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(54) IMAGE DISPLAY

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(57) **ABSTRACT**

The present invention provides an image display system in which an image can be seen from positions other than predetermined viewing position. The image display system includes optical means for allowing light from a backlight (**810**) to be transmitted to a left eye image area and a right eye image area and causing the transmitted lights from the respective image areas to enter into a left eye and a right eye of an viewer independently, and image parallax switching means for selectively displaying an image for three-dimensional display which causes parallax between both eyes of the viewer when displaying a three-dimensional image to the viewer or an image for two-dimensional display which does not cause parallax between the both eyes of the viewer when displaying a two-dimensional image to the viewer on the display area, auxiliary light sources (**814**) for irradiating a liquid crystal display panel (**804**) and causing the irradiated light to be transmitted through the left eye image area or the right eye image area and enter into the both eyes of the viewer and light source control means which turns on the backlight (**810**) when showing the three-dimensional image to the viewer and turns on the auxiliary light sources (**814**) when showing the two-dimensional image to the viewer are provided.

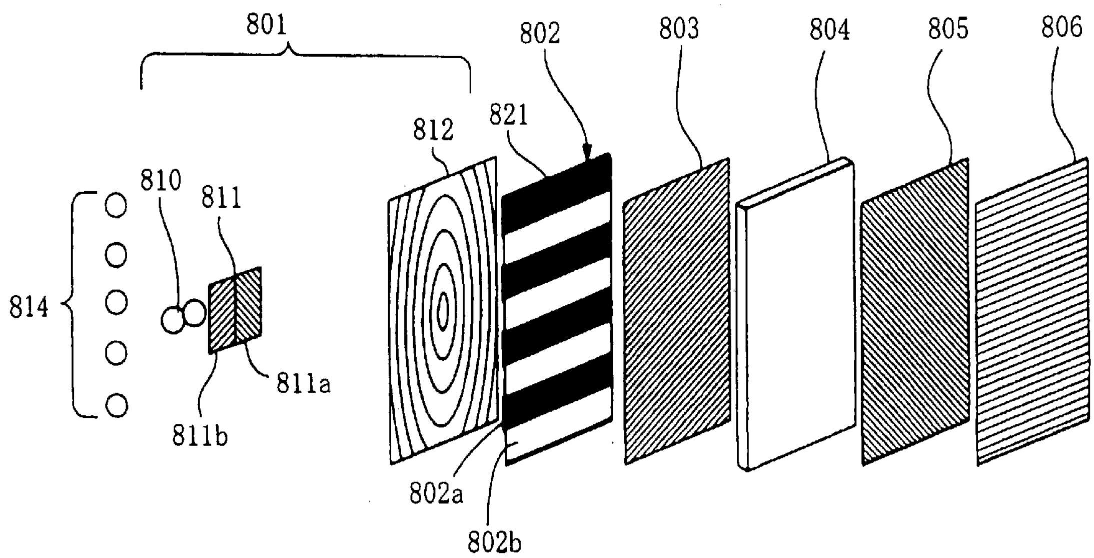


FIG. 1

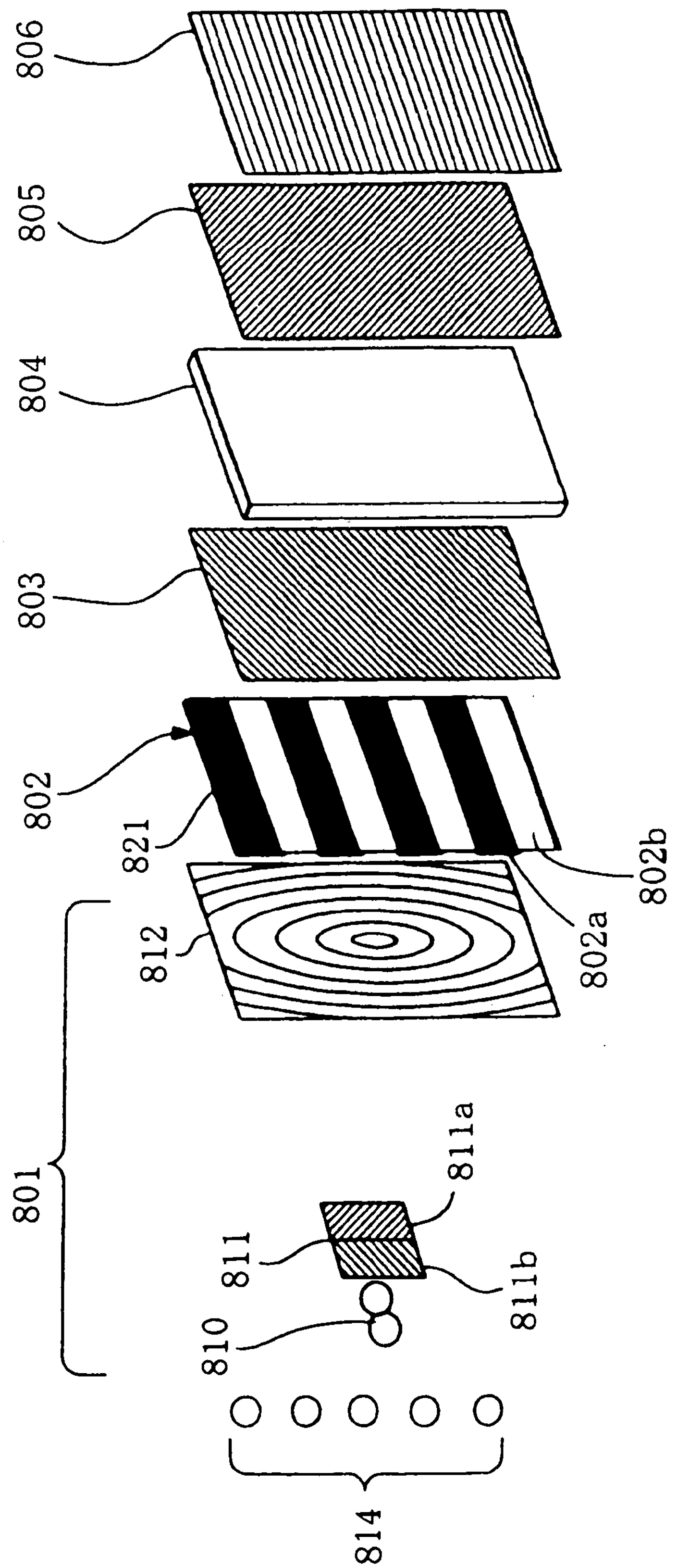


FIG. 2

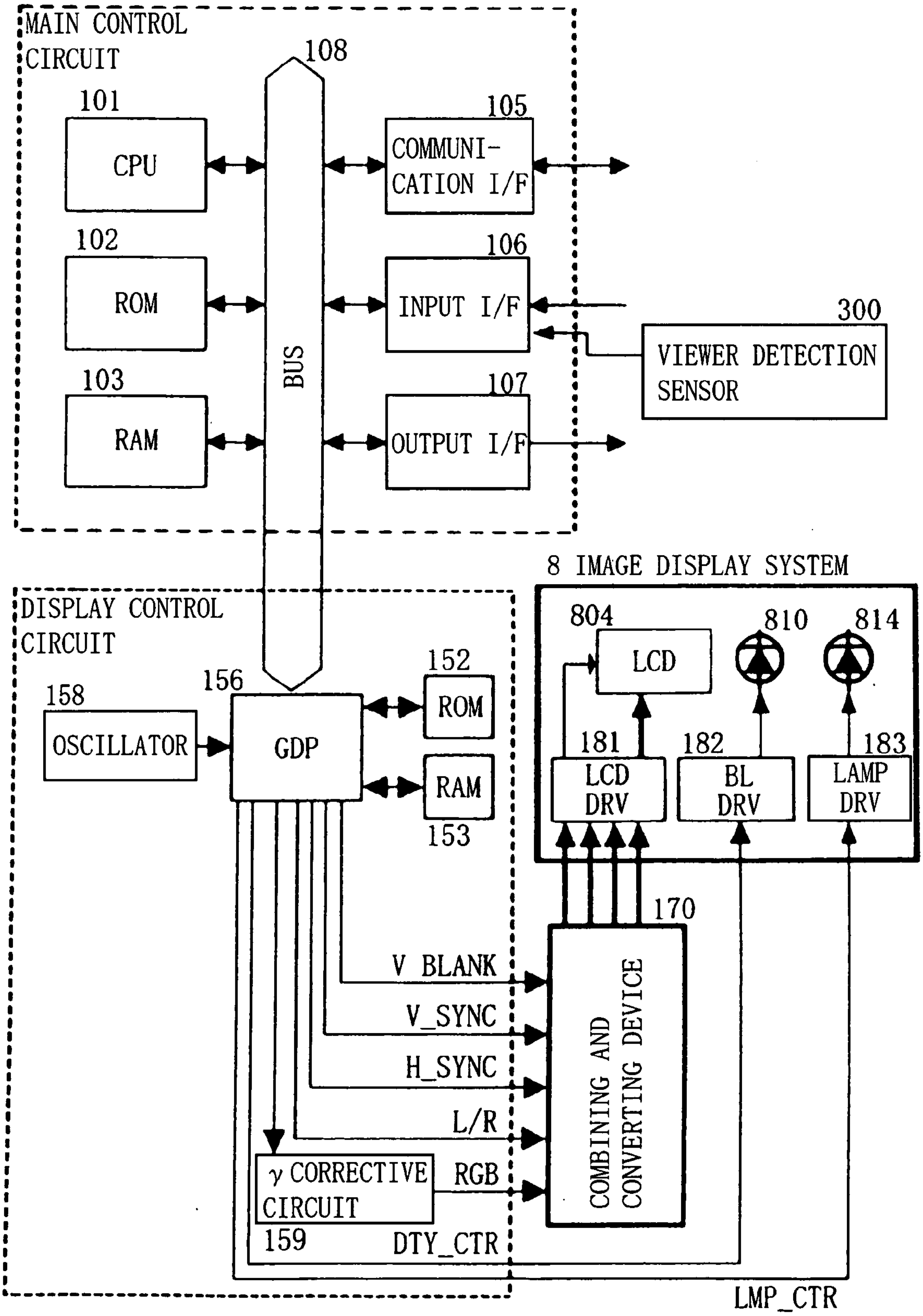

MAIN CONTROL CIRCUIT
108
101
CPU
105
COMMUNI-CATION I/F
102
ROM
106
INPUT I/F
300
VIEWER DETECTION SENSOR
103
RAM
BUS
107
OUTPUT I/F
8 IMAGE DISPLAY SYSTEM
DISPLAY CONTROL CIRCUIT
804
LCD
810
814
152
ROM
156
158
OSCILLATOR
GDP
181
LCD DRV
182
BL DRV
183
LAMP DRV
RAM
153
170
V BLANK
V_SYNC
H_SYNC
L/R
COMBINING AND CONVERTING DEVICE
γ CORRECTIVE CIRCUIT
RGB
159
DTY_CTR
LMP_CTR

FIG. 3

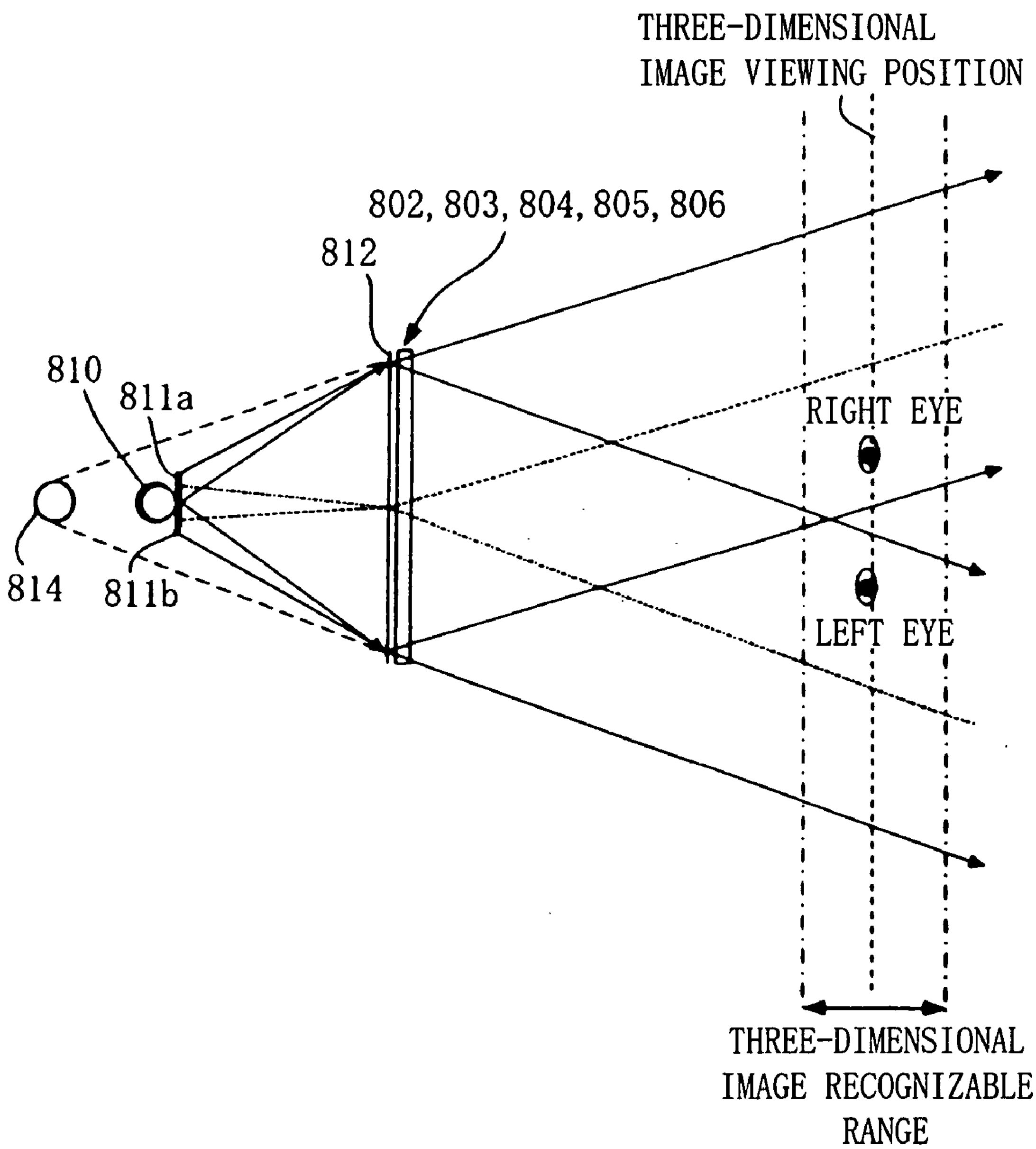

THREE-DIMENSIONAL
IMAGE VIEWING POSITION
802, 803, 804, 805, 806
812
810
811a
RIGHT EYE
814
811b
LEFT EYE
THREE-DIMENSIONAL
IMAGE RECOGNIZABLE
RANGE

