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(54) **DISPLAY APPARATUS WITH DISPLAY SWITCHING MODES**

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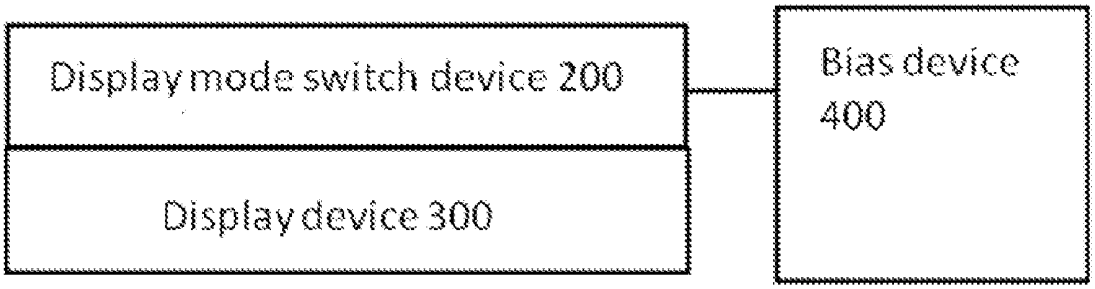
(57) **ABSTRACT**

The present invention discloses a display apparatus with display switching mode, the display apparatus includes a display device; an image mode switch device formed corresponding to the display device, wherein the image mode switch device includes: a liquid crystal layer; a first electrode set on a side of the liquid crystal layer; a second electrode set between the first electrode and the liquid crystal layer; a third electrode set on another side of the liquid crystal layer; and a voltage providing device electrically coupled to the image mode switch device to supply different voltage to the first electrode, the second electrode and the third electrode for switching displaying mode; the display apparatus may display the 2D, 3D and IP stereo image by using the electrodes with different pattern and voltage with different voltage on the first electrode, the second electrode and the third electrode.



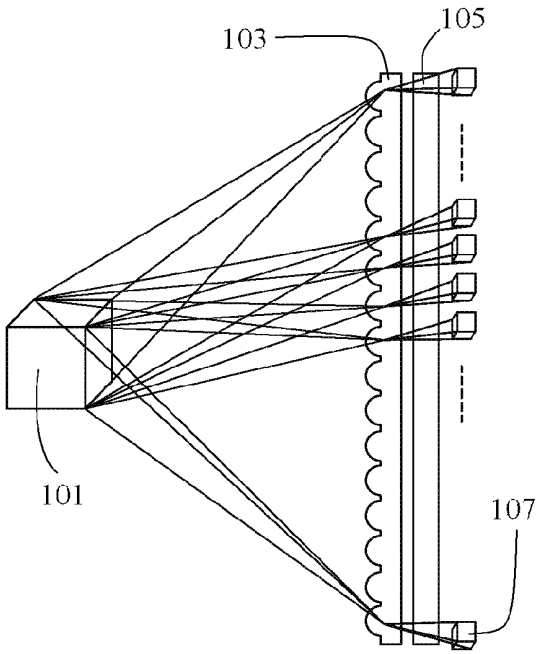


FIG. 1A (PRIOR ART)

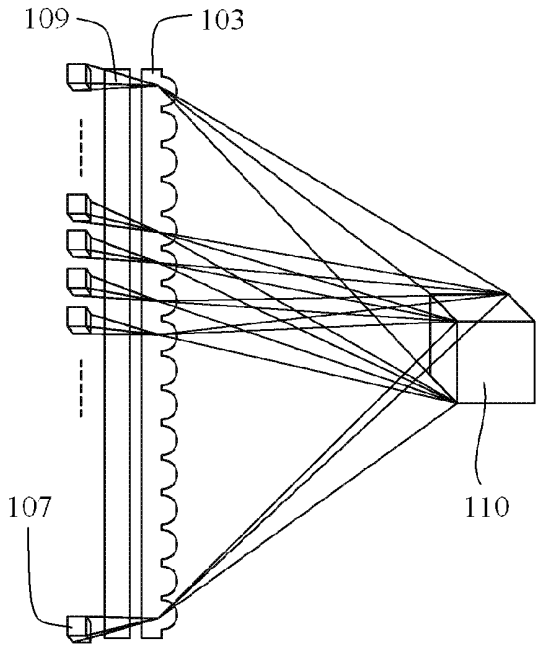


FIG. 1B (PRIOR ART)

