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(54) Double-vision backlight module and liquid crystal display device

Rückbeleuchtungsvorrichtung für zwei Ansichtrichtungen und Flüssigkristallanzeigevorrichtung

Module de rétroéclairage double-vision et dispositif d'affichage à cristaux liquides

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Description

FIELD OF THE ART

[0001] The present disclosure relates to autostereoscopic 3D technology, and more particularly, relates to a double-vision backlight module and a liquid crystal display (LCD) device.

BACKGROUND

[0002] The application of autostereoscopic 3D (also known as glasses-free 3D) double-vision (also known as dual field of view (FOV)) display technology, as a novel display technology, is more and more popular.

[0003] An autostereoscopic 3D double-vision display has two view areas on a display screen, that is, left and right view areas, which may display different images at the same time. Generally, a left FOV image is displayed on the left view area and a right FOV image is displayed on the right view area such that different viewers may see different images on different directions of the same display. However, there is a central-interference area, as illustrated in Fig. 1, between the left and right view areas. In the central-interference area, both left and right FOV images are visible, and this may degrade the display effect.

[0004] In the prior art, the central-interference area is reduced by modifying the double-vision display panel. However, the central-interference area cannot be eliminated completely. The central-interference area has high brightness, which will still degrade the display effect.

From US 2011/0221999 A1 it is known a beam splitting film, a backlight module and a stereo display apparatus. US 2012/0188788 A1 discloses a light guiding bar, a backlight assembly having the same and a display apparatus having the same. From US 5,724,108 A it is known a liquid crystal display device with a prism sheet that increases brightness in the optimum range of viewing angle. US 2004/0263698 A1 discloses a display device with capacity of displaying three-dimensional images. US 2001/0228387 A1 refers to a backlight modul, a stereo display apparatus and a beam splitting film. From WO 2010/ 036415 A1 it is known a directed illumination diffraction optics auto-stereo display. From WO 2005/071474 A2 it is known a directional backlight, a multiple view display and a multi-direction display.

SUMMARY

[0005] An objective of the present disclosure is to provide a double-vision backlight module and a LCD device, to solve the problem caused by the high brightness of the central-interference area which may degrade the display effect.

[0006] The objective of the present disclosure is realized with the following technical solutions.

[0007] A first aspect of the present disclosure provides a double-vision backlight as claimed in claim 1.

[0008] The present disclosure further provides a LCD device comprising the above backlight module.

[0009] By arranging the prism sheet such that the side having the prisms thereon of the prism sheet faces the LCD panel, the double-vision backlight module as provided by the embodiments of the invention effectively enhances the brightness while splits the light, display brightness of the images in the left and right view areas is increased, and the backlight brightness in the interference area is reduced, which in turn reduces the brightness of the images in the central-interference area and the central-interference, thereby improving the image display effect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Fig. 1 schematically illustrates a double-vision display image with a central-interference area existing between the left and right view areas of the prior art;
Fig. 2 schematically illustrates a configuration of a double-vision backlight module in accordance with Embodiment 1 of the invention;
Fig. 3 schematically illustrates a configuration of a double-vision backlight module in accordance with Embodiment 2 of the invention;
Fig. 4 schematically illustrates light-splitting effect realized by three prism sheets in accordance with Embodiment 2 of the invention;
Fig. 5 schematically illustrates a cross sectional polar coordinate diagram of a light filed distribution of a double-vision backlight after light-splitting in accordance with Embodiment 2 of the invention;

DETAILED DESCRIPTION

[0011] According to the embodiments of the invention, a double-vision backlight module is provided. By arranging prism sheets between a diffuser plate and a LCD panel such that the prism sheets split light and enhance brightness of the two view areas, so as to enhance the brightness of the two view areas and reduce brightness of a central-interference area. As a result, the central-interference is reduced and the double-vision display effect is improved.