FIG. 4

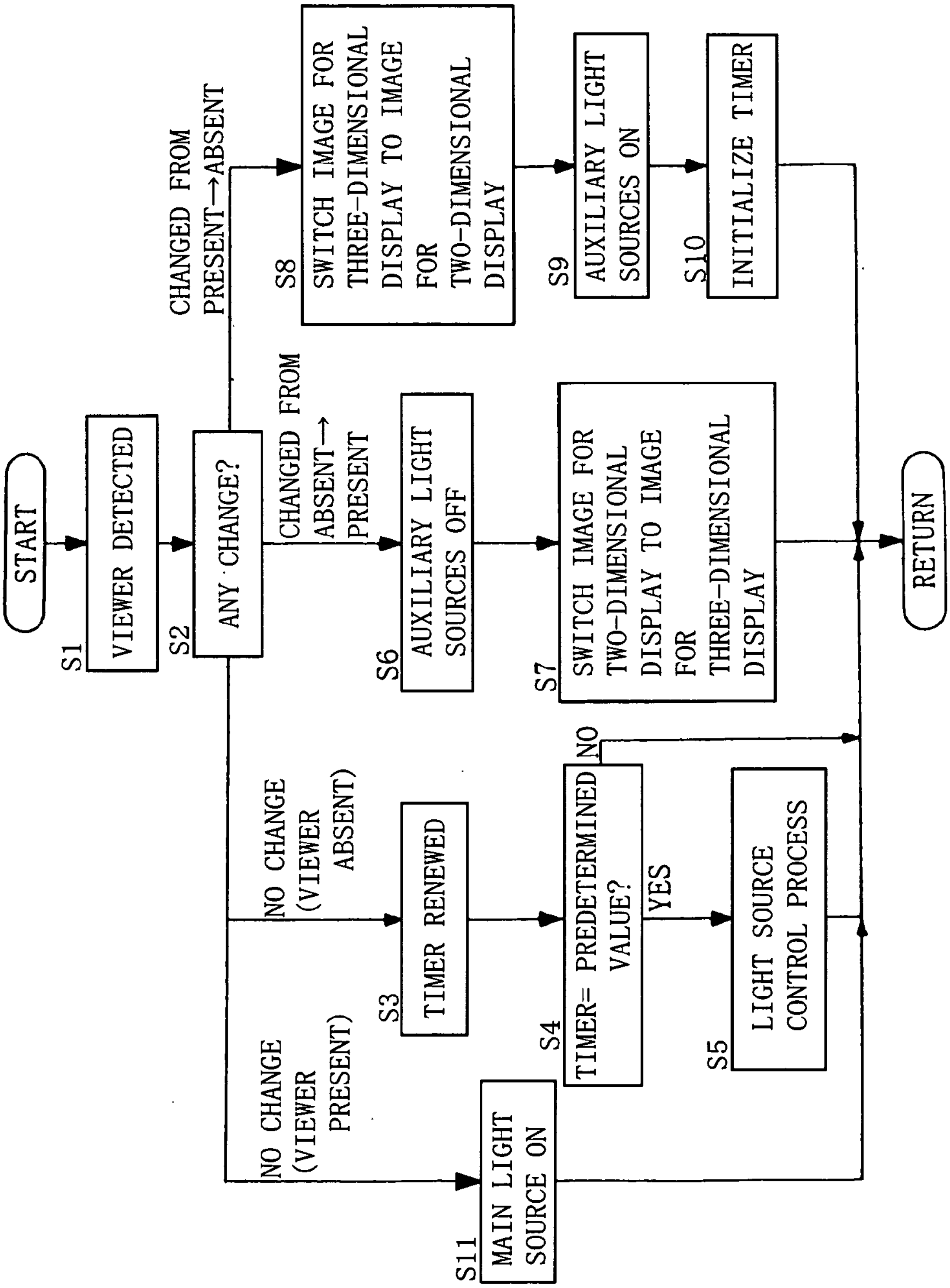
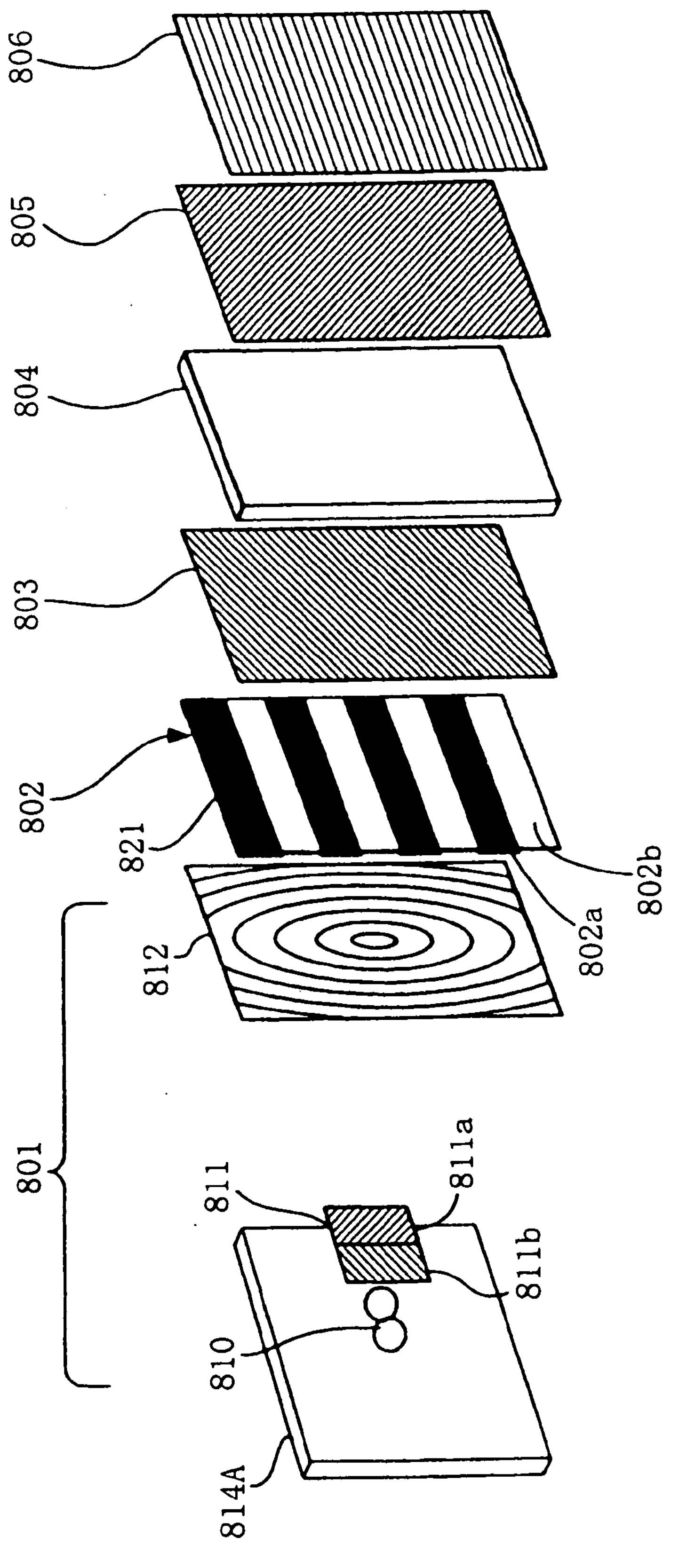

START
S1
VIEWER DETECTED
S2
ANY CHANGE?
CHANGED FROM PRESENT→ABSENT
S8
SWITCH IMAGE FOR THREE-DIMENSIONAL DISPLAY TO IMAGE FOR TWO-DIMENSIONAL DISPLAY
S9
AUXILIARY LIGHT SOURCES ON
S10
INITIALIZE TIMER
CHANGED FROM ABSENT→PRESENT
S6
AUXILIARY LIGHT SOURCES OFF
S7
SWITCH IMAGE FOR TWO-DIMENSIONAL DISPLAY TO IMAGE FOR THREE-DIMENSIONAL DISPLAY
RETURN
NO CHANGE (VIEWER ABSENT)
S3
TIMER RENEWED
S4
TIMER= PREDETERMINED VALUE?
NO
YES
S5
LIGHT SOURCE CONTROL PROCESS
NO CHANGE (VIEWER PRESENT)
S11
MAIN LIGHT SOURCE ON

FIG. 5


806
805
804
803
802
821
802b
802a
812
801
811
811a
811b
810
814A

# IMAGE DISPLAY

## TECHNICAL FIELD

[0001] The present invention relates to an image display system which can display an a three-dimensional image.