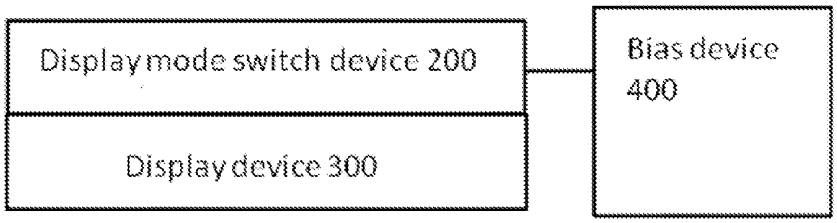


FIG. 2A

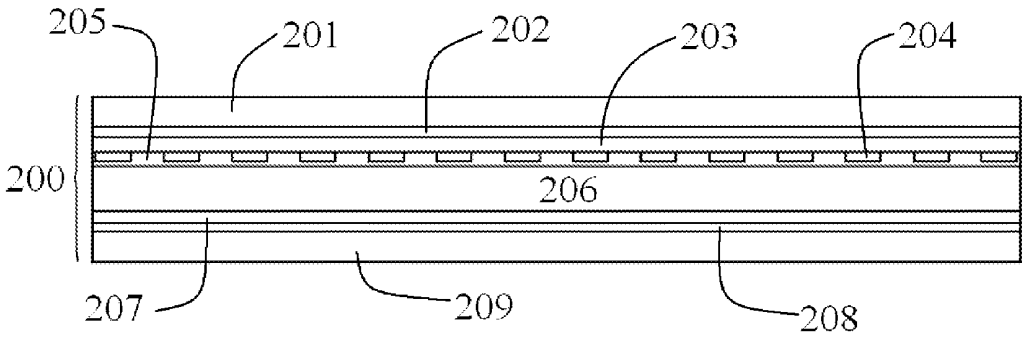


FIG. 2B

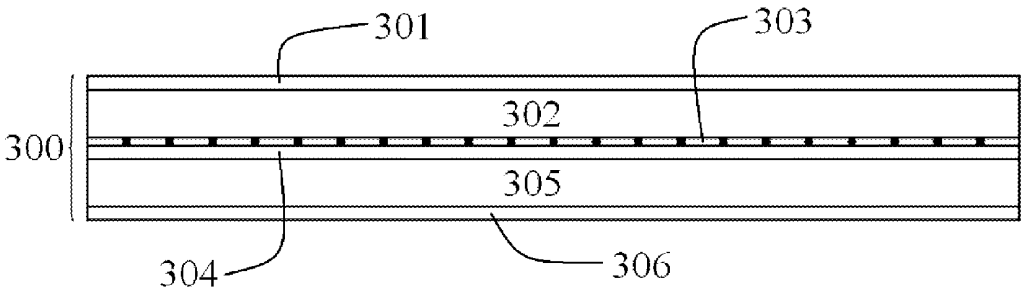


FIG. 2C

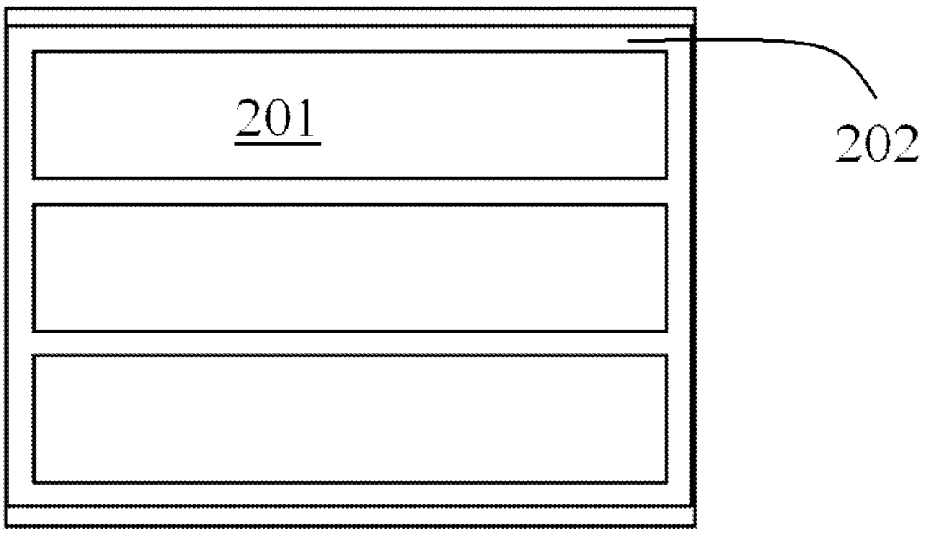


FIG. 3A

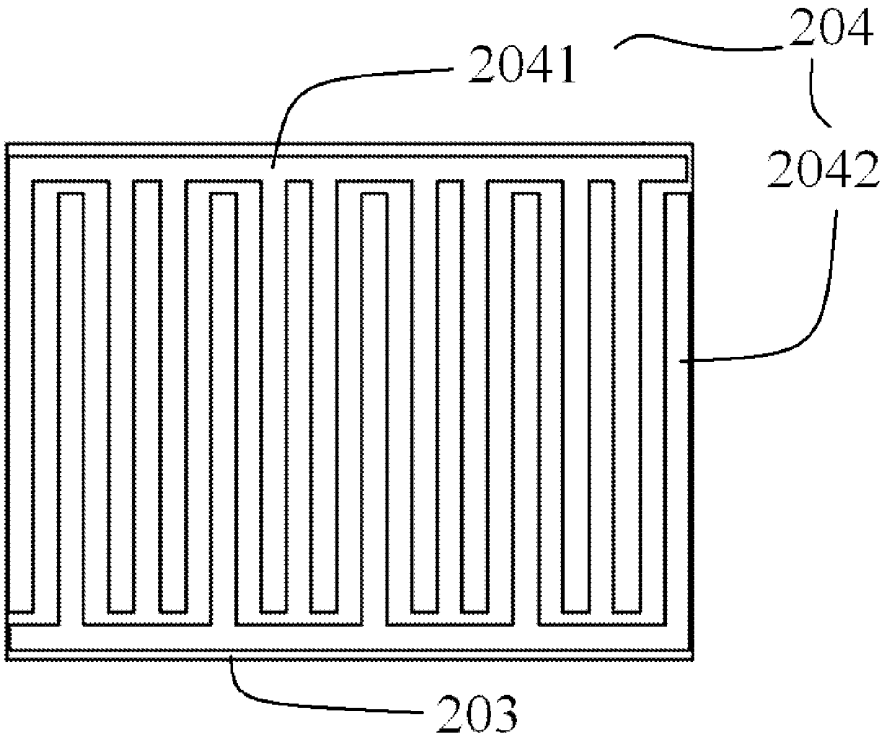


FIG. 3B

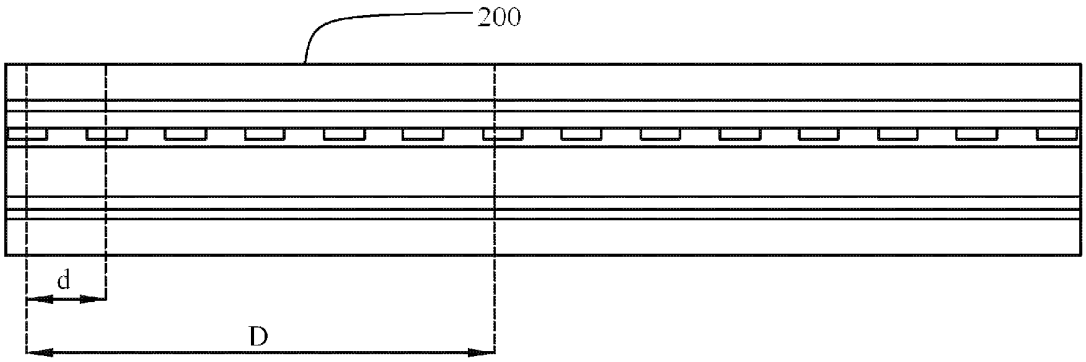


FIG. 4

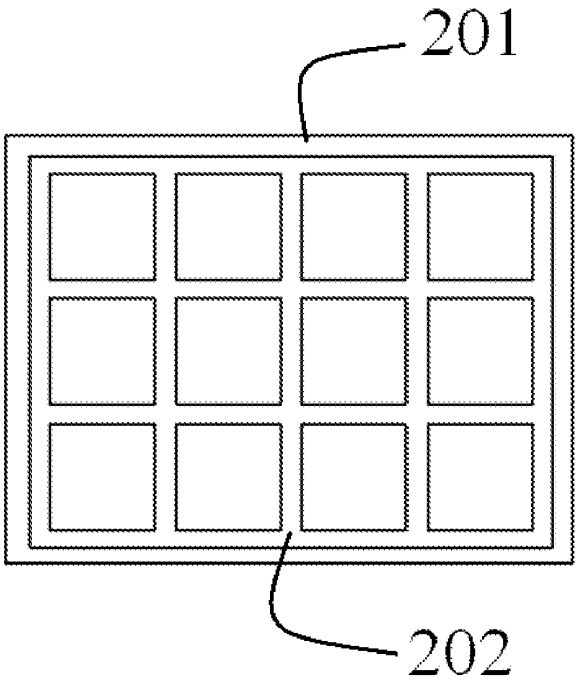


FIG. 5A

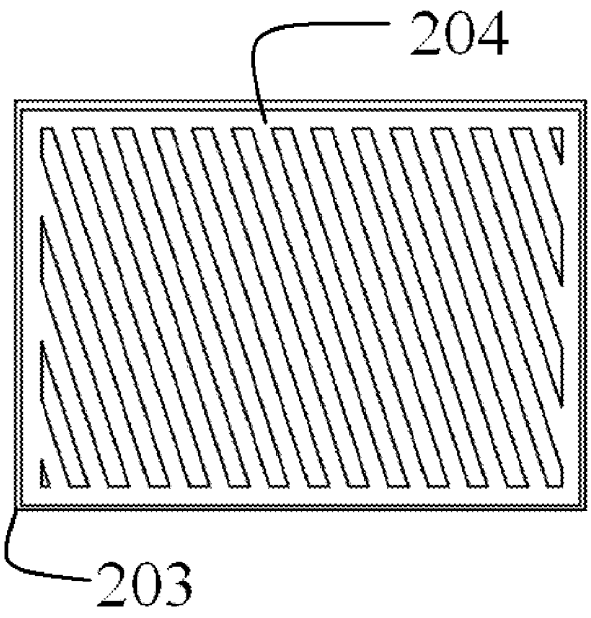


FIG. 5B

DISPLAY APPARATUS WITH DISPLAY SWITCHING MODES

FIELD OF THE INVENTION

[0001] The present invention relates to a three-dimension (3D) display apparatus, and more particularly, to a display apparatus for switching the display modes among two-dimension (2D), three-dimension (3D), Integral Photography (IP) images by altering the electrical field distribution to change the optical property of the liquid crystal lens to switch the display mode.

BACKGROUND OF THE INVENTION

[0002] The image display technology is continuously developed from the gray scale, true color into the stage of high definition to achieve the purpose of vivid and nature display. Therefore, the next generation display towards the development of three-dimension display.

[0003] Typically, the three dimension images are created through the user's eye by the stereo image theory which is based on that the images caught by each eye are different. Namely, when the eyes are separated with 5-7 cm, the images caught by the two eyes are slightly distinguishable, it leads to the result of visual difference. Thus, the traditional three-dimension image is obtained by the visual difference effect so as to allow the left eye only receives the left-eye image while the right eye only receives the right-eye image.

[0004] Typically, the visual difference based three-dimension image needs special design equipment to achieve the goal, the typical methods is introduced as follows:

[0005] The first type introduces the polarized glasses which includes a horizontal polarized glass and a vertical polarized glass for each eye to allow the left eye receive the horizontal polarized image and the right eye receive the vertical polarized image. The display apparatus may radiate the horizontal polarized left-eye image and the vertical polarized right-eye image, respectively. By the method, the left eye of the user may receive the horizontal polarized left-eye image while the right eye of the user may receive the vertical polarized right-eye image, thereby creating the three-dimension image. However, the polarized glasses will be failure when the head of the user inclines so as not allow the polarizer completely polarizes the light which passes through the glasses. It will case the user uncomfortable.

[0006] Another type involves the usage of red-blue (green) glasses. The technical introduces the displaying of the left, and right images by using the red-blue (green) glasses to allow the user receive the left and right images by each eye, respectively, thereby creating the three-dimension image after receiving the left and right images through the red-blue (green) glasses. However, the shortcoming of the type of the three-dimension image displaying is that the true color of the original image cannot be re-built by using the red-blue (green) glasses. The third type of the prior art involves the usage of the shuttle glasses. The image displaying apparatus will transmit odd images and even images to the shuttle glasses, respectively. If the odd images are set to act the right-eye images while the odd images are defined as the left-eye images, when the odd images are transmitted, the left eye will be covered by the shuttle glasses. Similarly, when the even images are transmitted, the right eye will be covered by the shuttle glasses so as to allow the uses may watch the three-dimension image. Another type is called helmet type image display which has two liquid crystal displays on the glasses directly, the uses receives the left and right eye images through the two displays by the left and right eyes, respectively. The method omits the red-blue (green) glasses to avoid the shortcoming. However, not only the cost of the equipment is high, but also the number of the user to watch the images is limited.