[0012] A schematic configuration of a double-vision backlight module in accordance with Embodiment 1 of the invention is illustrated in Fig. 2, which comprises a light source 1, a reflector plate 2, a light guide plate (LGP) 3, a diffuser plate 4 and prism sheets 5.

[0013] The light source 1, the reflector plate 2 and the LGP 3 constitute a non-parallel backlight source, and the light source 1 is preferably a LED source.

[0014] Specifically, the prism sheets 5 are disposed between the diffuser plate 4 and a LCD panel. Moreover, in the embodiment of the invention, there are at least two

layers of prism sheets 5 such that light-splitting function can be realized. A first prism sheet that is adjacent to the diffuser plate 4 is arranged such that a side having prisms thereon of the first prism sheet faces a side of the LCD panel, and the first prism sheet is adapted for converging light incident from the non-parallel back light source; prism sheets other than the first prism sheet are adapted for splitting the converged light stage by stage and focusing the split light into the left and/or right view areas.

[0015] Specifically, in an embodiment of the invention, at least three prism sheets disposed between the diffuser plate 4 and the LCD panel are superimposed along the vertical direction, and axes of the prisms are parallel to each other and vertical to a horizontal line connecting the left and right view areas.

[0016] In the double-vision backlight module as provided by the embodiment of the invention, the display brightness of the view area images is significantly improved and the brightness of the backlight in the interference area is reduced by arranging the prism sheet that is adjacent to the diffuser plate such that the side having the prisms thereon of that prism sheet faces the LCD panel and by means of the combination of the prism sheets which firstly converges light and then splits the light, which in turn reduces brightness of images in the central-interference area and thereby improving the image display effect.

[0017] A backlight module in accordance with Embodiment 2 of the invention is a preferable variant of Embodiment 1 and is not limitative to the invention.

[0018] In the embodiment of the invention, preferably, three layers of prism sheets are arranged. Fig. 3 schematically illustrates a cross section of the backlight module with three prism sheets.

[0019] The three prism sheets 5 are disposed parallel with each other between the diffuser plate 4 and the LCD panel, and all the prism sheets are arranged such that the sides having the prisms thereon of those prism sheets face the LCD panel. Axes of the prisms in each prism sheets are parallel to each other and vertical to a horizontal line connecting the left and right view areas.

[0020] Specifically, to achieve a better light-splitting effect, the first layer of prism sheet disposed adjacent to the diffuser plate has such a prism apex angle that keeps a beam angle of the light incident from the non-parallel back light source to a range of no greater than 45°, so as to converge more split light into the two view areas, and thereby further improve the display brightness of the two view areas and reduce the brightness of the central-interference area.

[0021] The apex angle of the prisms of the first layer of prism sheet disposed adjacent to the diffuser plate is set between 28°~42°, and the first layer of prism sheet converge light emitted from the non-parallel backlight source, and the beam angel of the light incident from the non-parallel backlight source is controlled within a range of no greater than 45°. For the purpose of maintaining the brightness of the split light while converging the light into the two view area stage by stage, the second prism sheet is arranged such that the prism apex angle of the second prism sheet is between II4°~122°, so as to split the light converged by the first prism sheet for the first time (hereafter also refers to as first splitting). The third prism sheet that is disposed adjacent to the LCD panel is arranged such that the prism apex angle of the third prism sheet is between 28°~42°, so as to split the light that has experienced the first splitting again, and thereby to widen the angle of light splitting. Fig. 4 schematically illustrates light-splitting effect realized by the aforesaid three prism sheets. A conventional non-parallel backlight source may emit light beams at all angles; however, the light beams are converged to the left and/or right view area after being split by the aforesaid three prism sheets, and there may be hardly any light beam that is converged to the central-interference area. Thus, the brightness of the left and right view areas is increased and that of the central-interference area is decreased, and thereby reducing central-interference and improving the double-vision effect.

[0022] Preferably, prisms of the prism sheets in accordance with an embodiment of the invention may be shaped as isosceles triangle such that the brightness is distributed symmetrically.