## BACKGROUND ART

[0002] Hitherto, an image display system for displaying a stereoscopic image (three-dimensional image) by displaying an right-eye image and a left-eye image having parallax using a liquid crystal display unit or the like is known (JP-A-10-63199, etc.).

[0003] [Patent Document 1] JP-A-10-63199

[0004] However, in the related art, since it is intended only to show the three-dimensional image to a viewer, the viewing angle is set to a small angle. Therefore, those who are not in the viewing angle cannot see the image, or the image appears to be extremely dark. In such an image display system, there is a problem that a wide viewing angle cannot be achieved due to the structure of an optical system thereof, when a demonstrative display for collecting people in front of the image display system is desired for people viewing from points other than a predetermined viewing zone set in front of the image display system, which may pose an impediment when appealing characteristics of the image display system.

## DISCLOSURE OF THE INVENTION

[0005] In view of the problem described above, it is an object of the present invention to provide an image display system which can view an image also from a position other than a predetermined viewing zone.

[0006] A first aspect of the invention is an image display system including a liquid crystal display panel being irradiated by a backlight and having a left eye image area and a right eye image area respectively on a display panel, optical means for allowing light from the backlight to be transmitted to the left eye image area and the right eye image area and causing the transmitted lights from the respective image areas to enter into a left eye and a right eye of an viewer independently, and image parallax switching means for selectively displaying an a three-dimensional image which causes parallax between both eyes of the viewer when showing the three-dimensional image to the viewer or a two-dimensional image which does not cause parallax between both eyes when showing the two-dimensional image to the viewer on the display area, wherein an auxiliary light source for irradiating the liquid crystal display panel and causing the irradiated light to be transmitted through the left eye image area or the right eye image area and enter into the both eyes of the viewer and light source control means which turns on the backlight when showing the three-dimensional image to the viewer, and turns on the one or a plurality of auxiliary light sources when showing the two-dimensional image to the viewer are provided.

[0007] In the first aspect of the invention, a second aspect of the invention is characterized in that when the image parallax switching means switches the image to be shown to the viewer from the three-dimensional image to the two-dimensional image, the one or a plurality of auxiliary light sources are turned on by the light source control means after switching to display from the three-dimensional image to the two-dimensional image by the image parallax switching means.

[0008] In the first and second aspects of the invention, a third aspect of the invention is characterized in that when the image parallax switching means switches the image to be shown to the viewer from the two-dimensional image to the three-dimensional image, the display is switched from the tow-dimensional image to the three-dimensional image by the image parallax switching means after turning off the one or plurality of auxiliary light sources by the light source control means.

[0009] In one of the first to third aspects of the invention, a fourth aspect of the invention is characterized in that the light source control means turns off or dims the backlight when the one or a plurality of auxiliary light sources are turned on.

[0010] In one of the first to third aspects of the invention, a fifth aspect of the invention is characterized in that the light source control means also turns on the backlight when turning on the one or a plurality of auxiliary light sources.

[0011] In one of the first to fifth aspects of the invention, a sixth aspect of the invention is characterized in that the one or a plurality of auxiliary light sources are higher in brightness than the backlight.

[0012] In one of the first to sixth aspects of the invention, a seventh aspect of the invention is characterized in that the backlight is disposed between the liquid crystal display panel and the one or a plurality of auxiliary light sources.

[0013] In one of the first to seventh aspects of the invention, an eighth aspect of the invention is characterized in that the one or a plurality of auxiliary light sources are composed of one or a plurality of surface light sources.

[0014] In one of the first to eighth aspects of the invention, a ninth aspect of the invention is characterized in that viewer detection means for detecting existence of the viewer, and the light source control means turns on the one or a plurality of auxiliary light sources when the existence of the viewer is not detected by the viewer detection means.

[0015] Therefore, according to the first aspect of the invention, the clear three-dimensional image can be provided by the backlight which irradiates a light for the left eye and a light for the right eye independently when displaying the three dimensional image, while the two-dimensional image with a wide viewing angle can be displayed by the one or a plurality of auxiliary light sources which irradiates the light transmitting through both the left eye image area and right eye image areas and reaching both eyes of the viewer when displaying the two-dimensional image, whereby an optimal image (a three-dimensional image or a two dimensional image) depending on the position of the viewer can be displayed.

[0016] According to the second aspect of the invention, since the one or a plurality of auxiliary light sources are turned on by the light source control means after switching the three-dimensional image the two-dimensional image, generation of cross-talk in the three-dimensional image is avoided by preventing the left-eye image and the right-eye image from reaching the both eyes by the one or a plurality of auxiliary light sources which widens the viewing angle, and switching from the three-dimensional image to the two-dimensional image is achieved without giving a feeling of discomfort to the viewer.

[0017] According to the third aspect of the invention, since switching to the three-dimensional image is performed after the one or a plurality of auxiliary light sources are turned off, both of the left-eye image and the right-eye image reach both eyes by illuminating the one or a plurality of auxiliary light sources. Therefore, by switching to the three-dimensional image after causing the light from the backlight to reach the both eyes of the viewer by turning off the one or a plurality of auxiliary light sources, generation of the cross-talk in the left-eye image and the right-eye image is reliably prevented, and hence switching from the image for two-dimensional display to the image for three-dimensional display can be performed smoothly without giving a sense of discomfort to the viewer.

[0018] According to the fourth aspect of the invention, since the backlight is turned off or dimmed when turning on the auxiliary light source, durability of the device can be improved by controlling heat generation of the light source and promotion of energy saving is achieved by controlling power consumption.

[0019] According to the fifth aspect of the invention, since the backlight is also turned on when turning on the auxiliary light source, the angle of visibility when displaying the image for two-dimensional display can be enlarged by increasing the light amount transmitting through the liquid crystal display panel.

[0020] According to the sixth aspect of the invention, since the auxiliary light source is higher in brightness than the backlight, the angle of visibility when displaying the image for two-dimensional display can be enlarged.

[0021] According to the seventh aspect of the invention, since the backlight is disposed between the liquid crystal display panel and the auxiliary light source, the lights for the left eye and for the right eye can be incident into the liquid crystal display panel without being intercepted by the auxiliary light source.

[0022] According to the eighth aspect of the invention, since the auxiliary light source is composed of the surface light source, the light amount can further be increased to enlarge the angle of visibility when displaying the image for two-dimensional display.

[0023] According to the ninth aspect of the invention, when the existence of the viewer is not detected by the viewer detection means, the auxiliary light source is turned on to enlarge the angle of visibility, so that the viewer can view from a range larger than that for the image for three-dimensional display.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0024] **FIG. 1** is an exploded perspective view showing an optical system of an image display system according to an embodiment of the present invention.

[0025] **FIG. 2** is a block diagram showing a control system of the same.

[0026] **FIG. 3** is a plan view of the optical system of the same.

[0027] **FIG. 4** is a flowchart showing an example of light source control.

[0028] **FIG. 5** is an exploded perspective view showing the optical system of the image display system according to another embodiment.

## BEST MODE FOR CARRYING OUT THE INVENTION

[0029] Referring now to the drawings, an embodiment of the present invention will be described.

[0030] **FIG. 1** is an exploded perspective view showing an optical system of an image display system according to an embodiment of the present invention.

[0031] **FIG. 2** is a block diagram showing a control system of the same.

[0032] **FIG. 3** is a plan view of the optical system of the same.

[0033] **FIG. 4** is a flowchart showing an example of light source control.

[0034] **FIG. 5** is an exploded perspective view showing the optical system of the image display system according to another embodiment.

