



(51) International Patent Classification:

G02F 1/133 (2006.01) **G09G 3/36** (2006.01)
G09G 3/20 (2006.01)

(21) International Application Number:

PCT/JP2011/055178

(22) International Filing Date:

1 March 2011 (01.03.2011)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

12/660,872 5 March 2010 (05.03.2010) US

(71) Applicant (for all designated States except US): **SHARP KABUSHIKI KAISHA** [JP/JP]; 22-22, Nagaike-cho, Abeno-ku, Osaka-shi, Osaka, 5458522 (JP).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **KEROFSKY, Louis Joseph**.

(74) Agent: **HARAKENZO WORLD PATENT & TRADE-MARK**; Daiwa Minamimorimachi Building, 2-6, Tenjin-bashi 2-chome Kita, Kita-ku, Osaka-shi, Osaka, 5300041 (JP).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

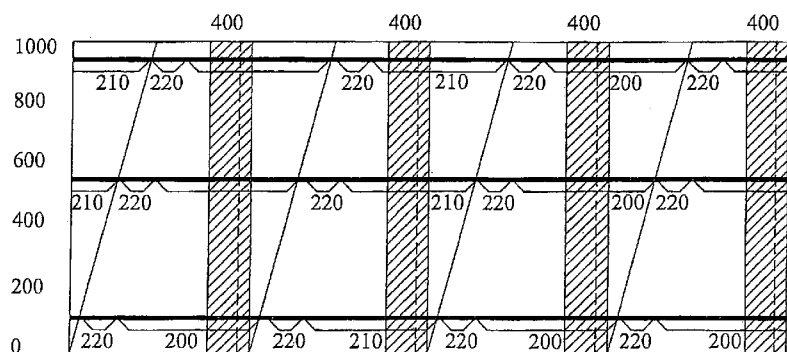
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: METHOD AND DISPLAY DEVICE FOR A CROSS TALK REDUCTION TECHNIQUE

FIG. 6



(57) Abstract: A method for reducing cross talk for a video displayed on a liquid crystal display includes addressing a portion of the liquid crystal display with data for first and second frames for a first image and a second image of a stereoscopic pair of images while a backlight of the liquid crystal display is free from illuminating the liquid crystal display. Illuminating the addressed portion of the display for the first image and the second image with the backlight after the addressing of the liquid crystal display. Wherein the addressing and the illumination occurs within respective frames of the video. A display device can also be used with the methods for reducing cross talk for a video displayed on a liquid crystal display.

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DESCRIPTION

TITLE OF INVENTION: METHOD AND DISPLAY DEVICE FOR A
CROSS TALK REDUCTION TECHNIQUE

TECHNICAL FIELD

5 The present invention relates generally to a method and
a display device for a stereoscopic display which provides
different views to each eye of a viewer. More specifically,
views are interleaved temporally alternating between eyes of a
viewer wearing active glasses which alternately block an
10 individual eye in synchronicity with the alternating frame
displayed by the display.

BACKGROUND ART

15 A stereoscopic three dimensional display typically
provides a viewer with parallax images in a time sequential
manner from the right eye viewpoint and the left eye
viewpoint. There are two principal techniques to provide the
two eyes of the viewer with the images. One technique
utilizes three dimensional glasses which selectively transmit
20 light to the viewer's eyes in synchronization with the left and
right images. Another technique utilizes a right eye viewpoint
and a left eye viewpoint that are alternatively displayed to the
respective eyes of the viewer but without using glasses.

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A liquid crystal display (LCD) is a sample and hold device, where the image at any pixel of the display is stable until that pixel is updated at the next image refresh time. In such a sample and hold display, requires careful timing sequencing of the light sources so that, for example, the left eye image light source is not on during the display of data for the right eye and vice versa. Typically, cross talk results from simultaneously viewing portions of the left and right images.

The foregoing and other objectives, features, and advantages of the invention will be more readily understood upon consideration of the following detailed description of the invention, taken in conjunction with the accompanying drawings.

SUMMARY OF INVENTION

Some embodiments of the present invention disclose a method for reducing cross talk for a video displayed on a liquid crystal display. The method comprises (a) addressing a portion of the liquid crystal display with data for viewing a first frame for a first image of a stereoscopic pair of images while a backlight of the liquid crystal display is free from illuminating the liquid crystal display; (b) illuminating the addressed portion of the liquid crystal display for the first image with the backlight after the addressing of the portion of

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the liquid crystal display; wherein the addressing and the illuminating for the first image occurs within a single frame of the video; (c) addressing a portion of the liquid crystal display with data for viewing a second frame for a second image of the stereoscopic pair of images while the backlight of the liquid crystal display is free from illuminating the liquid crystal display; (d) illuminating the addressed portion of the liquid crystal display for the second image with the backlight after the addressing of the portion of the liquid crystal display; wherein the addressing and the illuminating for the second image occurs within a single frame of the video. Some embodiments of the present invention disclose a display device for displaying a video with reduced cross talk on a liquid crystal display.