[0023] More preferably, in an embodiment of the invention, the prism apex angles of the first and third prism sheets are equal to each other, so that the fabrication process is simplified and at the same time light-splitting effect is achieved.

[0024] Furthermore, in accordance with an embodiment of the invention, the prism apex angles of the first and third prism sheets may be set to 40°, and the prism apex angle of the second prism sheet may be set to 120°, such the split light is converged to an area between $\pm 14°$~$\pm 45°$, which is an optimal brightness area for viewing the displayed images. Fig. 5 schematically illustrates a cross sectional polar coordinate diagram of the double-vision backlight light field distribution after light-splitting.

[0025] With the combination of the three prism sheets in accordance with the embodiment of the invention, the first prism sheet converging the light, the second prism sheet splitting light in a small angle and the third prism sheet splitting the light in a wider angle based on the small-angle splitting, the brightness is improved while the light-splitting effect for optimal view area is realized.

[0026] Furthermore, in order to further improve the brightness of the display area, a converging prism sheet having its prism axis parallel to a line horizontally connecting the left and right view areas may be disposed above the prism sheet most close to the LCD panel. The converging prism sheet is disposed between the prism sheet most close to the LCD panel and the LCD panel, and is superimposed with the prism sheet most close to the LCD panel in the vertical direction, so as to further improve the brightness of the display area.

[0027] In the double-vision backlight module in accordance with the embodiment of the invention, with the com-

bination of three prism sheets with different prism apex angles together with the converging prism sheet disposed on the prism sheets, the display brightness of the left and right view areas is increased and at the same time the brightness is further improved by the converging prism sheet.

[0028] Embodiment 4 of the invention further provides a LCD device. The LCD device comprises the same backlight module as that described in Embodiments 1 and 2. The rest part of the LCD device has a conventional configuration and will not be elaborated here.

[0029] What are described above is related to the illustrative embodiments of the disclosure only and not limitative to the scope of the claims.

Claims

1. A double-vision backlight module, comprising a non-parallel backlight source (1) and a diffuser plate (4), wherein the double-vision backlight module further comprises at least three prism sheets (5) disposed between the diffuser plate (4) and a LCD panel, the at least three prism sheets (5) are superimposed along a first direction, the axes of the prism sheets (5) are perpendicular to a line in a second direction connecting left and right view areas for left and right eyes, and the axes of the prism sheets (5) are parallel to each other, wherein,
   a first prism sheet (5) adjacent to the diffuser plate (4) is arranged such that a side having the prisms thereon of the first prism sheet faces the LCD panel, for converging light incident from the non-parallel backlight source (1), and the other prism sheets of the at least three prism sheets (5) are used for splitting the converged light and converging the split light into the left and right view areas for left and right eyes, wherein the double-vision backlight module is **characterized in that** the at least three prism sheets (5) are arranged such that a side having the prisms thereon of each prism sheet (5) faces the LCD panel, wherein a prism apex angle of the first prism sheet (5) that is adjacent to the diffuser plate (4) is arranged such that a beam angle of the light incident from the non-parallel back light source (1) and outputted by the first prism sheet is no larger than 45°,
   that a prism apex angle of the first prism sheet (5) that is adjacent to the diffuser plate (4) is 28°~42°;
   a prism apex angle of the second prism sheet (5) is 114°~122°; and
   a prism apex angle of the third prism sheet (5) that is adjacent to the LCD panel is 28°~42°,
   such that the split light is converged to an area between ±14° and ±45°.

2. The double-vision backlight module of claim 1, **characterized in that** the at least three prism sheets (5) are arranged such that their sides having the prisms thereon face the LCD panel.

3. The double-vision backlight module of claim 1, **characterized in that** the prism apex angle of the first prism sheet (5) is equal to that of the third prism sheet (5).