## BEST MODE FOR CARRYING OUT THE INVENTION

[0035] Referring now to the drawings, an embodiment of the present invention will be described.

[0036] **FIG. 1** shows an example of an image display system **8** to which the present invention is applied, and a light source **801** (main light source) includes a light emitting device **810**, a polarizing filter **811**, and a Fresnel lens **812**.

[0037] The light emitting device (backlight) **810** as a main light source is composed of a point light source such as white light emitting diode (LED) or linear light sources such as cold-cathode tube arranged in parallel. The polarizing filter **811** consists of a left area **811***b* and a right area **811***a* which are adapted to provide different polarizations to lights transmitting therethrough (for example, to differentiate between the polarization axes of the lights transmitting through the left area **811***b* and the right area **811***a* by 90 degrees). The Fresnel lens **812** has a lens surface having a concentric microstructures on one side.

[0038] Only the light emitted from the light emitting device **810** and having predetermined polarizations can be transmitted through the polarizing filter **811**. In other words, the light emitted from the light emitting device **810** which is passed through the left area **811***b* of the polarizing filter **811** and the light passed through the right area **811***a* thereof are irradiated on the Fresnel lens **812** as lights having different polarizations. As will be described later, the light passed through the left area **811***b* of the polarizing filter **811** reaches the right eye of the viewer, and the light passed through the right area **811***a* reaches the left eye of the viewer.

[0039] It is not necessarily required to use the light emitting device and the polarizing filter, and it's only necessary that the lights of different polarizations be irradiated from different positions. For example, it may be adapted in such a manner that two light emitting devices generating lights of different polarizations are provided so that the lights of different polarization are irradiated to the Fresnel lens **812** from different positions.

[0040] The lights transmitted through the polarizing filter **811** are irradiated on the Fresnel lens **812**. The Fresnel lens **812** is a convex lens, and refracts optical paths of light emitted from the light emitting device **810** in a diffusing manner into substantially parallel lights, then allows the same to pass through a micro-patterned half wave retarder **802** and then to be irradiated onto a liquid crystal display panel **804**.

[0041] At this time, the light irradiated through the micro-patterned half wave retarder **802** is emitted so as not to diffuse in the vertical direction, and is irradiated on the liquid crystal display panel **804**. In other words, the light transmitted through a specific area of the micro-patterned half wave retarder **802** is transmitted through specific units of display of the liquid crystal display panel **804**.

[0042] Regarding the lights irradiated to the liquid crystal display panel **804**, the light passing through the right area **811***a* of the polarizing filter **811** and the light passing through the left area **811***b* thereof are incident onto the Fresnel lens **812** at different angles, are refracted by the Fresnel lens **812**, and are emitted from the liquid crystal display panel **804** along the left and right paths respectively.

[0043] The liquid crystal display panel **804** is provided with liquid crystal comprising liquid crystal molecules oriented and twisted at a predetermined angle (for example, 90 degrees) and disposed between two transparent plates (for example, glass plates), to form, for example, of a TFT type liquid crystal display panel. The light incident upon the liquid crystal display panel is emitted with a polarization axis rotated by 90 degrees in a state in which no voltage is applied to the liquid crystal. On the other hand, when a voltage is applied to the liquid crystal, twisting of the liquid crystal is released, and the incident light is emitted without changing the polarization.

[0044] The micro-patterned half wave retarder **802** and a polarizing plate **803** (second polarizing plate) are disposed on the side of the light source **801** of the liquid crystal display panel **804**, and a polarizing plate **805** (first polarizing plate) is disposed on the viewer side.

[0045] The micro-patterned half wave retarder **802** includes regions which change the phase of light ray transmitting therethrough disposed at fine intervals repeatedly.

[0046] More specifically, a light transmitting base material is formed with regions **802***a* having the first polarization characteristics of a minute width, and regions **802***b* each having the same width as the width of the regions **802***a* and having the second polarization characteristics different from the first polarization characteristics, and arranged at minute intervals repeatedly.

[0047] In other words, the regions **802***a* which have the first polarization characteristics and change the phase of light transmitting therethrough by the ½ wave plates provided at minute intervals and the regions **802***b* which have the second polarization characteristics same as the polarization characteristics of the transmitting light and do not change the phase of light ray transmitting therethrough since the ½ wave plates **821** are not provided are arranged repeatedly at minute intervals.

[0048] The regions **802***a* are disposed so that the optical axis thereof is inclined by 45 degrees with respect to a polarization axis of the light transmitting through the right area **811***a* of the polarizing filter **811**, thereby emitting the light transmitted through the right area **811***a* with its polarization axis rotated by 90 degrees.

[0049] In other words, polarization axis of the light transmitting through the right area **811***a* is rotated by 90 degrees to equalize to that of the light transmitting through the left area **811***b*. In other words, the regions **802***b* having the second polarization characteristics are not provided allow lights passed through the left area **811***b* and having the same polarization as the polarizing plate **803** to be transmitted therethrough. The regions **802***a* having the first polarization characteristics cause the light passed through the right area **811***a* and having the polarization axis orthogonal to the polarizing plate **803** to be rotated so as to equalize the polarization axis thereof to that of the polarizing plate **803** before emission.

[0050] The array of regions of each polarization characteristics of the micro-patterned half wave retarder **802** is adapted to have substantially the same pitch as the unit of display of the liquid crystal display panel **804** to differentiate polarization of the lights transmitted therethrough by each unit of display (that is, by each horizontal line of the unit of display). Therefore, the polarization characteristics of the micro-patterned half wave retarder **802** are differentiated for each of the corresponding horizontal lines (scanning line) as the unit of display of the liquid crystal display panel **804**, whereby the directions of lights emitted from the adjacent horizontal lines are different.

[0051] Alternatively, the array of the regions having the polarization characteristics of the micro-patterned half wave retarder **802** may have a pitch which is integral multiple of the pitch of the unit of display of the liquid crystal display panel **804**, so that the polarization characteristics are differentiated for each set of a plurality of units of display on the micro-patterned half wave retarder **802** (that is, for each set of the plurality of horizontal lines as the unit of display), thereby differentiating the polarization of the lights transmitted therethrough for each set of the plurality of units of display. In this case, the polarization characteristics of the micro-patterned half wave retarder are different for each set of the plurality of horizontal lines as the unit of display (scanning lines), and hence the directions of the emitted lights are different for each set of plurality of horizontal lines.

[0052] In this case, since it is necessary to irradiate differently polarized lights onto the adjacent units of display of the liquid crystal display panel **804** (horizontal lines) for each region having a polarization characteristics of the micro-patterned half wave retarder **802**, the lights to be irradiated on the liquid crystal display panel **804** after transmitting through the micro-patterned half wave retarder **802** must be controlled to diffuse vertically.

[0053] In other words, the regions **802***a* of the micro-patterned half wave retarder **802** for changing the phase of the light change the light transmitting through the right area **811***a* of the polarizing filter **811** to have the same inclination of the polarization axis as the light transmitting through the left area **811***b*. On the other hand, the regions **802***b* of the micro-patterned half wave retarder **802** which have the second polarization characteristics allow the light transmitting through the left area **811***b* of the polarizing filter **811** to transmitted as is. Then, the lights emitted from the micro-patterned half wave retarder **802**, having the same polarizations of the light transmitting through the left area **811***b*, are incident upon the polarizing plate **803** provided on the light source side of the liquid crystal display panel **804**.

[0054] The polarizing plate **803** functions as the second polarizing plate, and has such polarization characteristics as to allow light having the same polarization as the light having transmitted through the left area **811***b* of the polarizing filer **811** to be transmitted. In other words, the light transmitting through the left area **811***b* of the polarizing filter **811** is transmitted through the second polarizing filter **803**, and the polarizing axis of the light transmitting through the right area **811***a* of the polarizing filter **811** is rotated by 90 degrees before transmitting through the second polarizing plate **803**. The polarizing plate **805** functions as the first polarizing plate, and has such polarizing characteristics as to allow light having a polarization different from the polarizing plate **803** by 90 degrees to be transmitted therethrough.

