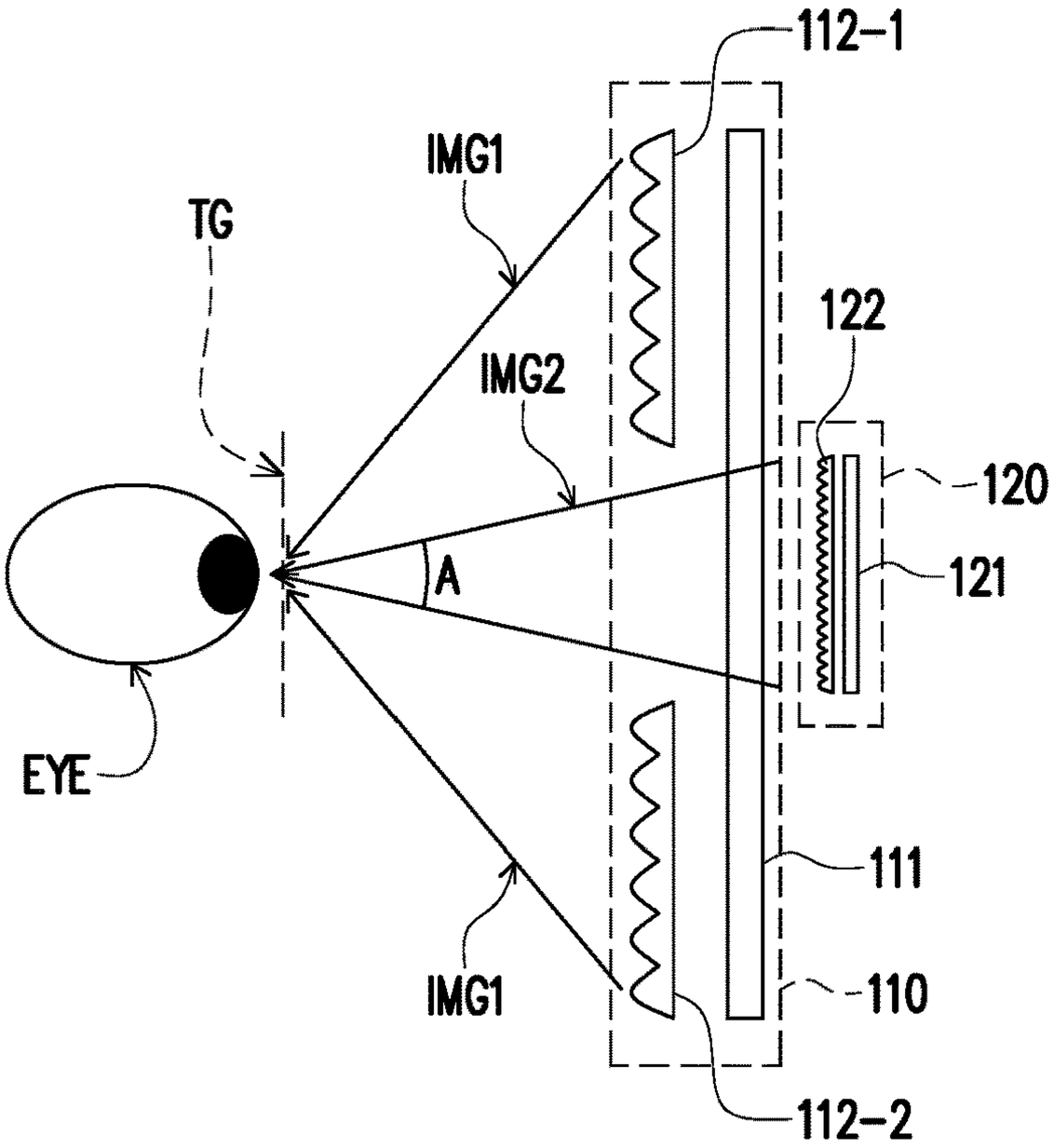

112-1
IMG1
TG
122
IMG2
120
A
121
EYE
111
IMG1
110
112-2
100

FIG. 1

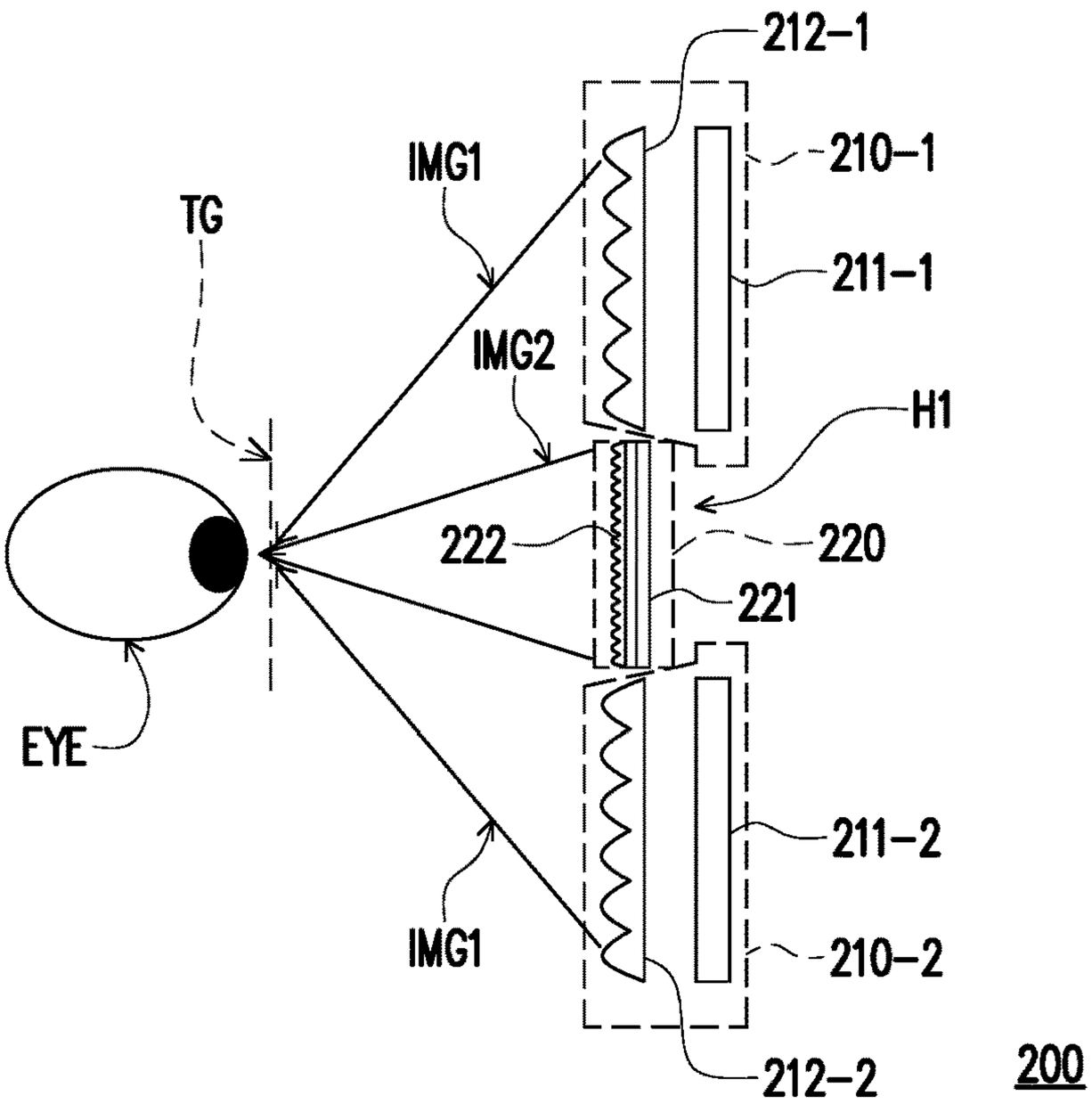

212-1
IMG1
210-1
TG
211-1
IMG2
H1
222
220
221
EYE
211-2
IMG1
210-2
212-2
200

FIG. 2

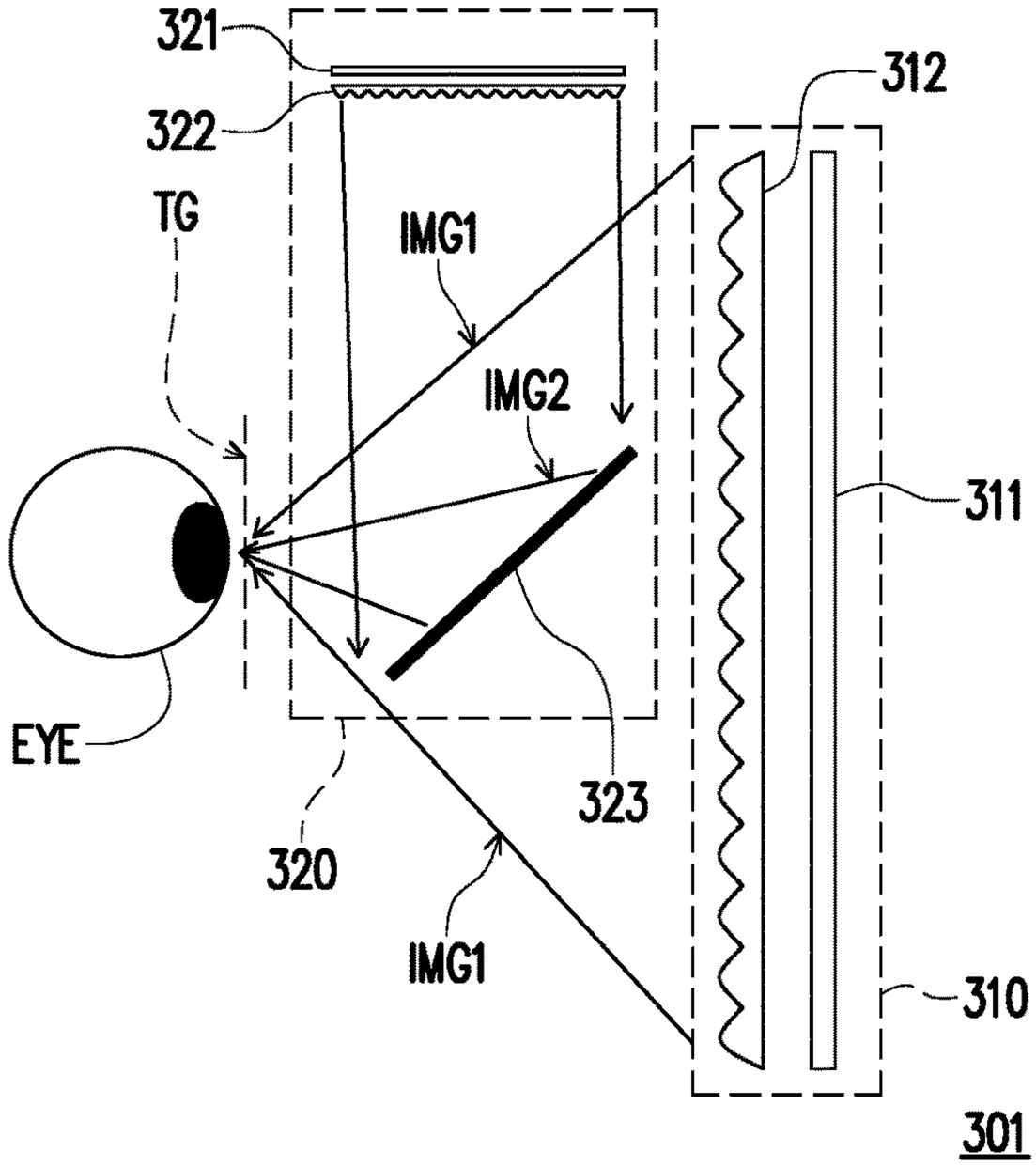

321
322
TG
IMG1
IMG2
312
311
EYE
323
320
IMG1
310
301

FIG. 3A

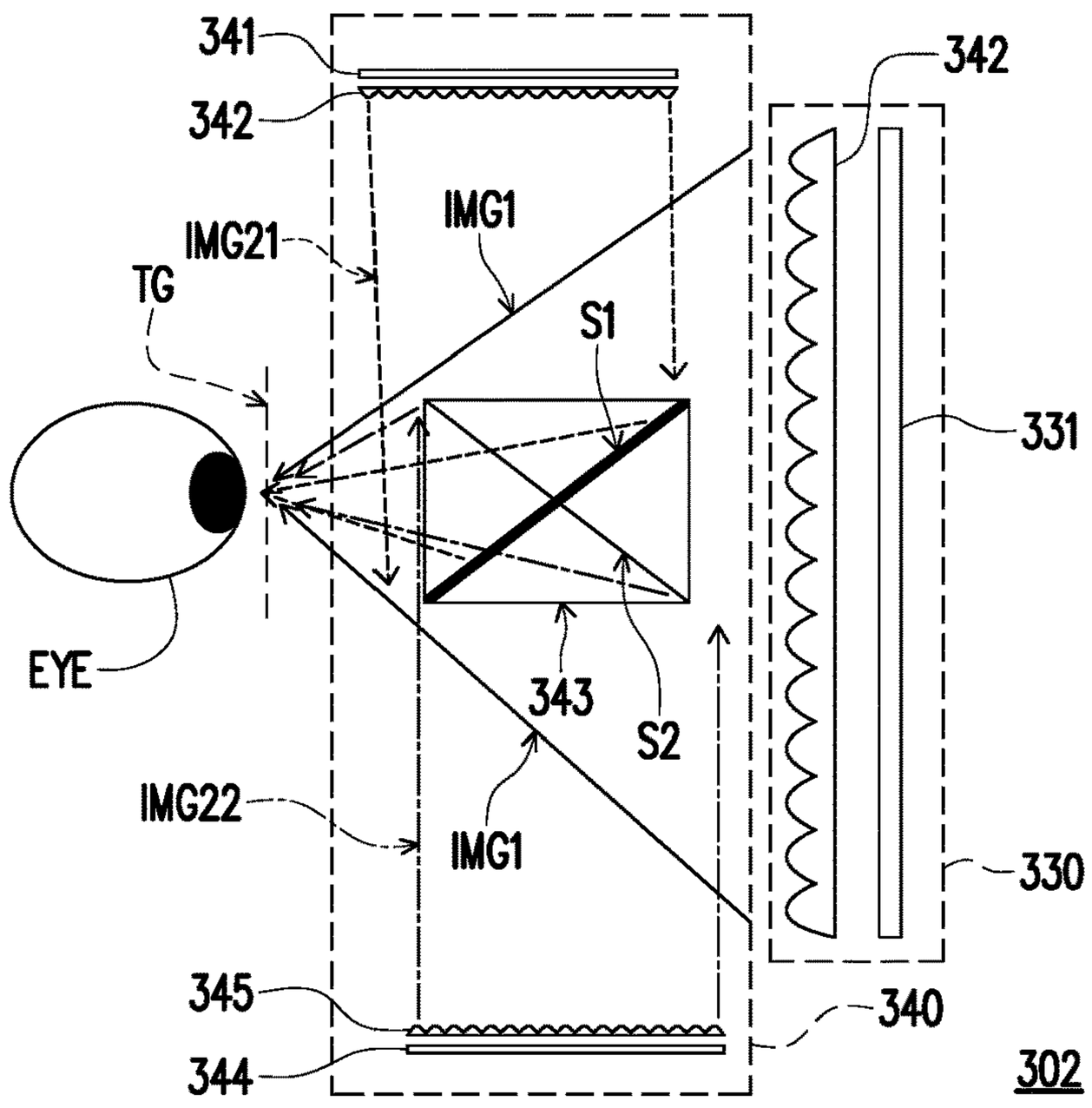

341
342
342
IMG21
IMG1
TG
S1
331
EYE
343
S2
IMG22
IMG1
330
345
340
344
302

FIG. 3B

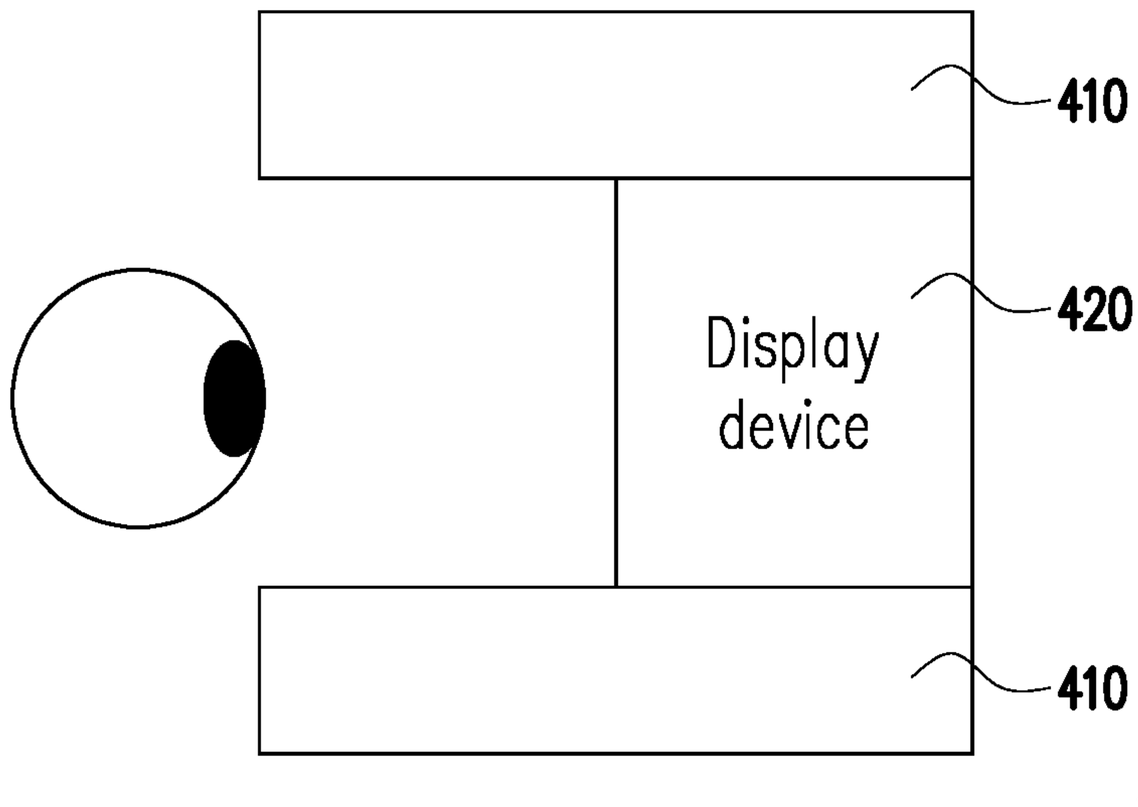

410
420
Display device
410
400

FIG. 4

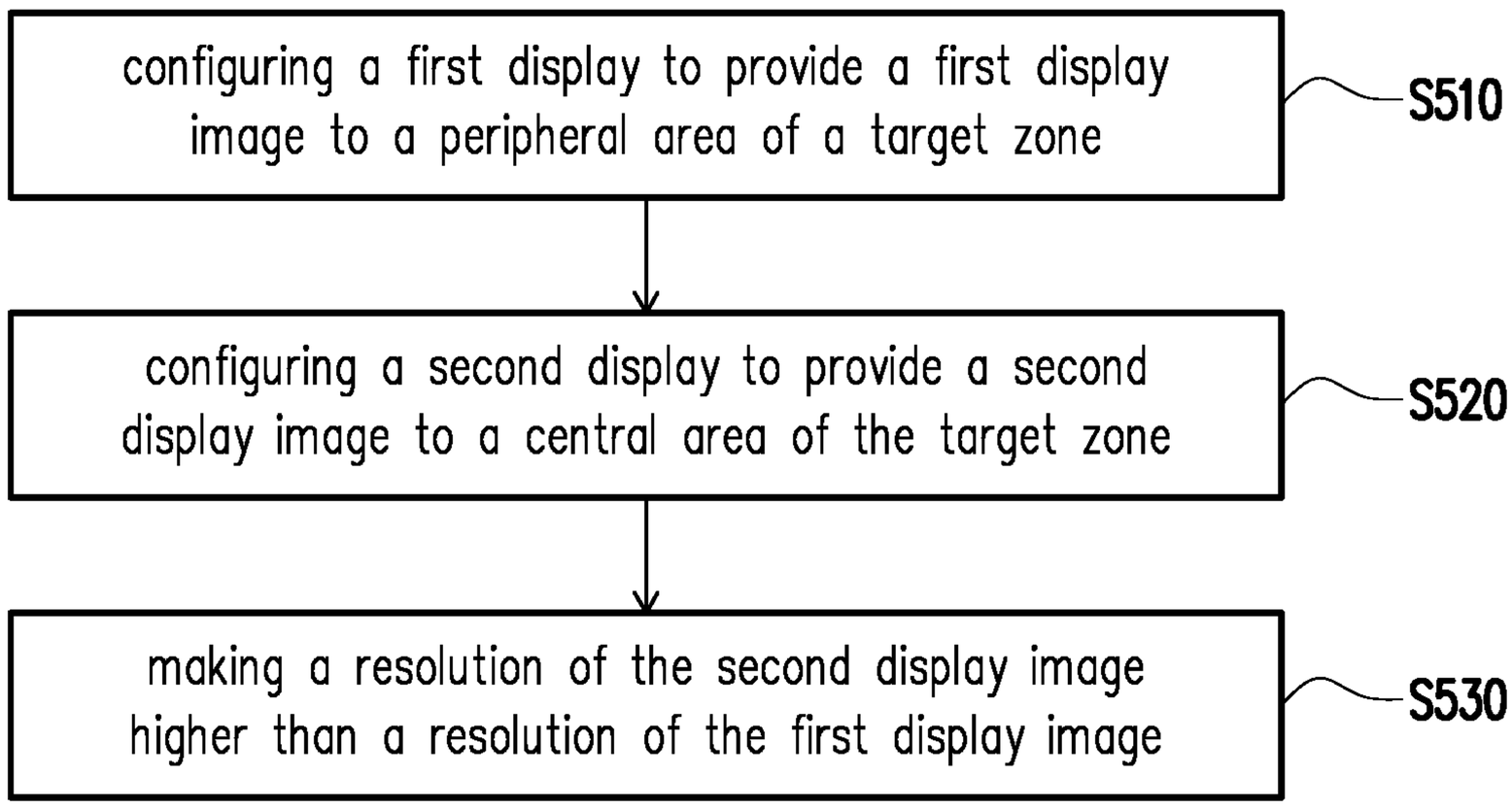

configuring a first display to provide a first display image to a peripheral area of a target zone
S510
configuring a second display to provide a second display image to a central area of the target zone
S520
making a resolution of the second display image higher than a resolution of the first display image
