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(71) Applicant *(for all designated States except US)*: **DEO COM Co., Ltd.** [KR/KR]; #403, 4th Floor, Cheong-Ryong Bldg., 142-26 Samsung-dong, Kangnam-gu, Seoul 135-090 (KR).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **SONG, Heyg kyu** [KR/KR]; #102-1104, Sinwon Suseonhwa Apt, 24 Ochun-dong, Uiwang-si, Kyonggi-do 437-816 (KR).

(74) Agent: **DARAE PATENT FIRM**; 10th Floor, KIPS, 647-9, Yeoksam-dong, Kangnam-ku, Seoul 135-980 (KR).

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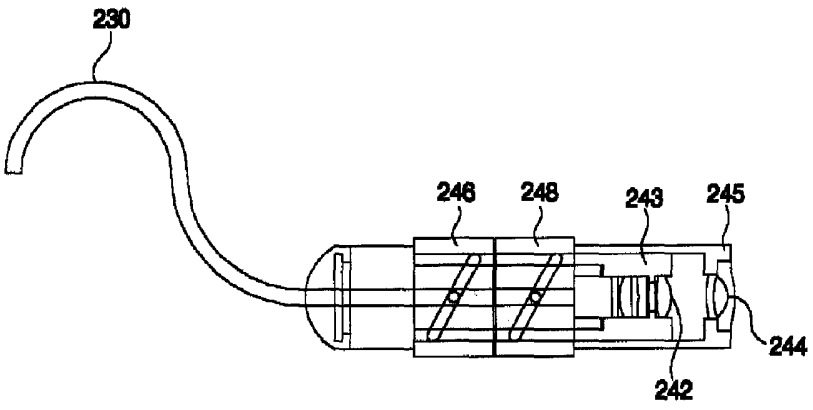
(54) **Title:** PROJECTION TYPE HEAD MOUNTED DISPLAY APPARATUS



(57) **Abstract:** The projection type head mounted display apparatus in accordance with the present invention comprises an image generating means for generating an image to be transmitted; an optical transmission means for transmitting the image; an image relaying means for relaying the image generated by the image generating means to the optical transmission means; an adjusting means for projecting image transmitted by the optical transmission means and manually adjusting a zoom or a focus of the image; and a reflecting means for reflecting the image passed through the adjusting means to be provided to a user. In accordance with the present invention, the zoom or the focus of the image is easily embodied at the headset by solving the problem of the conventional HMD, the integrated optical fiber is used to remove the boundary of the image generated in the conventional HMD, and the configuration of the headset is minimized to be applied to the wearable computer such that the user is comfortable after a long use.

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Description

PROJECTION TYPE HEAD MOUNTED DISPLAY APPARATUS

Technical Field

[1] The present invention relates to a projection type head mounted display, and more particularly, to a projection type head mounted display wherein a zoom or a focus of an image is easily embodied at a headset portion by solving a problem of a conventional HMD, a integrated optical fiber is used to remove a boundary of the image generated in the conventional HMD, and a configuration of the headset is minimized to be applied to a wearable computer such that a user is comfortable after a long use.

Background Art

[2] A head mount display (referred to as 'HMD' hereinafter), often referred to as a FMD (Face Mounted Display) refers to a type of a monitor which is wearable similar to an eyeglass.

[3] The HMD was developed for a military use and was use by the U.S. Air Force. However, the HMD is used by consumers due to a high performance computer system, a development of display devices such as an LCD, developments of and image and communication technology. Particularly, it is predicted that the HMD will become more popular as a personal display device for a wearable computer according to a development of the wearable computer.

[4] A structure of the conventional HMD is disclosed by patent application. For instance, Korean Patent No. 0136891 filed on Oct. 31, 1994 by Sharp Kabushiki Kaisha and registered on Jan. 31, 1998, or Korean Patent No. 10-0181724 filed on Jan 39, 1998 by Hughes Training, Inc. and registered on Dec. 9, 1998 titled "MICRO-MINIATURE DISPLAY OF OPTICAL FIBER RIBBON FOR HEAD/HELMET MOUNT DISPLAY" discloses the convention HMD in detail. In accordance with the conventional HMD disclosed by the Korean Patent No. 10-0181724, a laser light is modulated by a video data source, and the modulated light image data is transmitted by a fiber ribbon, which is provided to a user by a display device which is mounted on a head. In addition, in accordance with the conventional HMD, a component for generating light modulated image by processing the video data and a display are integrated, and a controller for the component and the display is included.

