(54) **Image degradation minimization in novel liquid crystal displays with split green subpixels**

Bildverschlechterungsminimierung in neuartigen Flüssigkristallanzeigen mit aufgeteilten grünen Subpixeln

Minimalisation de la dégradation des images dans de nouveaux affichages à cristaux liquides avec sous-pixels verts divisés

(72) Inventors:
• **Credelle, Thomas, Lloyd**
Morgan Hill, CA 95037 (US)
• **Stewart, Roger, Green**
Hillsborough, NJ 08844 (US)

(74) Representative: **Boult Wade Tennant**
Verulam Gardens
70 Gray's Inn Road
London WC1X 8BT (GB)

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US-B1- 6 335 719   US-B1- 6 552 706

EP 2 267 693 B1

Description

BACKGROUND

[0001] In commonly owned United States Patent Applications: (1) United States Patent Application Serial No. 09/916,232 ("the '232 application"), entitled "ARRANGEMENT OF COLOR PIXELS FOR FULL COLOR IMAGING DEVICES WITH SIMPLIFIED ADDRESSING," filed July 25, 2001; (2) United States Patent Application Serial No. 10/278,353 ("the '353 application"), entitled "IMPROVEMENTS TO COLOR FLAT PANEL DISPLAY SUB-PIXEL ARRANGEMENTS AND LAYOUTS FOR SUB-PIXEL RENDERING WITH INCREASED MODULATION TRANSFER FUNCTION RESPONSE," filed October 22, 2002; (3) United States Patent Application Serial No. 10/278,352 ("the '352 application"), entitled "IMPROVEMENTS TO COLOR FLAT PANEL DISPLAY SUB-PIXEL ARRANGEMENTS AND LAYOUTS FOR SUB-PIXEL RENDERING WITH SPLIT BLUE SUB-PIXELS," filed October 22, 2002; (4) United States Patent Application Serial No. 10/243,094 ("the '094 application), entitled "IMPROVED FOUR COLOR ARRANGEMENTS AND EMITTERS FOR SUB-PIXEL RENDERING," filed September 13, 2002; (5) United States Patent Application Serial No. 10/278,328 ("the '328 application"), entitled "IMPROVEMENTS TO COLOR FLAT PANEL DISPLAY SUB-PIXEL ARRANGEMENTS AND LAYOUTS WITH REDUCED BLUE LUMINANCE WELL VISIBILITY," filed October 22, 2002; (6) United States Patent Application Serial No. 10/278,393 ("the '393 application"), entitled "COLOR DISPLAY HAVING HORIZONTAL SUB-PIXEL ARRANGEMENTS AND LAYOUTS," filed October 22, 2002; (7) United States Patent Application Serial No. 01/347,001 ("the '001 application") entitled "IMPROVED SUB-PIXEL ARRANGEMENTS FOR STRIPED DISPLAYS AND METHODS AND SYSTEMS FOR SUB-PIXEL RENDERING SAME," filed January 16, 2003, novel sub-pixel arrangements are disclosed for improving the cost/performance curves for image display devices.

[0002] These improvements are particularly pronounced when coupled with sub-pixel rendering (SPR) systems and methods further disclosed in those applications and in commonly owned United States Patent Applications: (1) United States Patent Application Serial No. 10/051,612 ("the '612 application"), entitled "CONVERSION OF RGB PIXEL FORMAT DATA TO PENTILE MATRIX SUB-PIXEL DATA FORMAT," filed January 16, 2002; (2) United States Patent Application Serial No. 10/150,355 ("the '355 application"), entitled "METHODS AND SYSTEMS FOR SUB-PIXEL RENDERING WITH GAMMA ADJUSTMENT," filed May 17, 2002; (3) United States Patent Application Serial No. 10/215,843 ("the '843 application"), entitled "METHODS AND SYSTEMS FOR SUB-PIXEL RENDERING WITH ADAPTIVE FILTERING," filed August 8, 2002; (4) United States Patent

Application Serial No. 10/379,767 entitled "SYSTEMS AND METHODS FOR TEMPORAL SUB-PIXEL RENDERING OF IMAGE DATA" filed March 4, 2003; (5) United States Patent Application Serial No. 10/379,765 entitled "SYSTEMS AND METHODS FOR MOTION ADAPTIVE FILTERING," filed March 4, 2003; (6) United States Patent Application Serial No. 10/379,766 entitled "SUB-PIXEL RENDERING SYSTEM AND METHOD FOR IMPROVED DISPLAY VIEWING ANGLES" filed March 4, 2003; (7) United States Patent Application Serial No. 10/409,413 entitled "IMAGE DATA SET WITH EMBEDDED PRE-SUBPIXEL RENDERED IMAGE" filed April 7, 2003.