4. The double-vision backlight module of claim 1 or 3, **characterized in that** the prism apex angles of the first and third prism sheets (5) are both 40°.

5. The double-vision backlight module of any of claims 1 to 4, **characterized in that** the prism apex angle of the second prism sheet (5) is 120°.

6. The double-vision backlight module of any of claims 1 to 5, **characterized in that** the prisms of the prism sheets (5) are isosceles triangle shaped.

7. The double-vision backlight module of claim 6, **characterized in that** it further comprises an additional prism sheet for converging light, prism axis of the additional prism sheet being parallel to the line in the second direction connecting the left and right view areas for left and right eyes, the additional prism sheet being disposed between the prism sheet (5) that is adjacent to the LCD panel and the LCD panel, and superimposed with the prism sheet (5) that is adjacent to the LCD panel in the first direction.

Patentansprüche

1. Doppelbild-Hintergrundbeleuchtungs-Modul, umfassend eine nicht-parallele Hintergrundbeleuchtungsquelle (1) und eine Diffusorplatte (4), wobei das Doppelbild-Hintergrundbeleuchtungs-Modul außerdem umfasst zumindest drei Prismaplatten (5), angeordnet zwischen der Diffusorplatte (4) und einem LCD-Panel, wobei die zumindest drei Prismaplatten (5) entlang einer ersten Richtung übereinander gelagert sind, wobei die Achsen der Prismaplatten (5) senkrecht sind zu einer Linie in einer zweiten Richtung, verbindend linke und rechte Betrachtungsbereiche für linke und rechte Augen, und wobei die Achsen der Prismaplatten (5) parallel zueinander sind, wobei
   eine erste Prismaplatte (5) benachbart der Diffusorplatte (4) angeordnet ist, so dass eine Seite, welche die Prismen darauf aufweist, der ersten Prismaplatte dem LCD-Panel zugewandt ist, um von der nicht-parallelen Hintergrundbeleuchtung (1) einfallendes Licht zu konvergieren, und wobei die anderen Prismaplatten von den zumindest drei Prismaplatten (5) verwendet werden zum Aufsplitten des konvergierten Lichts und konvergierendes gesplitteten Lichts die linken und rechten Betrachtungsbereiche für linke und rechte Augen,

wobei das Doppelbild-Hintergrundbeleuchtungs-Modul **dadurch gekennzeichnet ist, dass** die zumindest drei Prismaplatten (5) so angeordnet sind, dass von jeder Prismaplatte (5) eine Seite, die darauf die Prismen aufweist, dem LCD-Panel zugewandt ist, wobei ein Prismenöffnungswinkel der ersten Prismaplatte (5), die benachbart zu der Diffusorplatte (4) angeordnet ist, so gewählt ist, dass ein Strahlenwinkel des Lichts, das von der nicht-parallelen Hintergrundbeleuchtungsquelle (1) einfällt und mittels der ersten Prismaplatte ausgegeben wird, nicht größer ist als 45°,
dass ein Prismenöffnungswinkel der ersten Prismaplatte (5), die zu der Diffusorplatte (4) benachbart ist, 28°~42° beträgt;
dass ein Prismenöffnungswinkel der zweiten Prismaplatte (5) 114°~122° beträgt;
und dass ein Prismenöffnungswinkel der dritten Prismaplatte (5), die zu dem LCD-Panel benachbart ist, 28°~42° beträgt, so dass das gesplittete Licht konvergiert wird zu einem Bereich zwischen ±14° und ±45°.

2. Doppelbild-Hintergrundbeleuchtungs-Modul gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die zumindest drei Prismaplatten (5) so angeordnet sind, dass ihre Seiten, die darauf die Prismen aufweisen, dem LCD-Panel zugewandt sind.

3. Doppelbild-Hintergrundbeleuchtungs-Modul gemäß Anspruch 1, **dadurch gekennzeichnet, dass** der Prismenöffnungswinkel der ersten Prismaplatte (5) gleich ist zudem der dritten Prismaplatte (5).