[5] The conventional HMD allows the user to be immersed in a virtual reality by isolating a sense of the user from an external environment. However, the user cannot be aware of the external environment during while the user is wearing the HMD. While this does not imposes any problem when the user us playing a virtual realty game, a complete isolation from the external environment causes serious problems

when the HMD is used in a house, a medical and a industrial environments.

[6] Moreover, the conventional HMD has a low resolution and a low FOV (Field of View).

[7] In addition, in accordance with the conventional HMD, the LCD is mounted immediately in front of an eye so that a volume and a size of HMD are large. Therefore, a request of the consumer for lighter and smaller HMD is not satisfied.

[8] In order to solve these problems, many technology have been proposed.

[9] U.S. Patent No. 5,348,477 invented by Brian L. Welch and assigned to CAE Electronics titled "HIGH DEFINITION TELEVISION HEAD MOUNTED DISPLAY UNIT" discloses an improved HMD.

[10] Fig. 1 is a diagram illustrating the HMD disclosed by U.S. Patent No. 5,348,477.

[11] As shown, the HMD disclosed by U.S. Patent No. 5,348,477 comprises an image source 110, a relay lens 120, a fiber optic bundle 130, a projection lens 140, a rear projection screen 150 and an eyepiece 160.

[12] The eyepiece 160 may use a spherical mirror 163 and a flat beam splitter 167.

[13] The eyepiece 160, for example, converts a image signal to an image similar to a projector. the wind screen filter 120 relays the image generated by the image source 110 to the fiber optic bundle 130. The fiber optic bundle 130 transmits the image. The projection lens 140 projects the image to the rear projection screen 150, and the spherical mirror 163 and the flat beam splitter 167 are used to display the image to a user.

[14] U.S. Patent No. 5,348,477 may be referred for a detailed description of each component.

[15] However, the HMD disclosed by A detailed description of each component has following problems.

[16] A headset (or the eyepiece) does not have a function to adjust the FOV or a focus of the image. That is, the headset merely displays the image transmitted by the fiber optic bundle 130 or a optical fiber to the user, and does not have a function to actively adjust the FOV or the focus of the image. Therefore, the user should passively see the image when the image is out of focus even when the user tries to zoom or focus the image.

[17] Moreover, when the image is enlarged, a honeycomb shape boundary may be shown since the fiber optic bundle 130, the optical fiber or the optical fiber ribbon is used. That is, in accordance with the conventional HMD, since the optical fiber bundle, the optical cable or the optical fiber ribbon having bundled multiple optical fibers is used, a single image is transmitted through the multiple optical fibers. Therefore, the boundary between the images transmitted through the multiple optical fibers are displayed even when the image is displayed in a projection form, which imposes a serious problem in case of Korean Patent No. 10-0181724 wherein the FOV is large.

[18] The HMD using the optical fiber bundle is also disclosed by Korean Patent No. 10-233045 filed on Oct. 30, 1997 by Samsung Electronics, Co., and registered on Sep. 9, 1999. In accordance with Korean Patent No. 10-233045, while a term "a plurality of optical fibers" is used, Korean Patent No. 10-233045 has the same problem since the single image is dividedly transmitted through the multiple optical fibers and displayed.

Disclosure of Invention

Technical Problem

[19] A HMD wherein the zoom or the focus of the image is easily adjusted at the user's headset and the boundary of the image generated due to the use of the optical cable is removed is needed in order to solve the problem of the conventional HMD. In addition, it is required that a weight of the headset is minimized and a structure thereof is simplified in order to be applicable to the wearable computer.

Technical Solution

[20] It is an object of the present invention to provide a projection type head mounted display wherein a zoom or a focus of an image is easily embodied at a headset portion by solving a problem of a conventional HMD, a integrated optical fiber is used to remove a boundary of the image generated in the conventional HMD, and a configuration of the headset is minimized to be applied to a wearable computer such that a user is comfortable after a long use.