[0003] The present application is related to commonly owned United States Patent Applications: (1) United States Patent Application Serial No. 10/455,925 entitled "DISPLAY PANEL HAVING CROSSOVER CONNECTIONS EFFECTING DOT INVERSION", filed on June 6, 2003; (2) United States Patent Application Serial No. 10/455,931 entitled "SYSTEM AND METHOD OF PERFORMING DOT INVERSION WITH STANDARD DRIVERS AND BACKPLANE ON NOVEL DISPLAY PANEL LAYOUTS", filed on June 6, 2003; (3) United States Patent Application Serial No. 10/455,927 entitled "SYSTEM AND METHOD FOR COMPENSATING FOR VISUAL EFFECTS UPON PANELS HAVING FIXED PATTERN NOISE WITH REDUCED QUANTIZATION ERROR", filed on June 6, 2003; (4) United States Patent Application Serial No. 10/456,806 entitled "DOT INVERSION ON NOVEL DISPLAY PANEL LAYOUTS WITH EXTRA DRIVERS", filed on June 6, 2003; and (5) United States Patent Application Serial No. 10/456,838 entitled "LIQUID CRYSTAL DISPLAY BACKPLANE LAYOUTS AND ADDRESSING FOR NON-STANDARD SUBPIXEL ARRANGEMENTS".

US 2003/0090581 discloses a display comprising a plurality of a subpixel group, said subpixel group comprising a plurality of subpixels wherein each subpixel has a height along a vertical axis and a width along a horizontal axis, the width being greater in length than the height.

[0004] The invention is defined by the appending claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The accompanying drawings, which are incorporated in, and constitute a part of this specification, illustrate exemplary implementations and embodiments of the invention and, together with the description, serve to explain principles of the invention.

[0006] **FIG. 1A** shows a conventional RGB stripe panel having a 1x1 dot inversion scheme.

[0007] **FIG. 1B** shows a conventional RGB stripe panel having a 1x2 dot inversion scheme.

[0008] **FIG. 2** shows a panel having a novel subpixel repeating group with an even number of pixels in a first (row) direction.

[0009] **FIG. 3** depicts a panel having the repeating

grouping of **FIG. 2** with multiple standard driver chips wherein any degradation of the image is placed onto the blue subpixels.

[0010] **FIG. 4** depicts the phase relationships for the multiple driver chips of **FIG. 3**.

[0011] **FIG. 5** depicts a panel having the subpixel repeating group of **FIG. 2** wherein the driver chip driving the panel is a 4-phase chip wherein any degradation of the image is placed onto the blue subpixels.

[0012] **FIG. 6** depicts a panel having a subpixel repeating group having two narrow columns of blue subpixels wherein substantially all or most of the degradation of the image is placed onto the narrow blue subpixel columns.

DETAILED DESCRIPTION

[0013] Reference will now be made in detail to implementations and embodiments, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0014] **FIG**. **1A** shows a conventional RGB stripe structure on panel 100 for an Active Matrix Liquid Crystal Display (AMLCD) having thin film transistors (TFTs) 116 to activate individual colored subpixels - red 104, green 106 and blue 108 subpixels respectively. As may be seen, a red, a green and a blue subpixel form a repeating group of subpixels 102 that comprise the panel.

[0015] As also shown, each subpixel is connected to a column line (each driven by a column driver 110) and a row line (e.g. 112 and 114). In the field of AMLCD panels, it is known to drive the panel with a dot inversion scheme to reduce crosstalk or flicker. **FIG. 1A** depicts one particular dot inversion scheme - i.e. 1x1 dot inversion - that is indicated by a "+" and a "-" polarity given in the center of each subpixel. Each row line is typically connected to a gate (not shown in **FIG. 1A)** of TFT 116. Image data - delivered via the column lines - are typically connected to the source of each TFT. Image data is written to the panel a row at a time and is given a polarity bias scheme as indicated herein as either ODD ("O") or EVEN ("E") schemes. As shown, row 112 is being written with ODD polarity scheme at a given time while row 114 is being written with EVEN polarity scheme at a next time. The polarities alternate ODD and EVEN schemes a row at a time in this 1x1 dot inversion scheme.