S530

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. **3**A and FIG. **3**B 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 IMG**1** toward a peripheral area of a target zone TG. The second display **120** is configured to provide a second display image IMG**2** 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 IMG**2** projected by the second display **120** may be greater than the resolution of the first display image IMG**1** 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 IMG**2** 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 IMG**1** 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 IMG**2** 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 IMG**2** 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 IMG**2** 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 H**1**, and the second display **220** may be disposed in the opening area H**1**. 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 IMG**1** 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 IMG**2** to the central area of the target zone TG.

[0021] By disposing the second display **220** in the opening area H**1** in the central area of the first display **210**, the second display **220** effectively provide the second display image IMG**2** for the central area of the target zone TG. And by making the resolution of the second display image IMG**2** higher than that of the first display image IMG**1**, the user may directly see the second display image IMG**2** with high resolution, which effectively enhance the visual effect of the user.

[0022] Incidentally, in this embodiment, the shape of the opening area H**1** may be disposed according to the shape of the second display **220**. The shape of the opening area H**1** 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. **3**A and FIG. **3**B. FIG. **3**A and FIG. **3**B are schematic views of different implementation manners of a display device according to another embodiment of the disclosure. In FIG. **3**A, 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 IMG**1**. 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 IMG**2** to the semi-transparent reflector **323**. In addition, the semi-transparent reflector **323** reflects the second display image IMG**2**, and the second display image IMG**2** is reflected to the central area of the target zone.

[0025] In addition, the first display image IMG**1** 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 IMG**2** 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. **3**B, 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 IMG**1**, and the first display image IMG**1** penetrates a beam splitter **343** to project to the peripheral area of the target zone TG.

[0029] Different from the embodiment in FIG. **3**A, 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 S**1** and S**2**. The display panel **341** is configured to project a first sub display image IMG**21** to the reflecting surface S**1** of the beam splitter **343**. The reflecting surface S**1** of the beam splitter **343** is configured to reflect the first sub display image IMG**21** to the central area of the target zone TG. The display panel **344** is configured to project a second sub display image IMG**22** to the reflecting surface S**1** of the beam splitter **343**. The reflecting surface S**1** of the beam splitter **343** is configured to reflect the second sub display image IMG**22** to the central area of the target zone TG. The first sub display image IMG**21** and the second sub display image IMG**22** 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 IMG**21** and the second sub display image IMG**22**. By making the first distance and the second distance different, the first sub

display image IMG**21** and the second sub display image IMG**22** 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 S**510**, the first display is configured to provide a first display image to a peripheral area of a target zone. In step S**520**, the second display is configured to provide a second display image to a central area of the target zone. In addition, in step S**530**, 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.

* * * * *