The display device comprises: a backlight for illuminating the liquid crystal display; a first addressing section for addressing a portion of the liquid crystal display with data for viewing a first frame for a first image of a stereoscopic pair of images while the backlight is free from illuminating the liquid crystal display; a first illuminating section for illuminating the addressed portion of the liquid crystal display for the first image with the backlight after the addressing of the portion of the liquid crystal display; wherein the addressing and the illuminating for the first image occurs within a single frame of the video; a second

addressing section for addressing a portion of the liquid crystal display with data for viewing a second frame for a second image of the stereoscopic pair of images while the backlight is free from illuminating the liquid crystal display; a
5 second illuminating section for illuminating the addressed portion of the liquid crystal display for the second image with the backlight after the addressing of the portion of the liquid crystal display; wherein the addressing and the illuminating for the second image occurs within a single frame of the video.

10 The foregoing and other objectives, features, and advantages of the invention will be more readily understood upon consideration of the following detailed description of the invention, taken in conjunction with the accompanying drawings.

15 BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 illustrates an active glass based stereoscopic display.

FIG. 2 illustrates a duty cycled lens.

20 FIG. 3 illustrates a display response.

FIG. 4 illustrates LCD addressing and response with interleaved views.

FIG. 5 illustrates cross talk with active glasses and LCD addressing.

25 FIG. 6 illustrates fast LCD addressing.

FIG. 7 illustrates parallel addressing from the center outward.

FIG. 8 illustrates a frame buffer.

FIG. 9 illustrates buffering with parallel addressing.

5 FIG. 10 illustrates addressing needs for parallel addressing.

FIG. 11 illustrates a liquid crystal display device.

DESCRIPTION OF EMBODIMENTS

10 Referring to Fig. 1, in order to provide a stereoscopic view, a display 10 may provide an alternating sequence of views 20. For example, the views may be a sequence of right, left, right, left, etc. In other cases, the views may be a sequence of right, right, left, left, right, right, left, left, etc.

15 Yet in other cases, the views may be a sequence of right, right, left, right, left, left, right, right, etc. Any other sequence of left and right images may likewise be used. In addition to providing the left and right images, a pair of active glasses 30 are provided, which are synchronized to the display in any

20 manner, such that they provide alternating views of a first image (a left view) to the left eye (or right eye) and a second image (a right view) to the right eye (or left eye). The first and second images are a stereoscopic pair of images. This is shown in Fig. 2 for a duty cycled lenses of active glasses 30,

25 where the left and the right lenses are open at different times.

In general it is desirable to reduce the cross talk between the views, e.g., some of the image intended for one eye is observed by the other eye, or some of the second image (or vice versa) is included with the desired first image (or vice versa) when viewed by the left eye (or right eye). One technique to attempt to reduce the cross talk between the eyes is to use active glasses with a very fast response time that is turned off and on and off very quickly. This reduces the time available for data from one view being passed to the unintended eye by reducing the number of lines with the opposite view. Due to addressing time limitations, the pixel data is not globally available for a single image at the same instant in time. This remains an issue even with glasses having instantaneous response.

Two fundamental issues of stereoscopic displays include reduction in brightness of each view as the available time for forming an image is decreased, and wasted energy used to generate light as the fraction of time when both lenses are closed.

It may be observed that the addressing and response time of the display are limitations to cross talk reduction. In a conventional liquid crystal display or other conventional displays (i.e. PDP or CRT) the image is not available at a single time but rather the image is drawn onto the display over a nonzero amount of time. Limitations on the addressing

circuitry and internal memory bandwidth dictate a non-zero addressing time for such a display. In general, displays may be further classified as hold type displays or impulsive type displays. In the hold type display, once the data is written to the pixels of the display, the value at the pixels are held until replaced by a different value at a temporally later time. In the impulsive type display, such as CRT or PDP, the data written to the pixels of the display are illuminated briefly after the pixel is written, then the pixels go dark. The impact of addressing schemes and the hold type display of an LCD is compared with an impulsive type display in FIG. 3. The horizontal axis is the display time assuming a 120Hz display, i.e. frame time of 8.3ms with each frame normally presented at 60Hz rate. The vertical axis shows the line of the display being addressed. As it may be observed, the addressing of the display occupies nearly all of the frame time with the exception of a small vertical blanking interval originally included to account for a retrace time inherent to CRT display technology.

Two sample lines are selected to show the difference in behavior of the response time and hold time of the LCD display, and the impulsive character of the CRT display. The LCD display is shown at roughly line 700. When the line is addressed by the addressing scheme 130, the LC begins to respond 100. The response time 100 is generally the time it

may take for the liquid crystal material to change its state to a new pixel value (the actual response time may be shorter or longer). After the response time 100, the display value is held 110 until it is addressed again. It is noted that the pixel values at line 700 are held until the line is readdressed, even though a new frame has begun as illustrated by the start of addressing of the first line of the display.

In contrast to the LCD hold type character, an impulsive type display is illustrated at roughly line 350. When the line is addressed, the display output 150 assumes the desired value very quickly. After a brief time 150, the addressed pixel ceases to emit light as indicated during the time 160.