[0007] No matter the cost of those prior art is, all of the prior arts mentioned above require the glasses for the user to wear on. It is not friendly to the user at all. Thus, the recent development is mainly focus on the glasses free three-dimension image display apparatus.

[0008] One of the types which involve the glasses free three-dimension image display apparatus is called visual-difference bare-eye three-dimension image display apparatus which is designed based on the visual difference phenomena. Under the scheme of the visual-difference bare-eye design, a parallax or optical grating is set before the liquid crystal display. The display transmitted the left-eye image and right-eye image in sequence. The parallax functions to allow the right-eye and left-eye receive the right-eye and left-eye images, respectively. The signals of the right-eye and left-eye images will be re-constructed by the brain of the user, thereby achieving the three-dimension image.

[0009] In addition to the above glasses free three-dimension image display apparatus, a further equipment free three-dimension image technical involves Integral Photography (IP) technology which is developed since 1908. The major principle of the IP uses the fly's eye lens to catch the stereo images from different angle. The fly's eye lens simulates the arrangement of the eye of the fly to arrange pluralities of tiny lens in an array configuration. Namely, pluralities of semi-sphere lens are arranged within a planar in an array from for catching image. The Integral Photography (IP) technology involves two major steps, the first one may refer to FIG. **1**A, an image capture device **105** catches the stereo image **107** from different angle of the object **101** by the fly's eye lens **103**. Thereafter, referring to FIG. **1**B, the next step is to process the caught images through the display apparatus **109** and the fly eye lens to re-built the three-dimension stereo image **110** of the object.