[21] In order to achieve the object of the present invention, there is provide a projection type head mounted display apparatus comprising: an image generating means for generating an image to be transmitted; an optical transmission means for transmitting the image; an image relaying means for relaying the image generated by the image generating means to the optical transmission means; an adjusting means for projecting image transmitted by the optical transmission means and manually adjusting a zoom or a focus of the image; and a reflecting means for reflecting the image passed through the adjusting means to be provided to a user.

[22] In accordance with the head mounted display apparatus of the present invention, it is preferable that the optical transmission means comprises an integrated optical fiber.

[23] In accordance with the head mounted display apparatus of the present invention, it is preferable that the image relaying means comprises: one or more convex lenses for magnifying the image larger; and one or more concave lenses for magnifying the image smaller such that the image magnified larger accurately corresponds to an input unit of the optical transmission means.

[24] In accordance with the head mounted display apparatus of the present invention, it is preferable that the adjusting means comprises: one or more zoom adjusting lenses for adjusting the zoom; one or more focus adjusting lenses for adjusting the focus;

zoom/focus driving unit for adjusting the zoom or the focus wherein the user manually adjusts a position of the one or more zoom adjusting lenses or the one or more focus adjusting lenses.

[25] In accordance with the head mounted display apparatus of the present invention, it is preferable that the image generating means comprises a self-luminous display device including an EL.

[26] In accordance with the head mounted display apparatus of the present invention, it is preferable that the image generating means comprises: a non-self-luminous display device for displaying the image by receiving an image signal; a light source for emitting a light; a polarized beam splitter for transmitting a first portion of the light emitted by the light source and reflecting a second portion of the light to the non-self-luminous display, and partially transmitting the image reflected from a surface of the non-self-luminous display; and a case for inputting the light emitted from the light source to the polarized beam splitter and providing the image to the image relaying means when the image reflected from the surface of the non-self-luminous display passes through the polarized beam splitter.

[27] In accordance with the head mounted display apparatus of the present invention, it is preferable that the image generating means generates a separate image for each of left and right eyes, wherein the optical transmission means, the image relaying means and the adjusting means transmits, relays or adjusts the separate image, and wherein the reflecting means is disposed at a front of a headset of an eyeglass type such that the separate image is displayed for each of the left and the right eyes.

[28] In accordance with the head mounted display apparatus of the present invention, it is preferable that the adjusting means is disposed at both sides of the headset for adjusting the zoom or the focus of the separate image.

Advantageous Effects

[29] As described above, in accordance with the present invention, a zoom or a focus of an image is easily embodied at a headset portion by solving a problem of a conventional HMD, a boundary of the image generated in the conventional HMD is removed by using a integrated optical fiber, and a configuration of the headset is minimized to be applied to a wearable computer such that a user is comfortable after a long use.

Brief Description of the Drawings

[30] Fig. 1 is a diagram illustrating a configuration of a conventional HMD.

[31] Fig. 2 is a block diagram illustrating a projection type HMD in accordance with the present invention.

[32] Fig. 3 is a diagram exemplifying a configuration of the projection type HMD in

accordance with the present invention.

[33] Fig. 4 is a diagram exemplifying another configuration of the projection type HMD in accordance with the present invention.

[34] Fig. 5 is a diagram illustrating an optical transmission means and an adjusting means in accordance with the present invention.

[35] Fig. 6 is a diagram illustrating a configuration of the projection type HMD in accordance with the present invention wherein the optical transmission means, the adjusting means and a reflecting means are illustrated.

Mode for the Invention

[36] A preferred embodiment of the projection type HMD in accordance with the present invention will now be described in detail with reference to the accompanied drawings.

[37] Fig. 2 is a block diagram illustrating a projection type HMD in accordance with the present invention. As shown, the projection type head mounted display comprises an image generating means 210, an image relaying means 220, an optical transmission means 230, and adjusting means 240 and a reflecting means 250.

[38] The image generating means 210 generates an image to be transmitted.

[39] The image relaying means 220 relays the image generated by the image generating means 210 to the optical transmission means 230.

[40] The optical transmission means 230 transmits the image relayed by the image relaying means 220.

[41] The adjusting means 240 projects the image transmitted by the optical transmission means 230 and manually adjusting a zoom or a focus of the image.