Unfortunately, the hold type character of the display typically results in significant motion artifacts in comparison to the impulsive type display, when viewing stereoscopic content using active glasses. In order to reduce motion artifacts and reduce cross talk when viewing stereoscopic image content, the hold type characteristics of the display may be used to allow an entire frame of data to be available at the same time for each view of the stereoscopic display. The undesirable attributes of the hold type behavior of the display can be reduced by selectively illuminating the backlight during different time intervals. With a LCD display having a backlight that may illuminate different lines or groups of lines (less than all lines) in a sequential manner, the backlight is

illuminating the pixels only during or shortly after those lines have been addressed. Thus the lines with active backlight scroll vertically following the corresponding pixel addressing. This manner of illumination of a hold type display generally mimics an impulsive type display, although the LCD holds the addressed value which is only observed when the corresponding backlight region is illuminated. It is noted that a stereoscopic display based on active glasses is intrinsically a global process where an entire view is active at the same time.

Referring to FIG. 4, the impact of LCD addressing with active glasses used for a stereoscopic display is illustrated. The addressing and hold type display response is illustrated at three different lines. The horizontal axis is the display time assuming a 120Hz display, i.e. frame time of 8.3ms. The vertical axis shows the line of the display being addressed. The addressing occupies nearly all of the frame time with the exception of a small vertical blanking interval originally introduced to account for retrace of a CRT display. The three delineated lines are selected to illustrate the temporal offset of the corresponding displayed values resulting from the display addressing, the LC response time, and the hold effect. The display interleaves the left and right views temporally. The display has stable values for the left view 200. The display has stable values for the right view 210. There are

time periods between the stable left and the stable right views indicated as LC transition times 220. As illustrated, each line has a repetitive structure of the stable left view, the transition period, the stable right view, the transition period, etc. In addition, the different time periods are also temporally offset in time when different rows are addressed. By way of example, during the vertical blanking time 250, the lower lines have stabilized (200, 210) while the upper lines are still in transition (220). It may be observed that during any interval of time some lines are holding the left view, some lines are in the transition period, and some lines are holding the right view.

With the characteristics of the hold type display illustrated, the inclusion of active glasses 30 is illustrated in an attempt to isolate individual views for each eye. Referring to FIG. 5, the interaction of the duty cycle of the active glasses 30 is shown with respect to alternate views between the right eye and the left eye. FIG. 5 results from FIG. 4 being overlaid with data for the active time of the left lens 300 (ie. viewing a first frame for the first image) and the right lens 310 (ie. viewing a second frame for the second image) of the glasses 30. Cross talk can be seen for example when the left lens 300 is open but the line of the LCD is holding data intended for the right eye. This is seen for example on the upper line near 5 ms. Likewise cross talk through the right

lens 310 can be seen on the same line at 12ms. The unstable region of the LCD is visible where the middle line intersects the respective left open lens or right open lens. The cross talk of a particular line can be removed (or otherwise reduced) by adjusting the opening/closing time of each of the right eye lens and the left eye lens. However, similar cross talk will be caused at other lines in the display as a result. This cross talk effect cannot be eliminated as long as all the data for a single view is not on the display for the entire time the lens is open. Limits on the response time of the glasses and the delay of the LC addressing and response make cross talk inevitable. Faster glasses and shorter duty cycles can somewhat mitigate the effect but are limited in what they can achieve.

To reduce this inherent cross talk limitation a combination of LCD addressing and backlight addressing may be used. The LCD is addressed for a frame in a shorter time than typical, such as for example half a frame time, while the backlight is off. The backlight remains off until after the addressing has finished and the LC has had some time to respond to the new data. The backlight is turned on during the remaining portion of the frame, or a portion thereof. With this combination, the responsive demands on the active glasses may be reduced since the state of the right lens and/or the left lens is generally unimportant when the

backlight is turned off. The appropriate lens may begin to open as soon as the backlight from the previous alternate view is turned off. The appropriate lens does not need to stabilize until the backlight for the current frame is activated, typically over 1/4 a frame time later. Once the backlight is off, the lens does not need to close until the next backlight cycle, again typically more than 1/4 a frame later. Since the backlight is only generating light while a lens is open, there is less energy loss, in comparison to techniques which use excessively short duty cycles for the glasses with a backlight that is always on.

Referring to FIG. 6, an illustration of the limited duration backlight 400 with fast line addressing is shown. The vertical axis on the left indicates the line being addressed while the horizontal axis is the display time with 8.3ms corresponding to one frame at 120Hz. Note that the addressing completes in half a frame time and the backlight is off during the addressing and response time. The backlight 400 is shown with a 25% duty cycle and is active in the last 25% of the frame. In this example, only data from a single view is present on the display when the backlight is active.

The fast addressing technique may require the line addressing to operate at a higher rate than it would otherwise operate, such as twice the rate. Another approach is to operate multiple addressing circuits in a parallel fashion to

address the same total number of lines in less time, such as twice the addressing circuits addressing the lines in half the time. This approach reduces the operating speed since the line addressing elements may operate at a lower rate.

5 Referring to FIG. 7, the addressing technique preferably starts from the center of the display outward, i.e. one starts at the center 500 and goes down 510 while the other starts at the center 500 and goes up 520. Starting at the center permits the center portions of the screen a longer time to respond
10 before the backlight is activated, thus possibly reducing artifacts that would have otherwise occurred if such a longer time was not provided.