4. Doppelbild-Hintergrundbeleuchtungs-Modul gemäß Anspruch 1 oder 3, **dadurch gekennzeichnet, dass** die Prismenöffnungswinkel der ersten und dritten Prismaplatten (5) beide 40° betragen.

5. Doppelbild-Hintergrundbeleuchtungs-Modul gemäß einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** der Prismenöffnungswinkel der zweiten Prismaplatte (5) 120° beträgt.

6. Doppelbild-Hintergrundbeleuchtungs-Modul gemäß einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** die Prismen der Prismaplatten (5) die Gestalt eines gleichschenkligen Dreieckes aufweisen.

7. Doppeltbild-Hintergrundbeleuchtungs-Modul gemäß Anspruch 6, **dadurch gekennzeichnet, dass** es außerdem eine zusätzliche Prismaplatte zum Konvergieren von Licht umfasst, wobei die Prismaachse der zusätzlichen Prismaplatte parallel zu der Linie in der zweiten Richtung, verbindend die linken und rechten Betrachtungsbereiche für linke und rechte Augen, wobei die zusätzliche Prismaplatte zwischen der Prismaplatte (5), die zu dem LCD-Panel benachbart ist, und dem LCD-Panel angeordnet ist, und überlagert ist mit der Prismaplatte (5), die benachbart zu dem LCD-Panel ist in der ersten Richtung.

Revendications

1. Un module de rétroéclairage double-vision, comprenant une source de rétroéclairage non-parallèle (1) et une plaque de diffusion (4), dans lequel le module de rétroéclairage double-vision comprend en outre au moins trois feuilles à prismes (5) disposées entre la plaque de diffusion (4) et un panneau LCD, les au moins trois feuilles à prismes (5) sont superposées le long d'une première direction, les axes des feuilles à prismes (5) sont perpendiculaires à une ligne dans une deuxième direction reliant des zones de vision gauche et droite pour yeux gauche et droit, et les axes des feuilles à prismes (5) sont parallèles entre eux, dans lequel

une première feuille à prismes (5) adjacente à la plaque de diffusion (4) est agencée de manière à ce qu'un côté sur lequel se trouvent les prismes de la première feuille à prismes fasse face au panneau LCD pour faire converger de la lumière incidente de la source de rétroéclairage non-parallèle (1), et les autres feuilles à prismes des au moins trois feuilles à prismes (5) sont utilisées pour diviser la lumière convergente et faire converger la lumière divisée dans les zones de vision gauche et droite pour yeux gauche et droit,
dans lequel le module de rétroéclairage double-vision est **caractérisé en ce qu'**au moins trois feuilles à prismes sont agencées de manière à ce qu'un côté sur lequel se trouvent les prismes de chaque feuille à prismes (5) fasse face au panneau LCD, dans lequel

un angle de sommet de prisme de la première feuille à primes (5) qui est adjacente à la plaque de diffusion (4) est agencée de manière à ce qu'un angle de faisceau de la lumière incidente de la source de rétroéclairage non-parallèle (1) et sortant de la première feuille à prismes ne soit pas supérieur à 45°, qu'un angle de sommet de prisme de la première feuille à prismes (5) qui est adjacente à la plaque de diffusion (4) est d'environ 28° à 42° ;
un angle de sommet de prisme de la deuxième feuille à prismes (5) est d'environ 114° à 122° ; et
un angle de sommet de prisme de la troisième feuille à prismes (5) qui est adjacente au panneau LCD est d'environ 28° à 42°,
de manière à ce que la lumière divisée soit convergée dans une zone entre +/- 14° et +/- 45°.

2. Le module de rétroéclairage double-vision de la revendication 1, **caractérisé en ce qu'**au moins trois feuilles à prismes (5) sont agencées de manière à ce que leurs côtés sur lesquels se trouvent les prismes fassent face au panneau LCD.