[42] The reflecting means 250 reflects the image that has passed through the adjusting means 240 and provides the image to a user.

[43] Fig. 3 is a diagram exemplifying a configuration of the projection type HMD in accordance with the present invention, wherein a non-self-luminous display device such as an LCD is used.

[44] As shown, the image generating means 210 comprises an LCD display 212, a PBS (polarized beam splitter) 214, a light source 216 and a case 218.

[45] The LCD display 212 receives an image signal and converts the image signal to the image to be displayed. Since the conversion of the image signal to the image is well-known to the skilled in the art, a detailed description is hereby omitted.

[46] The light source 216 emits a light, generally, for the non-self-luminous display device such as the LCD display 212, the light is radiated form the light source 216 and the image is displayed using the light. Since this is also well-known to the skilled in the art, a detailed description is hereby omitted.

[47] The PBS 214 transmits a first portion of the light emitted by the light source 216

and reflects a second portion of the light to the LCD display 212, and then partially transmits the light reflected from a surface of the LCD display 212 to the image relaying means 220.

[48] The case 218 inputs the light emitted from the light source 216 to the PBS 214 and provides the image to the image relaying means 220 when the image reflected from the surface of the LCD display 212 passes through the PBS 214.

[49] The image relaying means 220 comprises one or more convex lenses 223 for magnifying larger the image that has passed through the PBS 214 and provided through the case 218, and one or more concave lenses 226 for magnifying the image smaller such that the image magnified larger accurately corresponds to an input unit of the optical transmission means 230.

[50] The optical transmission means 230, for example, is an integrated optical fiber, the inputted image is transmitted to an output as is. Therefore, when the integrated optical fiber is used, the honeycomb shape boundary of the image generated when the conventional optical fiber bundle or the optical fiber ribbon is used may be removed. In addition, the optical transmission means 230 may be used as a simple projector. That is, the image outputted by the integrated optical fiber may be displayed on a surface of an object similar to the projector.

[51] Moreover, the optical fiber transmits the image according to an inputted angle. Therefore, an image converging lens 233 is disposed at an input unit of the optical transmission means 230 having a semi-circular shape for receiving the image so that the image is diffused from the input unit and more accurate image is inputted to the input unit.

[52] The image is inputted through the image relaying means 220 so that the image accurately corresponds, and the image is transmitted to the adjusting means 240 through the optical transmission means 230.

[53] The adjusting means 240 will now be described with reference to Fig. 5.

[54] Fig. 4 is a diagram exemplifying another configuration of the projection type HMD in accordance with the present invention, wherein a self-luminous display device such as an EL is used.

[55] The example shown in Fig. 4 differs from that of Fig. 3 in the image generating means 210.

[56] That is, while the example of Fig. 3 requires the light source 216 and the PBS 214, the light source 216 and the PBS 214 are not required since the example shown in Fig. 4 uses the EL which is the self-luminous display device. Since other components are identical to those of Fig. 2, a detailed description is hereby omitted.

[57] Fig. 5 is a diagram illustrating the optical transmission means 230 and the adjusting means 240 in accordance with the present invention.

[58] As shown, the image transmitted from the optical transmission means 230 is inputted to and projected by the adjusting means 240. Although not shown, the optical transmission means 230 may comprise an image diffusion lens of the semi-circular shape. The image diffusion lens carries out a function opposite to that of the image converging lens 233.

[59] The adjusting means 240 comprises one or more zoom adjusting lenses 242 for adjusting the zoom, one or more focus adjusting lenses 244 for adjusting the focus and zoom/focus driving units 246 and 248 for adjusting the zoom or the focus wherein the user manually adjusts a position of the one or more zoom adjusting lenses 242 or the one or more focus adjusting lenses 244.

[60] The one or more zoom adjusting lenses 242 comprise one or more lenses, and magnifies the image larger or smaller by manually adjusting a length of a zoom adjusting unit 243 through the zoom/focus driving units 246 and 248.

[61] The one or more focus adjusting lenses 244 comprise one or more lenses, and carrie out a focusing of the image by manually adjusting a length of a focus adjusting unit 245 through the zoom/focus driving units 246 and 248.

[62] The FOV may be enlarged through the zoom/focus adjustment.