Referring to FIG. 8, with both "fast" addressing and/or parallel addressing there is a need to buffer data. In general,
15 a half frame of buffered data is sufficient for either approach. With the fast addressing approach, half a frame is buffered before the output begins removing data from the buffer and writing the data to the display. Once the buffer is full, the output begins removing data at a rate twice the rate at which
20 data enters the buffer. After half a frame time of addressing an entire frame has been written to the display and the buffer is emptied. The process repeats for the next frame with half of the frame buffered before beginning to empty the frame at twice the input rate. In addition to the $1/2$ frame buffer, the
25 fast addressing may use line and column addressing which

can operate at twice the typical rate.

Referring to FIG. 9, with the parallel addressing approach, half a frame is buffered before output begins removing data from the buffer and writing it to the display.

5 Once the buffer is full, two addressing operations run in parallel. One process copies data from the buffer to the display. In a preferred embodiment this data is copied from the middle outward. The second process takes data directly from the source and directs it to the display. After half a
10 frame time, the buffer is empty and the source has completed an entire frame. The process begins again by buffering the first half of the next frame.

Referring to FIG. 10, in addition to the buffer, the parallel approach may generate two lines of addressing
15 signals. The column addressing signal can be shared. The line addressing signals may be derived from a common source operating at normal speed but for only half time. Offsets to the value may be used to generate the two parallel addressing signals. The column addressing can be shared. Note that the
20 speed of the addressing circuits is not increased compared to a traditional solution.

The above mentioned methods for displaying a video with reduced cross talk on a liquid crystal display can also be implemented using a display device. Fig. 11 shows such a
25 display device 10 that comprises a liquid crystal display 50

and a backlight 40 for illuminating the liquid crystal display 50.

5 The display device 10 also includes a first addressing section 12 for addressing a portion of the liquid crystal display 50 with data for viewing a first frame for a first image of a stereoscopic pair of images while the backlight 40 is free from illuminating the liquid crystal display 50.

10 The display device 10 also includes a first illuminating section 16 for illuminating the address portion of the liquid crystal display for the first image with the backlight 40 after the addressing of the portion of the liquid crystal display 50. The addressing and the illuminating for the first image may occur within a single frame of the video.

15 The display device 10 also includes a second addressing section 14 for addressing a portion of the liquid crystal display 50 with data for viewing a second frame for a second image of the stereoscopic pair of images while the backlight 40 is free from illuminating the liquid crystal display 50.

20 The display device 10 also includes a second illuminating section 18 for illuminating said addressed portion of the liquid crystal display for the second image with the backlight 40 after the addressing of the portion of the liquid crystal display 50. The addressing and the illuminating for the second image may occur within a single frame of the video.

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5 The terms and expressions which have been employed in the foregoing specification are used therein as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described or portions thereof, it being recognized that the scope of the invention is defined and limited only by the claims which follow.

CLAIMS

1. A method for reducing cross talk for a video displayed on a liquid crystal display comprising:

5 (a) addressing a portion of said liquid crystal display with data for viewing a first frame for a first image of a stereoscopic pair of images while a backlight of said liquid crystal display is free from illuminating said liquid crystal display;

10 (b) illuminating said addressed portion of said liquid crystal display for said first image with said backlight after said addressing of said portion of said liquid crystal display; wherein said addressing and said illuminating for said first image occurs within a single frame of said video;

15 (c) addressing a portion of said liquid crystal display with data for viewing a second frame for a second image of said stereoscopic pair of images while said backlight of said liquid crystal display is free from illuminating said liquid crystal display;

20 (d) illuminating said addressed portion of said liquid crystal display for said second image with said backlight after said addressing of said portion of said liquid crystal display; wherein said addressing and said illuminating for said second image occurs within a single frame of said video.

2. The method of claim 1 wherein said addressing for said first image addresses all of the pixels for said first image.

3. The method of claim 2 wherein said addressing for said second image addresses all of the pixels for said second image.

4. The method of claim 2 wherein said illuminating for said first image illuminates all of said pixels for said first image.

5. The method of claim 4 wherein said illuminating for said second image illuminates all of said pixels for said second image.

6. The method of claim 1 wherein said stereoscopic pair of images is viewed with active glasses that are synchronized to said illuminating of said first image and said second image.

7. The method of claim 1 wherein said addressing for said first image addresses all of the pixels for said first image; said addressing for said second image addresses all of the pixels for said second image; said illuminating for said first image illuminates all of said pixels for said first image;

and said illuminating for said second image illuminates all of said pixels for said second image.

8. The method of claim 1 wherein said addressing of
5 said first image is performed in less than half a frame time of said video.

9. The method of claim 8 wherein said frame rate of
said video is 60Hz.

10. The method of claim 8 wherein said frame rate of
said video is 120Hz.

11. The method of claim 1 wherein said first image is
15 an image for viewing with the left eye of a viewer and said second image is an image for viewing with the right eye of said viewer.

12. The method of claim 1 wherein said first image is
20 an image for viewing with the right eye of a viewer and said second image is an image for viewing with the left eye of said viewer.