[0055] The micro-patterned half wave retarder **802**, the polarizing plate **803**, and the polarizing plate **805** are bonded together to the liquid crystal display panel **804**, and the micro-patterned half wave retarder **802**, the polarizing plate **803**, the liquid crystal display panel **804**, and the polarizing plate **805** are combined to constitute the image display system. At this time, in a state in which a voltage is applied to the liquid crystal, the light transmitting through the polarizing plate **803** is transmitted through the polarizing plate **805**. On the other hand, in a state in which no voltage is applied to the liquid crystal, the light transmitting through the polarizing plate **803**, whereof the polarization is twisted by 90 degrees, is emitted from the liquid crystal display panel **804**, and hence does not transmit through the polarizing plate **805**.

[0056] A diffuser **806** is mounted to the front side (viewer side) of the first polarizing plate **805**, and functions as diffusing means for diffusing the light transmitting through the liquid crystal display panel in the vertical direction. More specifically, it diffuses the light transmitting through the liquid crystal display panel in the vertical direction using a lenticular lens having projections and depression of semi-circular shape in cross-section provided repeatedly in the vertical direction.

[0057] Instead of the lenticular lens, the one provided with a mat diffusing surface having stronger diffusing property in the vertical direction than in lateral direction. It can improve a disadvantage that the viewing angle is narrowed by diffusion control in the vertical direction until the light is completely transmitted through the liquid crystal display panel **804**.

[0058] In addition, the one or a plurality of auxiliary light sources **814** are disposed behind the light emitting device **810** as a main light source. The one or a plurality of auxiliary light sources **814** include a plurality of electric bulbs or a plurality of light emitting devices (LED or EL) or the like, which are turned on when the image is desired to be viewed by many viewers and increase the light amount transmitted through the liquid crystal display panel **804**, thereby enlarging the viewing angle of a screen of the image display system **8**.

[0059] Therefore, the lights from the one or a plurality of auxiliary light sources **814** are not required to pass through the polarizing filter **811**, and goes through the Fresnel lens **812**, the micro-patterned half wave retarder **802**, the polarizing plate **803**, the liquid crystal display panel **804**, the polarizing plate **805**, and then the diffuser **806** to reach viewers or working staff in the vicinity of the viewers.

[0060] Then, since most of the light from the one or a plurality of auxiliary light sources **814** is diffusive light which has not passed through the polarizing filter **811**, the light can be irradiated entirely on the liquid crystal display panel **804** to improve the brightness of the display system **8** to widen the viewing angle of the secondary image.

[0061] **FIG. 2** is a block diagram showing a drive circuit of an image display system according to an embodiment of the present invention.

[0062] A main control circuit **100** for driving the image display system **8** according to the embodiment of the present invention includes a CPU **101**, a ROM **102** having a program or the like stored therein in advance, and a RAM **103** as a memory used as a work area when the CPU **101** is in operation. The CPU **101**, the ROM **102**, and the RAM **103** are connected by a bus **108**. The bus **108** includes an address bus and a data bus which are used when the CPU **101** reads and writes data.

[0063] A communication interface **105**, an input interface **106**, and an output interface **107**, which perform input and output with respect to the outside, are connected to the buss **108**. The communication interface **105** is a data input/output section for data transmission according to a predetermined communication protocol. The input interface **106** and the output interface **107** input and output image data to be displayed on the image display system **8**.

[0064] An viewer detection sensor **300** for detecting whether or not an viewer is present at a position from which the viewer can see a three-dimensional image and in a range in which the viewer can see the image display system **8** is connected to the input interface **106**. The viewer detection sensor **300** includes an infrared ray sensor, a motion sensor, or a pressure sensor or the like which is provided on a seat or the like.

[0065] A graphic display processor (GDP) **156** of a display control circuit **150** is connected to the bus **108**. The GDP **156** calculates image data generated by the CPU **101**, writes the same to a frame buffer provided in the RAM **153**, and generates signals (RGB, V BLANK, V_SYNC, H_SYNC) to be outputted to the image display system **8**. The ROM **152** and the RAM **153** are connected to the GDP **156**, and the RAM **153** is provided with a work area where the GDP **156** works and the frame buffer for storing the display data. The ROM **152** includes a program and data required for the operation of the GDP **156**.

[0066] The GDP **156** includes an oscillator **158** for supplying a clock signal to the GDP **156** connected thereto. The clock signal for generating the oscillator **158** defines the operating frequency of the GDP **156** and generates a frequency of the synchronized signal outputted from the GDP **156** (for example, V_SYNC, V BLANK).

[0067] The RGB signal outputted from the GDP **156** is inputted to a γ corrective circuit **159**. The γ corrective circuit **159** corrects a non-linear characteristic of brightness with respect to the signal voltage of the image display system **8**, adjusts the illumination brightness of display of the image display system **8**, and generates the RGB signal outputted to the image display system **8**.

[0068] A combining and converting device **170** is provided with a frame buffer for right-eye, a frame buffer for left-eye and a frame buffer for viewing a three-dimensional image, and writes a right-eye image sent from the GDP **156** in the frame buffer for right-eye, a left-eye image to the frame buffer for left-eye. Then, the combining and converting device combines the right-eye image and the left-eye image to generate the three-dimensional image, and writes the same in the frame buffer for viewing the three-dimensional image, and outputs the image data for three-dimensional view to the image display system **8** as a RGB signal.

[0069] Generation of the three-dimensional image by combining the right-eye image and the left-eye image is done by combining the right-eye image and the left-eye image according to the regions **802***a* and **802***b* of the micro-patterned half wave retarder **802**. More specifically, since the regions **802***a* and **802***b* of the micro-patterned half wave retarder **802** of the image display system **8** according to the present embodiment are disposed at intervals of the unit of display of the liquid crystal display panel **804**, the image for viewing a three-dimensional image is displayed so that the right-eye images and the left-eye images are alternately displayed by each lateral line (scanning line) as the unit of display of the liquid crystal display panel **804**.

[0070] The left-eye image data transmitted from the GDP **156** during output of L signal is written in the frame buffer for left-eye and the right-eye image data transmitted from the GDP **156** during output of R signal is written in the frame buffer for right-eye. Then, the left-eye image data written in the frame buffer for left-eye and the right-eye image data written in the frame buffer for right-eye are read out for each scanning line and written in the frame buffer for viewing a three-dimensional image.

[0071] The image display system **8** includes a liquid crystal driver (LCD DRV) **181**, a backlight driver (BL DRV) **182**, and a lamp driver **183** for driving the one or a plurality of auxiliary light sources **814**. The liquid crystal driver (LCD DRV) **181** applies a voltage to the electrodes of the liquid crystal display panel in sequence based on the V BLANK signal, the V_SYNC signal, H_SYNC signal, and the RGB signal transmitted from the combining and converting device **170** to display a combined image for viewing a three-dimensional image on the liquid crystal display panel.

[0072] The backlight driver **182** changes duty ratios of voltage applied to the light emitting device (backlight) **810** as a main light source **801** and the one or a plurality of auxiliary light sources **814** respectively based on the DTY_CTR signal outputted from the GDP **156**, thereby changing brightness of the liquid crystal display panel **804**. The DTY_CTR signal (duty ratio) for controlling the light emitting device **810** and the duty ratio for controlling the one or a plurality of auxiliary light sources **814** are independent.

[0073] The lamp driver **183** controls turning on and off of the one or a plurality of auxiliary light sources **814** according to the control signal (LMP_CTR) from the CPU **151**.

[0074] **FIG. 3** is a plan view showing an optical system of the image display system **8**.