3. Le module de rétroéclairage double-vision de la revendication 1, **caractérisé en ce que** l'angle de sommet de prisme de la première feuille à prismes (5) soit égal à celui de la troisième feuille à primes (5).

4. Le module de rétroéclairage double-vision de la revendication 1 ou 3, **caractérisé en ce que** les angles de sommet de prisme des première et troisième feuilles à prismes (5) sont tous les deux de 40°.

5. Le module de rétroéclairage double-vision de l'une quelconque des revendications 1 à 4, **caractérisé en ce que** l'angle de sommet de prisme de la deuxième feuille à prismes (5) est de 120°.

6. Le module de rétroéclairage double-vision de l'une quelconque des revendications 1 à 5, **caractérisé en ce que** les prismes de la première feuille à prismes (5) sont en forme de triangles isocèles.

7. Le module de rétroéclairage double-vision de la revendication 6, **caractérisé en ce qu'**il comprend en outre une feuille à prismes additionnelle pour faire converger la lumière, l'axe des prismes de la feuille à prismes additionnelle étant parallèle à la ligne dans la deuxième direction reliant les zones de vision gauche et droite pour yeux gauche et droit, la feuille à prismes additionnelle étant disposée entre la feuille à prismes (5) qui est adjacente au panneau LCD et le panneau LCD, et superposée à la feuille à prismes (5) qui est adjacente au panneau LCD dans la première direction.

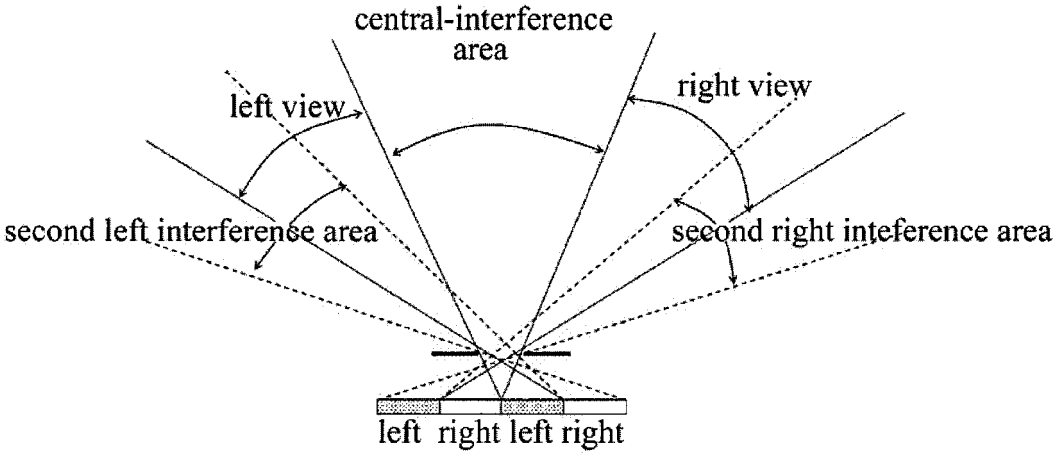
central-interference area
left view
right view
second left interference area
second right inteference area
left right left right