13. A display device for displaying a video with reduced
25 cross talk on a liquid crystal display, the display device

comprising:

a backlight for illuminating said liquid crystal display;

a first addressing section for addressing a portion of
said liquid crystal display with data for viewing a first frame
for a first image of a stereoscopic pair of images while said
backlight is free from illuminating said liquid crystal display;

a first illuminating section for illuminating said
addressed portion of said liquid crystal display for said first
image with said backlight after said addressing of said portion
of said liquid crystal display; wherein said addressing and
said illuminating for said first image occurs within a single
frame of said video;

a second addressing section for addressing a portion of
said liquid crystal display with data for viewing a second
frame for a second image of said stereoscopic pair of images
while said backlight is free from illuminating said liquid
crystal display;

a second illuminating section for illuminating said
addressed portion of said liquid crystal display for said
second image with said backlight after said addressing of said
portion of said liquid crystal display; wherein said addressing
and said illuminating for said second image occurs within a
single frame of said video.

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FIG. 1

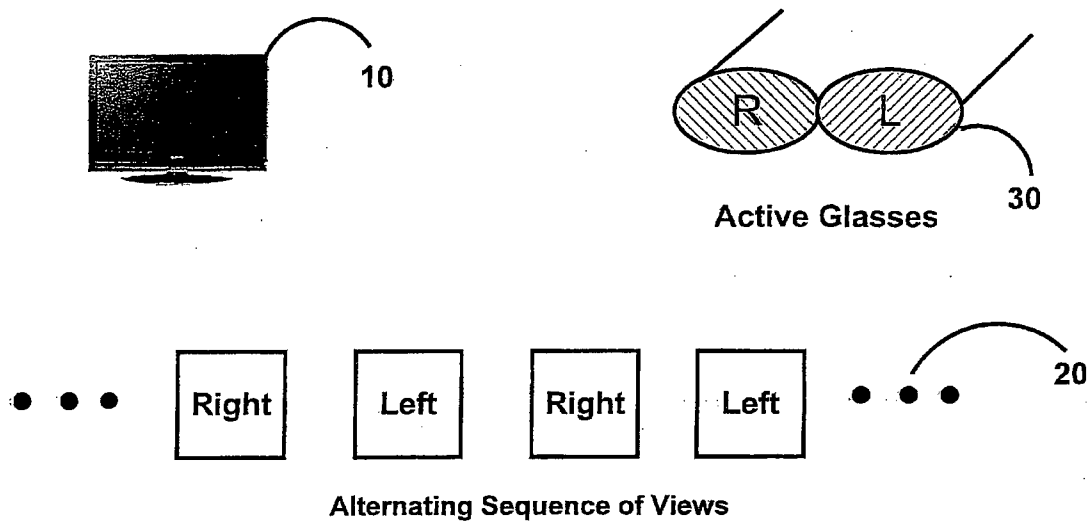
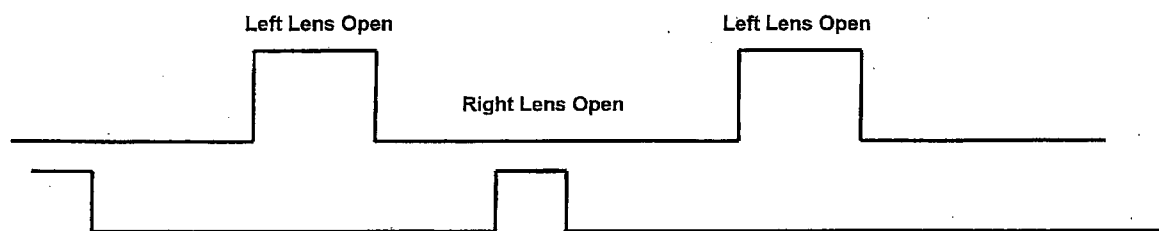