[0010] From above, the parallax or optical grating is required within the display by using the visual difference three-dimension image technical. A fly's eye lens is demand within the display to show the three-dimension image by using the IP three-dimension image technical. The specify display may display the specify three-dimension image generated by specify solution, thus, the three-dimension image will be limited to the display the user employed. If the method to catch the images is not compatible to the hardware, the three-dimension image cannot be displayed at all.

SUMMARY OF THE INVENTION

[0011] To solve the aforementioned problems of the conventional techniques, the present invention provides a display apparatus with display switching mode for displaying 2D, different type of 3D image information by employing one apparatus.

[0012] One advantage of the present invention is to offer a display apparatus for switching among the 2D, 3D, and IP stereo image.

[0013] In one aspect of the present invention, a display apparatus with display switching mode is disclosed, it comprises a display device; an image mode switch device formed

corresponding to the display device, wherein the image mode switch device includes: a liquid crystal layer; a first electrode set on a side of the liquid crystal layer; a second electrode set between the first electrode and the liquid crystal layer; a third electrode set on another side of the liquid crystal layer; and a voltage providing device electrically coupled to the image mode switch device to supply different voltage to the first electrode, the second electrode and the third electrode for switching displaying mode; the display apparatus may display the 2D, 3D and IP stereo image by using the electrodes with different pattern and voltage with different voltage on the first electrode, the second electrode and the third electrode.

[0014] In another aspect of the present invention, a display apparatus with display switching mode is disclosed, it comprises a display device; an image mode switch device formed corresponding to the display device, wherein the image mode switch device includes: a liquid crystal layer; a first electrode set on a side of the liquid crystal layer; a second electrode set between the first electrode and the liquid crystal layer; a third electrode set on another side of the liquid crystal layer; and a voltage providing device electrically coupled to the image mode switch device to supply different voltage to the first electrode, the second electrode and the third electrode for switching displaying mode; wherein the first electrode includes a first pattern, the second electrode including a second pattern having a first portion and a second portion, wherein the first portion and the second portion have different pattern spacing and are constructed by an interdigitated configuration.

[0015] The first electrode is constructed by a square frame with pluralities of horizontal lines formed therein; the second electrode includes a first portion and a second portion. The first portion and the second portion are formed by pluralities of vertical lines which are connected by a horizontal line. Additionally, the vertical lines of the first portion and the second portion are formed in parallel; both horizontal lines are set on sides which are in opposition with each other. The second electrode and the third electrode are ground when the display apparatus displays two-dimension image. The first electrode is ground, the second electrode and the third electrode is supplied with a first voltage when the display apparatus displays three-dimension image. The first electrode and the third electrode are supplied with a second voltage, and the second portion of the second electrode and the third electrode are supplied with a third voltage, the first potion of the second electrode being ground when the display apparatus displays a stereo image.

[0016] A display apparatus with display switching mode comprises a display device; an image mode switch device formed corresponding to the display device, wherein the image mode switch device includes: a liquid crystal layer; a first electrode set on a side of the liquid crystal layer; a second electrode set between the first electrode and the liquid crystal layer; a third electrode set on another side of the liquid crystal layer; and a voltage providing device electrically coupled to the image mode switch device to supply different voltage to the first electrode, the second electrode and the third electrode for switching displaying mode; wherein the first electrode includes a first pattern, the first pattern being constructed by a grid pattern with pluralities of square frames; the second electrode includes a second pattern constructing by pluralities of titled lines. The square frame is formed with 1×1 to 500×500 pixels.

[0017] The first electrode, the second electrode and the third electrode are ground when the display apparatus displays two-dimension image. The first electrode is ground, the second electrode and the third electrode is supplied with a first voltage when the display apparatus displays three-dimension image. The first electrode and the third electrode are supplied with a second voltage, and the third electrode is ground when the display apparatus displays a stereo image.

[0018] These and other advantages will become apparent from the following description of preferred embodiments taken together with the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The present invention may be understood by some preferred embodiments and detailed descriptions in the specification and the attached drawings below. The identical reference numbers in the drawings refer to the same components in the present invention. However, it should be appreciated that all the preferred embodiments of the invention are only for illustrating but not for limiting the scope of the Claims and wherein:

[0020] FIG. **1**A-**1**B illustrate a method of fetching and displaying IP stereo image technology of the prior art;

[0021] FIG. **2**A-**2**C illustrate a display apparatus with the ability of switching among 2D, 3, and IP stereo image with one embodiment of the present invention;

[0022] FIG. **3**A-**3**B illustrate the first and the second electrode with one embodiment of the present invention;

[0023] FIG. **4** illustrates the arrangement of the liquid crystal molecular for displaying 3D and IP image by applying different voltage on the liquid crystal layer with one embodiment of the present invention;

[0024] FIG. **5**A-**5**B illustrates further embodiments of first and the second electrode of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0025] The invention will now be described with the preferred embodiments and aspects and these descriptions interpret structure and procedures of the invention only for illustrating but not for limiting the Claims of the invention. Therefore, except the preferred embodiments in the specification, the present invention may also be widely used in other embodiments.