[63] Fig. 6 is a diagram illustrating a configuration of the projection type HMD in accordance with the present invention wherein the optical transmission means 230, the adjusting means 240 and a reflecting means 250 are illustrated. As shown, optical transmission means 230a and 230b and adjusting means 240a and 240b for left and right eyes are shown.

[64] The HMD displays the image to both eyes. In accordance with the projection type head mounted display, the image generating means 210 generates separate images for the left and right eyes, and each of the separate images is transmitted through separate the image relaying means 220 and the optical transmission means 230.

[65] As shown in (a) or (b) of Fig. 6, reflecting means 250a and 250b reflect the image that has passed through the adjusting means 240a and 240b to be provided to the user. The reflecting means 250a and 250b is disposed at a front surface of a headset 260 of an eyeglass type, and may be embodied as a projection lens or a screen type which passes through a portion the light and reflects another portion of the light to the user. Such configuration provides a see-through type display to the user, thereby preventing a visual impediment and a dizziness which are generated in the conventional HMD of a see-close type. As shown, each of the reflecting means 250a and 250b provides a viewing angle of 121 to the user, and provide an viewing angle of 138 for both eyes.

[66] In addition, contrary to the conventional HMD, the image is not directly incident on the eyes of the user but a portion of the light is incident thereon by a reflection to reduce a fatigue of the eyes.

[67] Moreover, the headset 260 may be embodied as one body including the reflecting means 250a and 250b and the adjusting means 240a and 240b. such configuration allows a minimization of the weight of the headset 260 and adjustment of the zoom and the focus of the image when used in the wearable computer. In this case, when a surrounding light is incident on the eyes of the user from a side of the user, a resolution of the image may be reduced. In order to prevent this, the headset 260 has a large side to be in contact with a face to prevent the light from the side as shown in (c) of Fig. 6.

[68] As shown, the adjusting means 240a and 240b are disposed at a side portion of the headset 260 so that the zoom or the focus of the left and the right images may be adjusted.

[69] While the present invention has been particularly shown and described with reference to the preferred embodiment thereof and drawings, it will be understood by those skilled in the art that various changes in form and details may be effected therein without departing from the spirit and scope of the invention as defined by the appended claims.

Industrial Applicability

[70] In accordance with the projection type head mounted display, and more particularly of the present invention, since the zoom or the focus of the image is easily embodied at the headset by solving the problem of the conventional HMD, the integrated optical fiber is used to remove the boundary of the image generated in the conventional HMD, and the configuration of the headset is minimized to be applied to the wearable computer such that the user is comfortable after a long use, the present invention is industrially applicable.

Claims

[1] A projection type head mounted display apparatus comprising:
an image generating means for generating an image to be transmitted;
an optical transmission means for transmitting the image;
an image relaying means for relaying the image generated by the image generating means to the optical transmission means;
an adjusting means for projecting the image transmitted by the optical transmission means and manually adjusting a zoom or a focus of the image; and
a reflecting means for reflecting the image passed through the adjusting means to be provided to a user.

[2] The apparatus in accordance with claim 1, wherein the optical transmission means comprises an integrated optical fiber.

[3] The apparatus in accordance with claim 1, wherein the image relaying means comprises:
one or more convex lenses for magnifying the image larger; and
one or more concave lenses for magnifying the image smaller such that the image magnified larger accurately corresponds to an input unit of the optical transmission means.

[4] The apparatus in accordance with claim 1, wherein the adjusting means comprises:
one or more zoom adjusting lenses for adjusting the zoom;
one or more focus adjusting lenses for adjusting the focus;
zoom/focus driving unit for adjusting the zoom or the focus wherein the user manually adjusts a position of the one or more zoom adjusting lenses or the one or more focus adjusting lenses.

[5] The apparatus in accordance with claim 1, wherein the image generating means comprises a self-luminous display device including an EL.