[0075] Light emitted from the light emitting device **810** is passed through the polarizing filter **811** and is radially diffused. The light emitted from the light source passes through the right area **811***a* of the polarizing filter **811** (a dashed line indicates a center of the optical path) and reaches the Fresnel lens **812**, where the direction of travel of the light is changed, then is transmitted through the micro-patterned half wave retarder **802**, the polarizing plate **803**, the liquid crystal display panel **804**, and the polarizing plate **805** substantially orthogonally thereto (substantially from the right side to the left side), and then reaches the left eye.

[0076] On the other hand, part of the light emitted from the light emitting device **810** which is transmitted through the left area **811***b* of the polarizing filter **811** (a broken line indicates a center of the optical path) reaches the Fresnel lens **812**, where the direction of travel is changed, is passed through the micro-patterned half wave retarder **802**, the polarizing plate **803**, the liquid crystal display panel **804**, and the polarizing plate **805** substantially in the vertical direction (substantially from the left side to the right side), and then reaches the right eye.

[0077] In this manner, the light emitted from the light emitting device **810** and transmitted through the polarizing filter **811** is irradiated to the liquid crystal display panel **804** by the Fresnel lens **812** as the optical system substantially in the vertical direction. In other words, the light source **801** which irradiates the lights having different planes of polarization onto the liquid crystal display panel **804** substantially in the vertical direction along the different routes is configured with the light emitting device **810**, the polarizing filter **811** and the Fresnel lens **812**, and the light transmitted through the liquid crystal display panel **804** is emitted along the different routes and reaches the left eye or the right eye.

[0078] In **FIG. 3**, a position indicated by a wave line in the drawing is set as a three-dimensional image viewing zone with respect to the depth direction. The three-dimensional image viewing zone includes a reference position where only the light transmitting through the right area **811***a* of the polarizing filter **811** enters into the viewer's left eye, and only the light transmitting through the left area **811***b* of the polarizing filter **811** enters into the viewer's right eye, whereby the three-dimensional image can be recognized. Since the distance between the left eye and the right eye of the viewer is different from person to person, the three-dimensional image viewing zone is defined by the average value of the distance between the left and right eyes. Therefore, actually, as shown by a dashed line in the drawing, a predetermined range with respect to the depth direction of the image display system **8** corresponds to a three-dimensional image recognizable range. The three-dimensional image viewing zone in the horizontal direction (vertical direction in the drawing) of the image display system **8** is a correct position with respect to the center of the image display system **8** in the case of **FIG. 3**.

[0079] In other words, by equalizing the pitch of the scanning lines of the liquid crystal display panel **804** and the pitch of the regions having the polarization characteristics on the micro-patterned half wave retarder **802**, the lights coming from the different directions are irradiated on each pitch of the scanning lines of the liquid crystal display panel **804** and hence the lights are emitted in the different directions.

[0080] On the other hand, most of the lights from the one or a plurality of auxiliary light sources **814** do not pass through the polarizing filter **811**, but pass through the Fresnel lens **812**, the micro-patterned half wave retarder **802**, the polarizing plate **803**, the liquid crystal display panel **804**, the polarizing plate **805**, and the diffuser **806** in a state of diffused light and reaches the viewer side. Therefore, different from the aforementioned light passed through the polarizing filter **811**, the lights from the one or a plurality of auxiliary light sources **814** display the two-dimensional image without constituting the three-dimensional image. The two-dimensional image recognizable range corresponds to a range in which the viewer can see the lights passed from the one or a plurality of auxiliary light sources **814** through the liquid crystal display panel **804**, the polarizing plate **805**, and the diffuse **806**, and is an extremely larger than the three-dimensional image recognizable range.

[0081] **FIG. 4** is a flowchart of control carried out by the GDP **151**, which is carried out at predetermined intervals (for example, at intervals of a cycle of vertical synchronous signals; 16.7 msec=1/60 seconds).

[0082] In Step S**1**, signals from the viewer detection sensor **300** is read to detect whether or not the viewer is in the three-dimensional image recognizable range, and then determine whether or not the current detection result is changed from the previous detection result.

[0083] In Step S**2**, the procedure is routed according to the change of the state of the viewer. When the state of the viewer is not changed and the viewer is not in the three-dimensional image recognizable zone, the procedure goes to Step S**3**, and when the state of the viewer also isn't changed and the viewer is in the three-dimensional image recognizable zone, the procedure goes to Step S**11**. Then, regarding the case in which the state of the viewer is changed, when the state of the viewer is changed from "absent" to "present", the procedure goes to Step S**6**, and when the state of the viewer is changed from "present" to "absent", the procedure goes to Step S**8**.

[0084] In Step S**3** in which the viewer is not in the three-dimensional image recognizable zone and the state of the viewer is not changed, the value of the timer is renewed (for example, incremented), and in Step S**4**, whether or not the value of the timer has become the predetermined value is determined. When the value of the timer has become the predetermined value, the procedure goes to Step S**5**, where the light source control process as described later is performed, and when the value of the timer has not become the predetermined value, the procedure is ended as is.

[0085] In Step S**11** in which the viewer is in the three-dimensional image recognizable range, and the state of the viewer is not changed, turning-on control of the light emitting device **810** as a main light source is performed at a predetermined duty ratio.

[0086] On the other hand, in Step S**6** where the state of the viewer is changed from "absent" to "present", the one or a plurality of auxiliary light sources **814** are turned off and only the main light source **810** is turned on, and then the procedure goes to Step S7, where the image to be displayed on the image display system **8** is switched from an two-dimensional image having no parallax (two-dimensional image) to the three-dimensional image having parallax (image for displaying a three-dimensional image).

[0087] In Step S**8** where the state of the viewer is changed from "present" to "absent", the image to be displayed on the image display system **8** is switched from the three-dimensional image having parallax (image for displaying a three-dimensional image) to the two-dimensional image (two-dimensional image) having no parallax, and in Step S**9**, the one or a plurality of auxiliary light sources **814** are turned on to increase the light amount which is transmitted through the liquid crystal panel display **804**.

[0088] Then, in Step S**10**, the timer is initialized (for example, zero-reset) to end the procedure.

[0089] In the light source control process performed in the above-described Step S**5**, when the value of the timer exceeds a predetermined value, the one or a plurality of auxiliary light sources **814** are turned off to control heat generation and power consumption of the light sources.

[0090] Alternatively, when the value of the timer exceeds a predetermined value, the one or a plurality of auxiliary light sources **814** are made to blink, whereby the heat generation and the power consumption of the light sources can be controlled while displaying the two-dimensional image continuously. In the one or a plurality of auxiliary light sources **814** which include a plurality of the light emitting members, light emitting members may be divided into groups and light emission control may be applied to those groups to make them blink alternately.

[0091] With the above-described control, when the state is changed from a state in which the viewer is "absent" to "present" in the three-dimensional image recognizable zone of the image display system **8**, the one or a plurality of auxiliary light sources **814** are turned off and then the two-dimensional image is switched to the image, so that only the light emitting device **810** as a main light source is turned on to provide the three-dimensional image to the viewer who is present at a predetermined position.

[0092] At this time, since switching to the three-dimensional image is done after the one or a plurality of auxiliary light sources **814** are turned off, both of the left-eye image and the right-eye image reach the both eyes by illumination of the one or a plurality of auxiliary light sources **814**. Therefore, by switching to the three-dimensional image after turning off the one or a plurality of auxiliary light sources **814** to cause the light from the light emitting device **810** as a main light source to reach the viewer's both eyes, generation of cross-talk of the left-eye image and the right-eye image can reliably be prevented, and hence switching from the two-dimensional image to the three-dimensional can be performed smoothly without giving a feeling of discomfort to the viewer.

[0093] On the other hand, when the state is changed from the state in which the viewer is "present" to "absent" in the three-dimensional image recognizable zone of the image display system **8**, the image to be displayed is switched from the three-dimensional image to the two-dimensional image, and then the one or a plurality of auxiliary light sources **814** are turned on.