[0026] The present invention discloses a display apparatus which may be switched among the two-dimension, three-dimension and IP stereo image so as to allow the user may fetch the image information according to the image type by switching the electrode pattern with specified voltage to alter the display mode, thereby displaying the image of two-dimension, three-dimension or IP stereo image. The stereo image mentioned within the present invention refers to the image created by visual difference bare-eye three-dimension technology and the method thereof.

[0027] It is because that the arrangement and distribution of the liquid crystal molecular will be altered based on the electrical field distribution, therefore, the twisted angle of the liquid crystal is not the same under different electrical field distribution caused by the electrode pattern with different applied voltage. Consequently, the optical property such as the focal length of the liquid crystal lens will be change in order to achieve the optical effect of convex lens, concave

lens, fly-eye lens or parallax. Thus, the present invention employs the different electrode pattern to cause the electrical filed distribution change, thereby driving the liquid crystal lens to allow the display apparatus displays the image of two-dimension, three-dimension or IP stereo image according to the type of the display image.

[0028] Referring to FIGS. **2**A-**2**C, it shows the display apparatus having the mode to switch among two-dimension, three-dimension or IP stereo image. The apparatus includes image mode switching device **200**, a display device **300** and a voltage providing device **400**. The image mode switching device **200** is responsive to the display device **300** to display the different image and switch the mode by the voltage providing device **400** to show the effect of two-dimension, three-dimension or IP stereo image.

[0029] Next, referring to FIG. **2**B, it illustrates the structure of the image mode switch device **200** which includes a first glass substrate **201**, a first electrode **202**, an isolation layer **203**, a second electrode **204**, a first alignment layer **205**, a first liquid crystal layer **206**, a second alignment layer **207**, a third electrode **208** and a second glass substrate **209**. The first electrode **202** is disposed adjacent to one side of the first liquid crystal layer **206**, a second electrode **204** is formed between the first electrode **202** and the first liquid crystal layer **206**. The third electrode **208** is set on another side of the first liquid crystal layer **206**.

[0030] The present invention offers different electrode pattern and provides different voltage to the first electrode **202**, the second electrode **204** and the third electrode **208** so as to cause the liquid crystal molecular in the liquid crystal layer **206** suffers different electrode field distribution, thereby changing the arrangement of the liquid crystal molecular, which leads to the change of optical property. The illustration of the switch among the two-dimension, three-dimension or IP stereo image is seen as follows.

[0031] In one embodiment, the display apparatus may employs the liquid crystal display to carry out the present invention. Turn to FIG. **2**C, it illustrates the panel structure of the liquid crystal display **300** which includes a first polarizer **301**, a third glass substrate **302**, a color layer **303**, a second liquid crystal layer **304**, a fourth glass substrate **305**, and a second polarizer **306**. In one embodiment, the image display switch mode is set based on the liquid crystal display **300** to switch among two-dimension, three-dimension or IP stereo image according to the image information type. Although the liquid crystal panel is illustrated, the detailed structure is omitted, which is well-known by the person having ordinary skill in the art. It should be noted that the present invention uses the liquid crystal panel as an example, the other type of display can also be implemented in the present invention, the display includes but not limited to organic light emitting display (OLED), plasma display panel (PDP), field emission display (FED).

[0032] In some embodiments of the present invention, the first electrode **202**, the second electrode **204** and the third electrode **208** are formed by the material with high transmittance and high conductivity, for instance, it includes but not limited to Indium Tin Oxide (ITO), Indium Zinc Oxide (IZO). In a preferred embodiment, the first electrode **202**, the second electrode **204** and the third electrode **208** are formed by ITO. In some embodiments of the present invention, the first alignment layer **205** and the second alignment layer **207** are Polyimide (PI).

[0033] Referring to FIG. **2**A again, the image mode switch device **200** is electrically coupled the voltage providing device **400**. Preferably, the image mode switch device **200** is electrically coupled to the first electrode **202**, the second electrode **204** and the third electrode **208**, to offers the different voltage to the first electrode **202**, the second electrode **204** and the third electrode **208**. In some embodiments, the voltage providing device **400** is also electrically coupled to the display device **300** so as to offer voltage on the image mode switch device **200** and the display device **300**. In another embodiment, the voltage providing device **400** can be set in the display device **300** to allow the display device **300** control the action and operation of the image mode switch device **200**.