FIG. 2



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FIG. 3

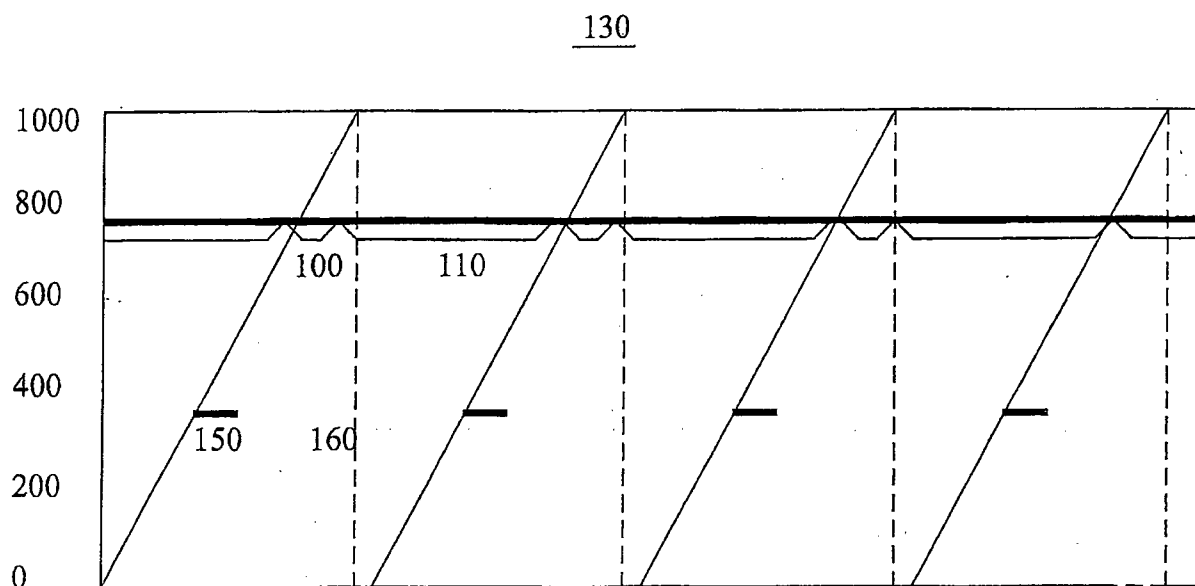
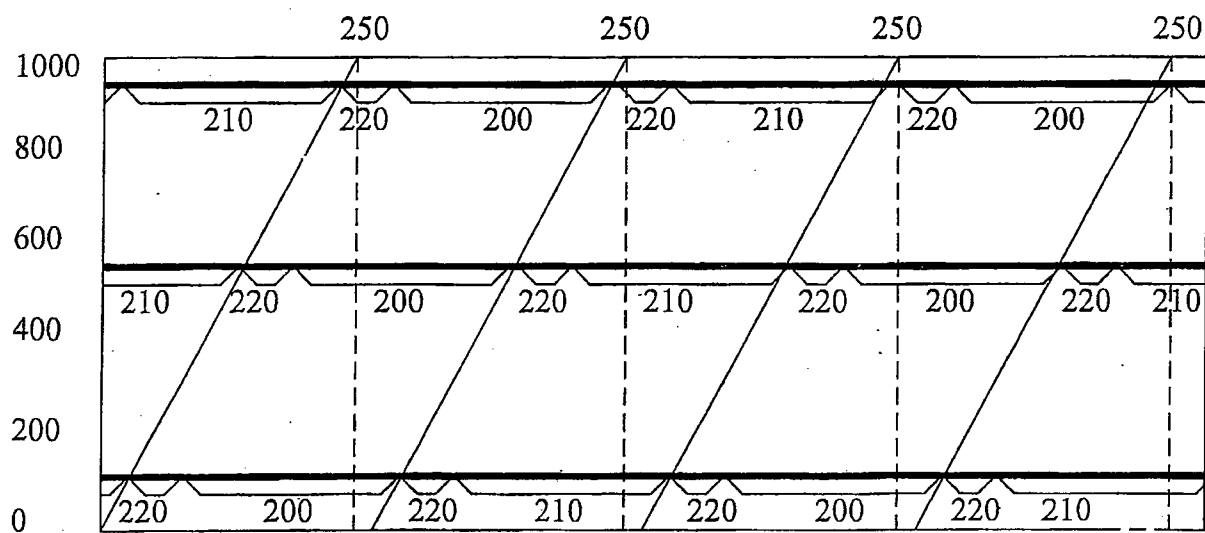