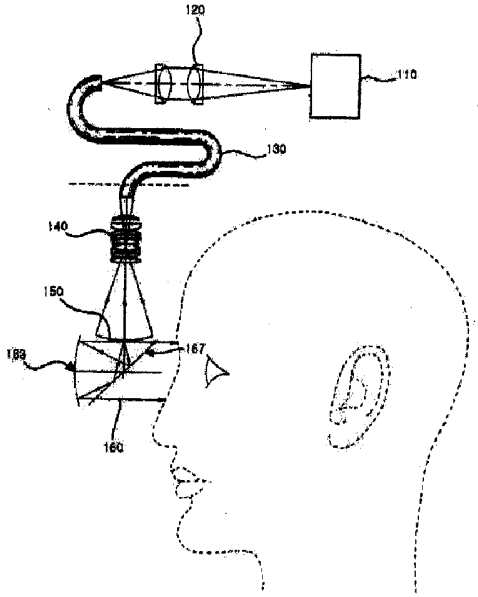
[6] The apparatus in accordance with claim 1, wherein the image generating means comprises:
a non-self-luminous display device for displaying the image by receiving an image signal;
a light source for emitting a light;
a polarized beam splitter for transmitting a first portion of the light emitted by the light source and reflecting a second portion of the light to the non-self-luminous display, and partially transmitting the image reflected from a surface of the non-self-luminous display; and
a case for inputting the light emitted from the light source to the polarized beam

splitter and providing the image to the image relaying means when the image reflected from the surface of the non-self-luminous display passes through the polarized beam splitter.

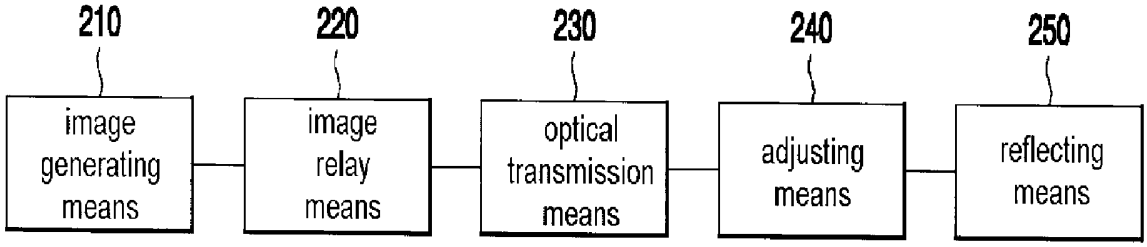
[7] The apparatus in accordance with claim 1, wherein the image generating means generates a separate image for each of left and right eyes,
wherein the optical transmission means, the image relaying means and the adjusting means transmits, relays or adjusts the separate image, and
wherein the reflecting means is disposed at a front of a headset of an eyeglass type such that the separate image is displayed for each of the left and the right eyes.

[8] The apparatus in accordance with claim 7, wherein the adjusting means is disposed at both sides of the headset for adjusting the zoom or the focus of the separate image.

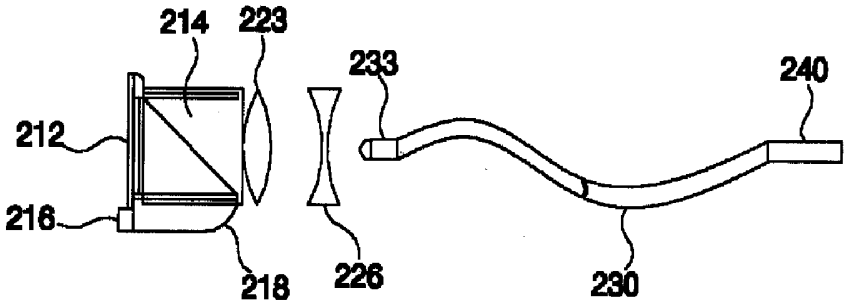
[Fig. 1]



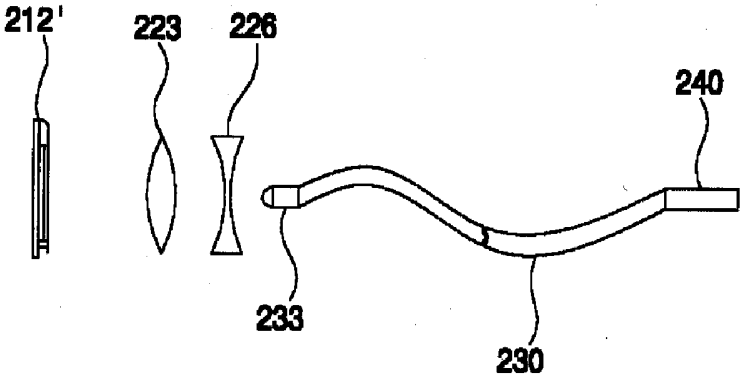
[Fig. 2]