[0034] FIG. **3**A illustrates the structure of the first electrode **202**. The ITO is formed on one side of the first glass substrate **201** with rectangular frame having pluralities horizontal lines pattern within the rectangular frame. The manufacture process includes steps of forming a first electrode **202** on the first glass substrate **201**. The isolation layer **203** is subsequently formed on the other side, which is opposite to the surface of the glass substrate **201**, of the first electrode **202**, followed by forming the second electrode **204** thereon. The steps may be altered to achieve the same result. Please refer to FIG. **3**B, it shows the second electrode **204** structure. The second electrode **204** is formed on the other side of the isolation layer **203**, which is opposite to the surface of the first electrode **202**. In addition, the second electrode **204** is divided into a first portion **2041** and a second portion **2042**. The first portion **2041** and the second portion **2042** are formed by ITO thin film with vertical lines pattern, and are connected by a horizontal line. The vertical lines of the first portion **2041** and the second portion **2042** are formed in parallel, and the two horizontal lines of the first portion **2041** and the second portion **2042** are formed at the opposition sides with each other. The spacing between the vertical lines of the second portion **2042** is wider than the one of the first portion **2041** so as to allow the spacing wide of the second portion **2042** may arrange two vertical lines of the first portion **2041** with equal spacing. The configuration of the first portion **2041** and the second portion **2042** constructs as shape by an interdigitated configuration. Namely, the spacing of the second portion **2042** is wider than the one of the first portion **2041**. The number of the fingers and the spacing may be design under demand. In addition, the voltage applied on the electrode is provided according to the spacing to construct multiple different electrical field distribution. The third electrode **208** is formed between the second glass substrate **209** and the second alignment **207**, the third electrode **208** is formed of ITO and is coated on the entire surface of the second glass substrate **209**.

[0035] Please refer to FIG. **2**B, the different voltage is applied on the first electrode **202**, the second electrode **204** and third electrode **208** to switch among the two-dimension, three-dimension or IP stereo image. The embodiment shows the two-dimension display voltage mode. The voltage providing device **400** does not offers, namely zero voltage (ground), to the first electrode **202**, the second electrode **204** and third electrode **208**. The arrangement of the liquid crystal molecular of the first liquid layer **206** is alignment with order to allow the two-dimension image may directly pass through the image mode switch device **200** to display the two-dimension image. If the three-dimension is displayed, the first electrode **202** is grounded by the voltage providing device **400**, and supplies the second electrode **204** and third electrode **208**

with a first voltage. In one embodiment, first voltage is around ±1 volt ~±100 volts. If the user would like to show the IP stereo image, the voltage providing devices **400** supplies a second voltage to the first electrode **202** and the third electrode **208**, and applies a third voltage on the second portion **2042** of the second electrode **204** and, and the first portion **2041** of the second electrode **204** is grounded. It should be noted that the spacing of the first portion **2041** and the second portion **2042** is different. In one embodiment, the second voltage is around ±1 volt ~±100 volts; the third voltage is around ±1 volt ~±100 volts. The second voltage is different from the third voltage. It should be noted that the second voltage and the third voltage is higher than the first voltage.

[0036] Turning to FIG. **4** and FIG. **2**B, the aforementioned different voltage is offered to the first electrode **202**, the second electrode **204** and third electrode **208** of the image mode switch device **200** to arrange the liquid crystal molecular of the first liquid crystal layer **206** with order having a spacing d to achieve the effect of optical grating. When the IP stereo image is displayed, the spacing of the arranged liquid crystal molecular is D to achieve the fly-eye effect. The voltage providing device **400** may offer different voltage on the first electrode **202**, the second electrode **204** and third electrode **208** of the image mode switch device **200** based on the different display mode to achieve the purpose of displaying two-dimension, three-dimension and IP stereo image. Further, the real image and virtual image of the apparatus can be controlled based on the different voltage.

[0037] Another embodiment of the present invention is referred to FIG. **5**A, it shows the first electrode **202** structure. The first electrode **202** is formed on one of the surfaces of the first glass substrate with grid pattern having pluralities of square frames. The dimension of each square frame is about 1×1 pixel to 500×500 pixels. Similarly, the first electrode **202** is formed on the first glass substrate **201**, followed by forming the isolation layer **203** on the other surface, which is opposite to the first glass substrate **201**, of the first electrode **202**. Thereafter, the second electrode **204** is formed as shown in FIG. **5**B. The sequence of the formation can be switched. Please refer to FIG. **5**B, it shows the second electrode **204** structure. The second electrode **204** is formed on the surface, which is opposite to the first electrode, of the isolation layer **203**. The second electrode **204** is formed by ITO thin film with square frame. Pluralities of titled lines are constructed within the square frame. Namely, the pattern is formed with pluralities of titled lines. The third electrode **208** is formed between the second glass substrate **209** and the second alignment **207**. The third electrode **208** is formed with ITO thin film which is coated on the entire surface of the second glass substrate **209**.