**[0094]** When the one or a plurality of auxiliary light sources **814** are turned on, the brightness of the image display system **8** (the light amount of the liquid crystal display panel) increases and the viewing angle of the image display system **8** increases by the diffusing light from the one or a plurality of auxiliary light sources **814** which is not passed through the polarizing filter **811**, and hence the two-dimensional image can be provided to the viewer who is out of the three-dimensional image recognizable range. Therefore, for example, demonstration images which are intended to be viewed by unspecified viewers can be displayed effectively.

**[0095]** Since it is adapted to turn on the one or a plurality of auxiliary light sources **814** after having switched the three-dimensional image to the two-dimensional image, the left-eye image and the right-eye image are prevented from reaching to the both eyes due to the one or a plurality of auxiliary light sources **814** which provide diffusing light, and hence generation of cross-talk in the three-dimensional image is prevented, whereby switching from the three-dimensional image to the two-dimensional image can be carried out without giving feeling of discomfort to the viewer.

**[0096]** Then, when the state of "absent" is continued for a period exceeding the predetermined value, the one or a plurality of auxiliary light sources **814** can be turned off or made to blink by controlling the light source, and hence heat generation and power consumption of the light source can be controlled.

**[0097]** In this manner, since it is adapted to switch between the three-dimensional image and the two-dimensional image depending on the presence or absence of the viewer and to turn on the one or a plurality of auxiliary light sources **814** depending on the type of the image, the characteristics of the light emitting device **810** as a main light source for irradiating the light for the left eye and the light for the right eye independently and the one or a plurality of auxiliary light sources **814** for irradiating diffusing light and providing the wide viewing angle are selectively used as needed, so that an optimal image (a three-dimensional image or a two-dimensional image) can be displayed according to the position of the viewer.

**[0098]** Also, since the one or a plurality of auxiliary light sources **814** are arranged behind the light emitting device **810** as a main light source, in other words, since the light emitting device **810** as a main light source is disposed between the one or a plurality of auxiliary light sources **814** and the Fresnel lens **812**, the light of the light emitting device **810** as a main light source can be irradiated to the Fresnel lens **812** and the liquid crystal display panel **804** as is without being intercepted by the one or a plurality of auxiliary light sources **814** when displaying the three-dimensional image, so that the light from the light emitting device **810** can be transmitted to the viewer efficiently and hence the clear three-dimensional image can be provided.

**[0099]** In this manner, since the present embodiment is adapted to turn on the one or a plurality of auxiliary light sources **814** and the main light source **810** simultaneously when displaying the two-dimensional image, the light amount transmitted through the liquid crystal display panel **804** increases and hence the viewing angle can be widened, whereby the range in which the two-dimensional image is recognizable can be widened.

**[0100]** It is also possible to turn off or dim the light emitting device **810** as a main light source when turning on the one or a plurality of auxiliary light sources **814**. In this case, by using only the one or a plurality of auxiliary light sources **814** for displaying the two-dimensional image, heat generation and power consumption of the light emitting device **810** as a main light source can be controlled to improve durability of the system and promotion of energy saving.

**[0101]** In the above-described embodiment, it is preferable to set the brightness of the one or a plurality of auxiliary light sources **814** higher than the brightness of the light emitting device **810** as a main light source, and type of the light emitting devices used for the respective light sources, the number of the light emitting devices, the current or voltage to be supplied to the light emitting devices, the blinking duty ratio of the light emitting devices and so on, must be selected as needed.

**[0102]** In the case in which the one or a plurality of auxiliary light sources **814** and the light emitting device **810** as a main light source are turned on simultaneously when displaying the two-dimensional image, the light amount transmitted through the liquid crystal display panel **804** increases, and hence the viewing angle can be widened, and hence the range in which the two-dimensional image is recognizable can be widened.

**[0103]** Although drive of the light emitting device **810** as a main light source is set to a predetermined duty ratio in the above-described embodiment, in the case in which the viewer is "present" in the three-dimensional image recognizable zone, the light emitting device **810** may be driven at the maximum brightness.

**[0104]** Alternatively, as shown in **FIG. 5**, the one or a plurality of auxiliary light sources **814** may be a surface light source **814**A, and in this case, the viewing angle can be widened by increasing the brightness when displaying the two-dimensional image.

**[0105]** It must be understood that the embodiment disclosed in this specification is not intended to limit the invention, and is disclosed simply as an example at all events. The scope of the present invention is not defined by the description described above, but defined by claims, and all the modifications covered within the claims and equivalent thereto are included in the invention.

**1**. An image display system comprising a liquid crystal display panel being irradiated by a backlight and having a left eye image area and a right eye image area on a display area respectively, optical means for allowing light from the backlight to be transmitted to the left eye image area and the right eye image area and causing the transmitted lights from the respective image areas to enter into a left eye and a right eye of an viewer independently, and image parallax switching means for selectively displaying a three-dimensional image which causes parallax between the both eyes of the viewer when showing a three-dimensional image to the viewer or a two-dimensional image which does not cause parallax between the both eyes when showing a two-dimensional image to the viewer on the display area, characterized in that an one or a plurality of auxiliary light sources for irradiating the liquid crystal display panel and causing the irradiated light to be transmit through the left eye image area or the right eye image area and enter into the both eyes of the viewer and light source control means which turns on the backlight when showing the three-dimensional image to the viewer, and turns on the one or a plurality of auxiliary light sources when showing the two-dimensional image to the viewer are provided.

**2**. The image display system according to claim 1, characterized in that when the image parallax switching means switches the image to be shown to the viewer from the three-dimensional image to the two-dimensional image, the one or a plurality of auxiliary light sources are turned on by the light source control means after switching to display from the three-dimensional image to the two-dimensional image by the image parallax switching means.

**3**. The image display system according to claim 1 or 2, characterized in that when the image parallax switching means switches the image to be shown to the viewer from the two-dimensional image to the three-dimensional image, the display is switched from the two-dimensional image to the three-dimensional image by the image parallax switching means after turning off the one or a plurality of auxiliary light sources by the light source control means.

**4**. The image display system according to any one of claim 1 to claim 3, characterized in that the light source control means turns off or dims the backlight when the one or a plurality of auxiliary light sources are turned on.

**5**. The image display system according to any one of claim 1 to claim 3, characterized in that the light source control means also turns on the backlight when turning on the one or a plurality of auxiliary light sources.

**6**. The image display system according to any one of claim 1 to claim 5, characterized in that the one or a plurality of auxiliary light sources are higher in brightness than the backlight.

**7**. The image display system according to any one of claim 1 to claim 6, characterized in that the backlight is disposed between the liquid crystal display panel and the one or a plurality of auxiliary light sources.

**8**. The image display system according to any one of claim 1 to claim 7, characterized in that the one or a plurality of auxiliary light sources are composed of one or a plurality of surface light source.

**9**. The image display system according to any one of claim 1 to claim 8, characterized in that viewer detection means for detecting existence of the viewer is provided, and the light source control means turns on the one or a plurality of auxiliary light sources when the existence of the viewer is not detected by the viewer detection means.

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摘要(译)

本发明提供一种图像显示系统，其中可以从除预定观看位置之外的位置看到图像。图像显示系统包括光学装置，用于允许来自背光（810）的光被传输到左眼图像区域和右眼图像区域，并使来自各个图像区域的透射光进入左眼和右眼。独立的观察者的眼睛，以及用于选择性地显示用于三维显示的图像的图像视差切换装置，该三维显示在向观看者显示三维图像时引起观看者的双眼之间的视差或者用于二维显示的图像。当在显示区域上向观看者显示二维图像时，不会引起观看者双眼之间的视差，用于照射液晶显示面板（804）并使照射的光透过的辅助光源（814）左眼图像区域或右眼图像区域进入观察者的双眼和在显示时打开背光（810）的光源控制装置提供三维图像给观看者并在向观看者显示二维图像时打开辅助光源（814）。