FIG. 4



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FIG. 5

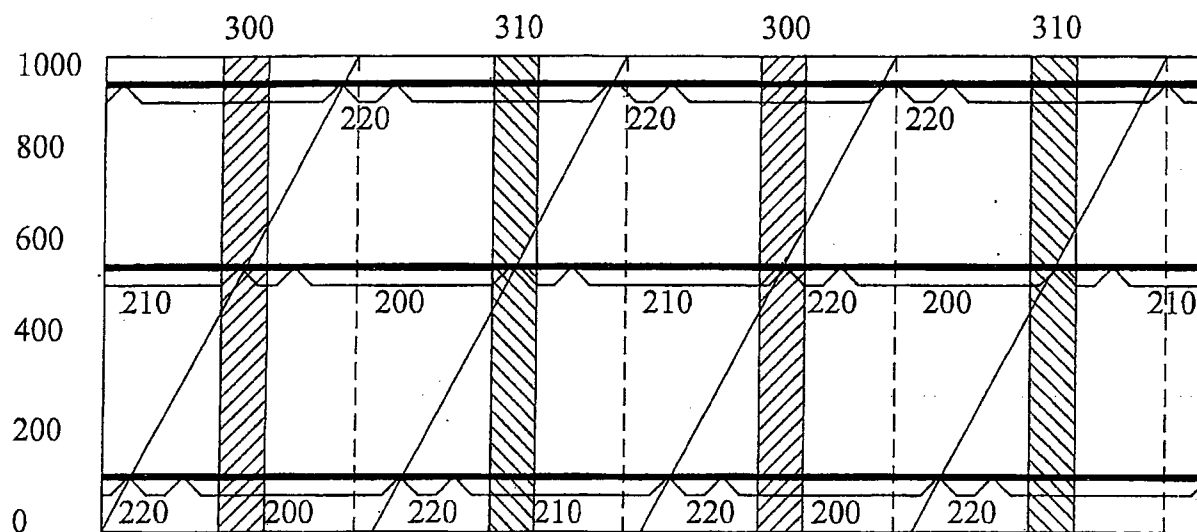
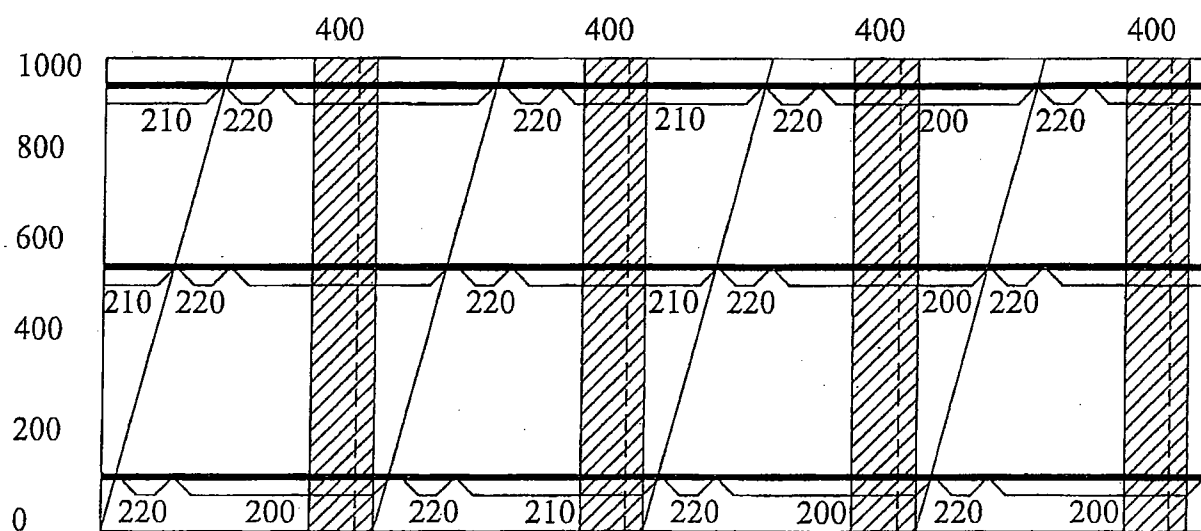


FIG. 6



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FIG. 7

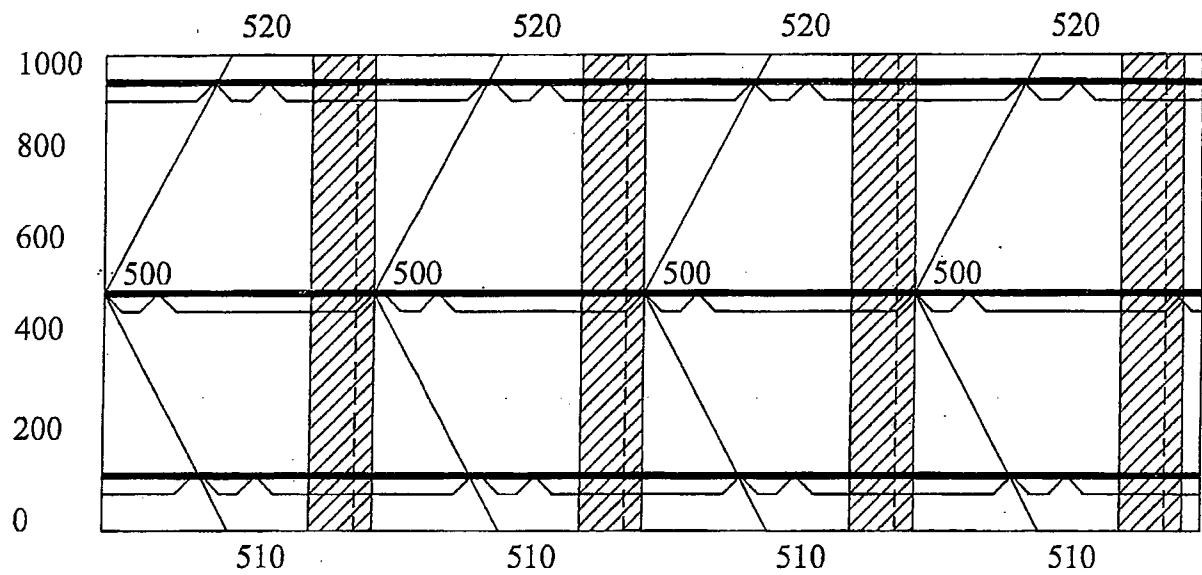
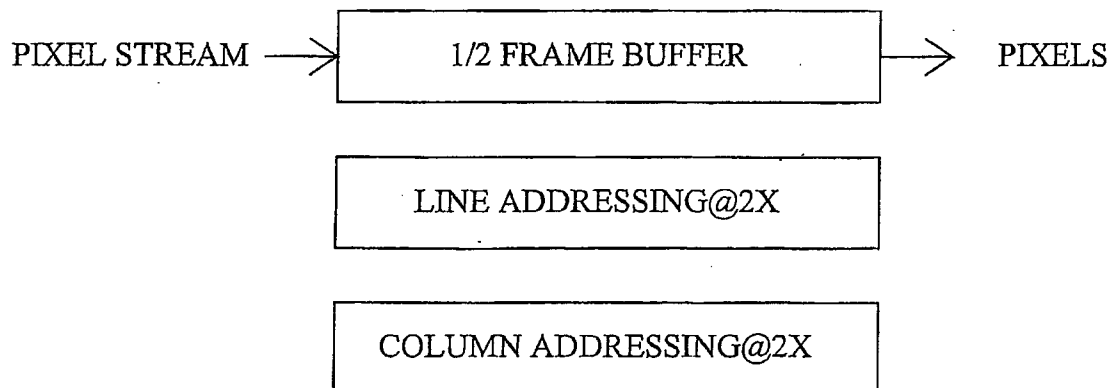