[0038] The different electrode pattern in accompany with the different voltage is illustrated for the first electrode **202**, the second electrode **204** and the third electrode **208** to achieve the purpose of switching among the two-dimension, the three-dimension and the IP stereo image. In one embodiment, the first voltage is around ±1 volt ~±100 volts; When the IP stereo image is displayed, the voltage providing device **400** may let the potential of the second electrode **204** is ground; and offers a second voltage on the first electrode **201** and the third electrode **208**, the second voltage is around ±1 volt ~±100 volts. Therefore, the present invention may allow the liquid crystal layer **206** creates visual different grating or optical grating when the three-dimension image is display; while the liquid crystal layer **206** creates fly eye lens when the IP stereo image is display. It should be noted that the second voltage is higher than the first voltage.

[0039] Therefore, the present invention may perform the display of 2D, 3D or IP stereo image by using the image mode switch device **200** to allow the user display any type of image, and display the clear 2D, 3D or IP stereo image through the image mode switch device **200** and the display device **300**.

[0040] The foregoing description is a preferred embodiment of the present invention. It should be appreciated that this embodiment is described for purposes of illustration only, not for limiting, and that numerous alterations and modifications may be practiced by those skilled in the art without departing from the spirit and scope of the invention. It is intended that all such modifications and alterations are included insofar as they come within the scope of the invention as claimed or the equivalents thereof.

What is claimed is:

1. A display apparatus with display switching mode comprising:

a display device;

an image mode switch device formed corresponding to said display device, wherein said image mode switch device includes: a liquid crystal layer; a first electrode set on a side of said liquid crystal layer; a second electrode set between said first electrode and said liquid crystal layer; a third electrode set on another side of said liquid crystal layer; and

a voltage providing device electrically coupled to said image mode switch device to supply different voltage to said first electrode, said second electrode and said third electrode for switching displaying mode;

wherein said first electrode includes a first pattern, said second electrode including a second pattern having a first portion and a second portion, wherein said first portion and said second portion have different pattern spacing and are constructed by an interdigitated configuration.

2. The apparatus of claim **1**, wherein a spacing of said second portion is wider than the one of said first portion.

3. The apparatus of claim **1**, wherein a spacing wide of said second portion arranges two vertical lines of said first portion with equal spacing.

4. The apparatus of claim **1**, wherein said first electrode, said second electrode and said third electrode are ground when said display apparatus displays two-dimension image.

5. The apparatus of claim **1**, wherein said first electrode is ground, said second electrode and said third electrode being supplied with a first voltage when said display apparatus displays three-dimension image.

6. The apparatus of claim **1**, wherein said first electrode and said third electrode are supplied with a second voltage, and said second portion of said second electrode and said third electrode being supplied with a third voltage, said first potion of said second electrode being ground when said display apparatus displays a stereo image.

7. The apparatus of claim **1**, wherein said first electrode, said second electrode and said third electrode are formed with ITO.

8. The apparatus of claim **1**, wherein said first electrode, said second electrode and said third electrode are formed with IZO.

9. A display apparatus with display switching mode comprising:

a display device;

an image mode switch device formed corresponding to said display device, wherein said image mode switch device includes: a liquid crystal layer; a first electrode set on a side of said liquid crystal layer; a second electrode set between said first electrode and said liquid crystal layer; a third electrode set on another side of said liquid crystal layer; and

a voltage providing device electrically coupled to said image mode switch device to supply different voltage to said first electrode, said second electrode and said third electrode for switching displaying mode;

wherein said first electrode includes a first pattern, said first pattern being constructed by a grid pattern with pluralities of square frames; said second electrode includes a second pattern constructing by pluralities of titled lines.

10. The apparatus of claim **9**, wherein said square frame is formed with 1×1 to 500×500 pixels.

11. The apparatus of claim **9**, wherein said first electrode, said second electrode and said third electrode are ground when said display apparatus displays two-dimension image.

12. The apparatus of claim **9**, wherein said first electrode is ground, said second electrode and said third electrode being supplied with a first voltage when said display apparatus displays a stereo image.

13. The apparatus of claim **9**, wherein said first electrode and said third electrode are supplied with a second voltage, and said third electrode being ground when said display apparatus displays a stereo image.

14. The apparatus of claim **9**, wherein said first electrode, said second electrode and said third electrode are formed with ITO.

15. The apparatus of claim **9**, wherein said first electrode, said second electrode and said third electrode are formed with IZO.

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专利名称(译)	具有显示切换模式的显示装置		
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摘要(译)

本发明公开了一种具有显示切换模式的显示装置，该显示装置包括显示装置;对应于显示装置形成的图像模式切换装置，其中图像模式切换装置包括：液晶层;第一电极设置在液晶层的一侧;第二电极设置在第一电极和液晶层之间;第三电极设置在液晶层的另一侧;电压提供装置，电连接到图像模式开关装置，以向第一电极，第二电极和第三电极提供不同的电压，用于切换显示模式;显示装置可以通过在第一电极，第二电极和第三电极上使用具有不同图案和电压的电极来显示2D，3D和IP立体图像。