FIG. 1

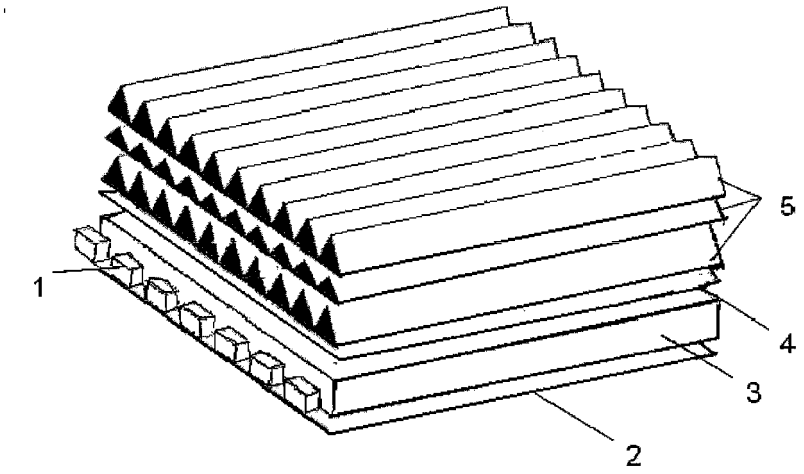
1
2
3
4
5

FIG. 2

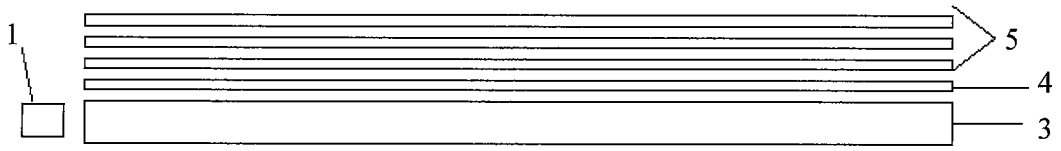

FIG. 3

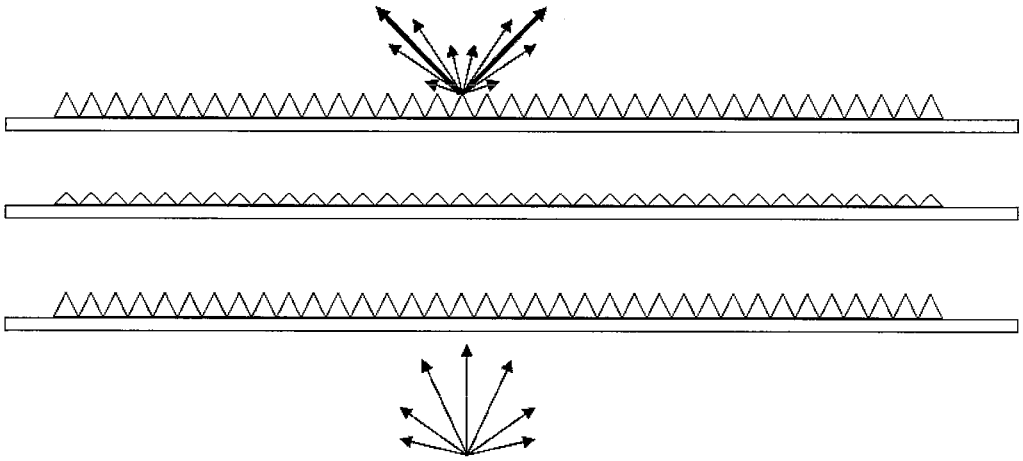

FIG. 4

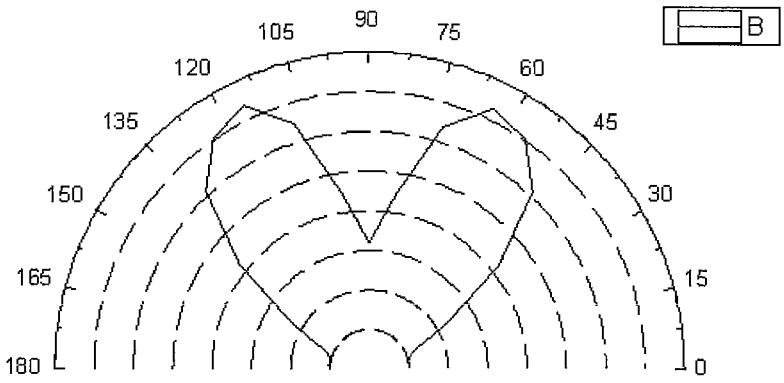

FIG. 5

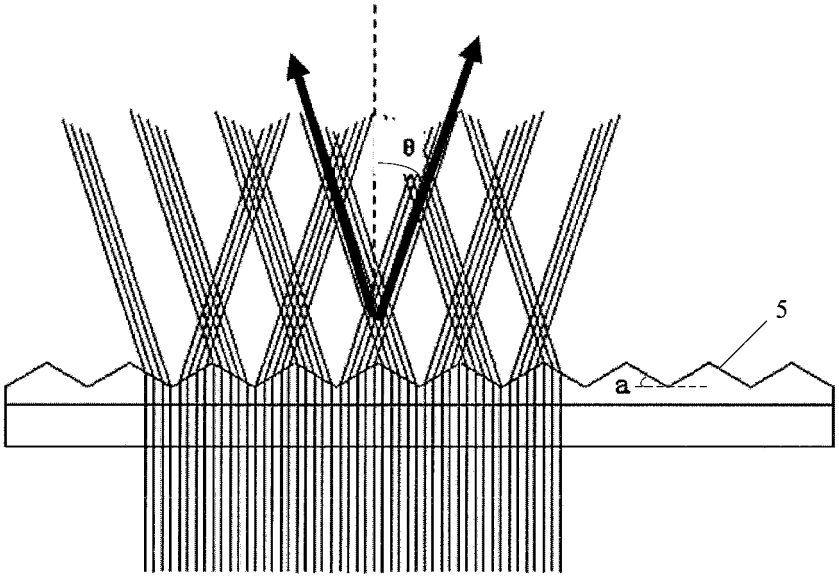

FIG. 6

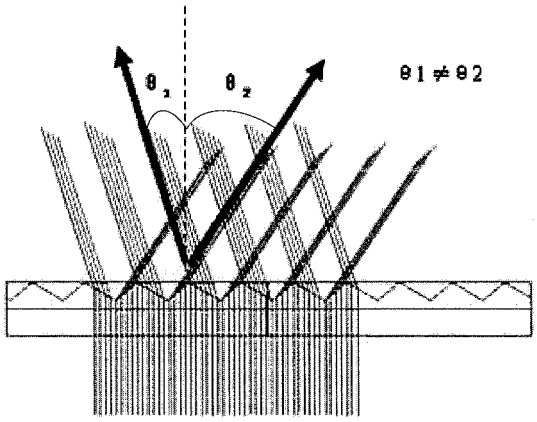

FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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- US 20010228387 A1 **[0004]**
- WO 2010036415 A1 **[0004]**
- WO 2005071474 A2 **[0004]**