FIG. 8



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FIG. 9

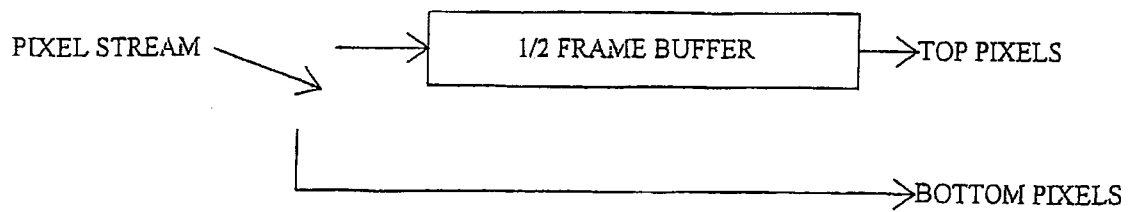


FIG. 10

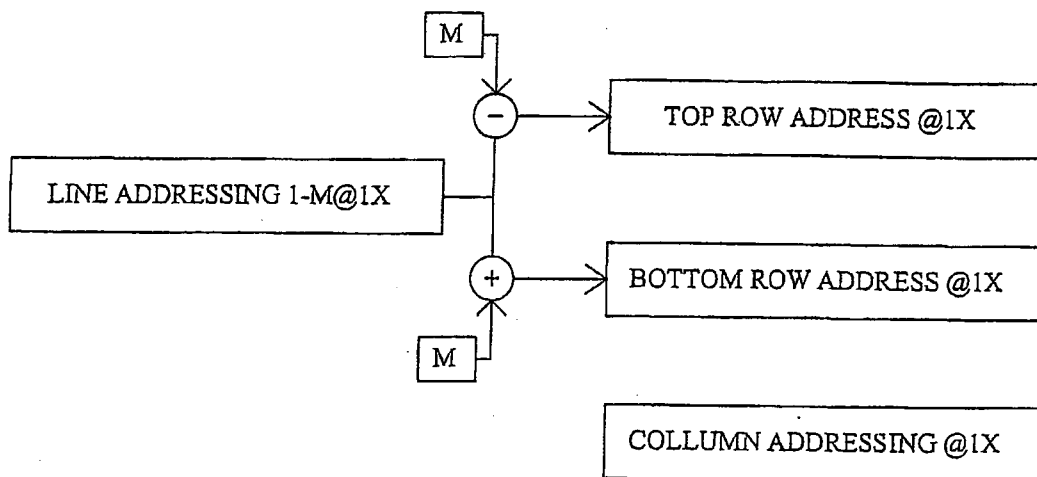
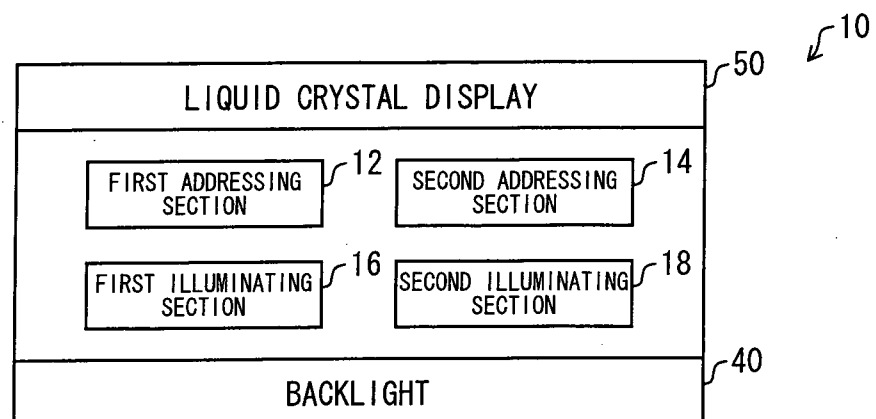


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/055178

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. G02F1/133 (2006.01) i, G09G3/20 (2006.01) i, G09G3/36 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. G02F1/133, G09G3/20, G09G3/36

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

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2011
 Registered utility model specifications of Japan 1996-2011
 Published registered utility model applications of Japan 1994-2011

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2003-259395 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 2003.09.12, Fig.1-4 Family : none	1-13
X	JP 2006-157775 A (MITSUBISHI ELECTRIC CORPORATION) 2006.06.15, [0057], Fig.5 Family : none	1-5, 7, 13



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

23.03.2011

Date of mailing of the international search report

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Authorized officer

Yusuke Okuda

Telephone No. +81-3-3581-1101 Ext. 3293

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