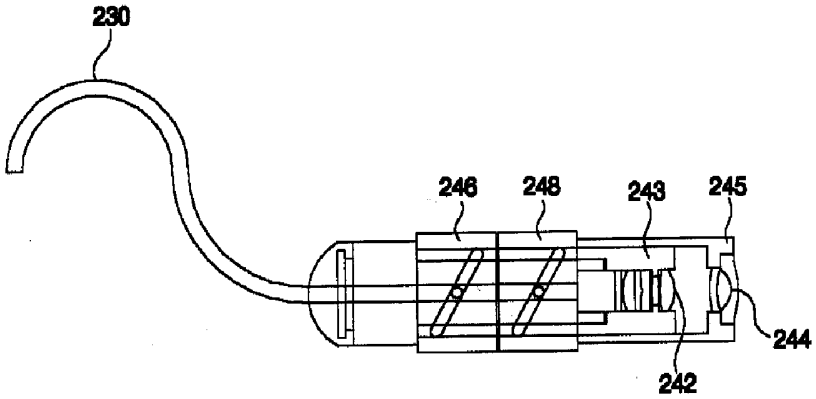
[Fig. 3]



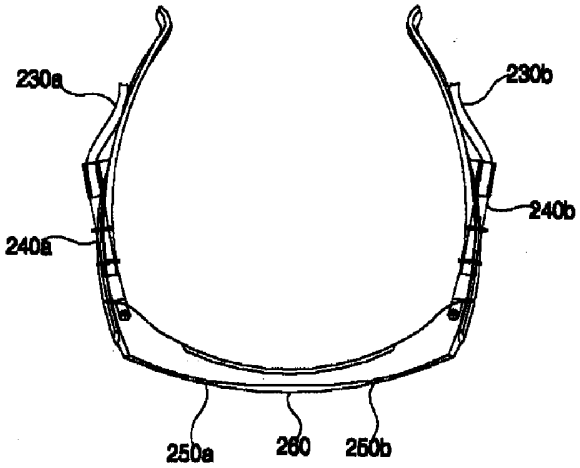
[Fig. 4]



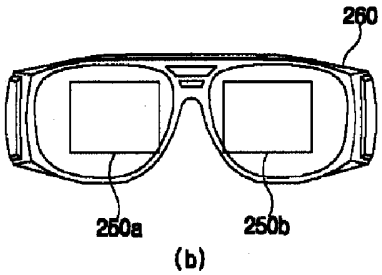
[Fig. 5]



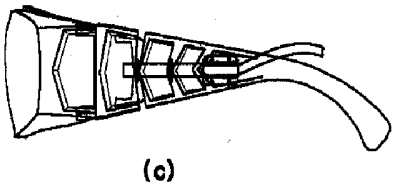
[Fig. 6]



(a)



(b)



(c)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2006/001381

A. CLASSIFICATION OF SUBJECT MATTER

G02B 27/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 G02B 27

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Patents and applications for inventions since 1975

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search terms used)

eKIPASS "HMD(Head Mounted Display", "adjusting focus and zoom"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	US 5,348,477 A (CAE ELECTRONICS LTD) 20 SEP 1994 See Col.2-4, Fig.1-4 and claims	1-3, 5 4, 6-8
Y A	US 5,903,395 A (I-O DISPLAY SYSTEMS LLC) 11 MAY 1999 See Col. 10 and Fig. 14B	1-3, 5 4, 6-8
A	US 6,771,423 B2 (RICHARD GEIST) 3 AUG 2004 See the whole documents(especially Fig.3, claims 4 & 17)	1-8
A	US 6,353,503 B1 (THE MICROPITICAL CORPORATION) 5 MAR 2002 See the whole documents(especially Fig.11B)	1-8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
24 JULY 2006 (24.07.2006)	**24 JULY 2006 (24.07.2006)**

Name and mailing address of the ISA/KR

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Authorized officer

HAN, Choong Hee

Telephone No. 82-42-481-8475

INTERNATIONAL SEARCH REPORT

Information on patent family members

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