专利名称(译)	双视背光模组和液晶显示装置		
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[标]申请(专利权)人(译)	京东方科技集团股份有限公司		
申请(专利权)人(译)	京东方科技集团有限公司.		
当前申请(专利权)人(译)	京东方科技集团股份有限公司.		
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外部链接	Espacenet		

摘要(译)

在本发明的实施例中，提供了一种双视背光模块和LCD装置。在本发明的实施例中，分光棱镜片设置在漫射板和LCD面板之间，用于分光。棱镜片被布置成使得棱镜片上具有棱镜的一侧面向LCD面板，从而分离光并增强亮度，并最终增强左右视野区域的亮度，同时减小中心干涉区域的亮度，从而改善双视效果。

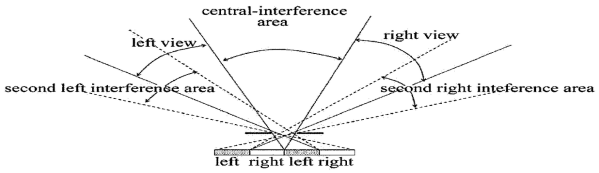

FIG. 1

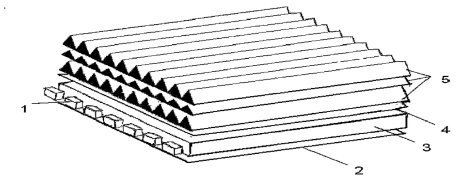

FIG. 2