[0016] **FIG. 1B** depicts another conventional RGB stripe panel having another dot inversion scheme - i.e. 1x2 dot inversion. Here, the polarity scheme changes over the course of two rows - as opposed to every row, as in 1x1 dot inversion. In both dot inversion schemes, a few observations are noted: (1) in 1x1 dot inversion, every two physically adjacent subpixels (in both the horizontal and vertical direction) are of different polarity; (2) in 1x2 dot inversion, every two physically adjacent subpixels in the horizontal direction are of different polarity; (3) across any given row, each successive colored sub-

pixel has an opposite polarity to its neighbor. Thus, for example, two successive red subpixels along a row will be either (+,-) or (-,+). Of course, in 1x1 dot inversion, two successive red subpixels along a column will have opposite polarity; whereas in 1x2 dot inversion, each group of two successive red subpixels will have opposite polarity. This changing of polarity decreases noticeable visual effects that occur with particular images rendered upon an AMLCD panel.

[0017] **FIG. 2** shows a panel comprising a repeat subpixel grouping 202, as further described in the '353 application. As may be seen, repeat subpixel grouping 202 is an eight subpixel repeat group, comprising a checkerboard of red and blue subpixels with two columns of reduced-area green subpixels in between. If the standard 1x1 dot inversion scheme is applied to a panel comprising such a repeat grouping (as shown in **FIG. 2**), then it becomes apparent that the property described above for RGB striped panels (namely, that successive colored pixels in a row and/or column have different polarities) is now violated. This condition may cause a number of visual defects noticed on the panel - particularly when certain image patterns are displayed. This observation also occurs with other novel subpixel repeat grouping -or example, the subpixel repeat grouping in **FIG. 1** of the '352 application - and other repeat groupings that are not an odd number of repeating subpixels across a row. Thus, as the traditional RGB striped panels have three such repeating subpixels in its repeat group (namely, R, G and B), these traditional panels do not necessarily violate the above noted conditions. However, the repeat grouping of **FIG. 2** in the present application has four (i.e. an even number) of subpixels in its repeat group across a row (e.g. R, G, B, and G).

[0018] To prevent visual degradation and other problems within AMLCDs, not only must the polarity of data line transitions be randomized along each select line, but the polarity of data line transitions must also be randomized also for each color and locality within the display. While this randomization occurs naturally with RGB triplet color sub-pixels in combination with commonly-used alternate column-inversion data driver systems, this is harder to accomplish when an even-number of sub-pixels are employed along row lines.

[0019] In one even modulo design, rows are formed from a combination of smaller green pixels and less-numerous-but-larger red and blue pixels. Normally, the polarity of data line transitions is reversed on alternate data lines so that each pixel is capacitively coupled about equally to the data lines on either side of it. This way, these capacitor-induced transient errors are about equal and opposite and tend to cancel one another out on the pixel itself. However in this case, the polarity of same-color subpixels is the same and image degradation can occur.

[0020] **FIG. 3** shows an even modulo pixel layout according to the present invention which utilizes 2x1 dot inversion. Vertical image degradation is eliminated since

same color pixels alternate in polarity. Horizontal image degradation due to same-color pixels is reduced by changing the phase of the dot inversion periodically. Driver chips 301A through D provide data to the display; the driver outputs are driven +,-,+,-,... or -,+,-,+,... The phasing of the polarity is shown in **FIG. 4** for the first 4 lines of the display. For example, the first column of chip 301B has the phase -,-,+,+,....

[0021] In one embodiment, a subpixel - bordered on either side by column lines driving the same polarity at a given time -- may suffer a decreased luminance for any given image signal. So, two goals are to reduce the number of effected subpixels -- and to reduce the image degradation effects of any particular subpixel that cannot avoid having been so impacted. Several techniques in this application and in other related applications incorporated herein are designed to minimize both the number and the effects of image degraded subpixels.

[0022] One such technique is to choose which subpixels are to be degraded, if degradation may not be avoided. In **FIG. 3,** the phasing is designed so as to localize the same-polarity occurrence on the circled blue subpixels 302. In this manner, the polarity of same color subpixels along a row is inverted every two driver chips, which will minimize or eliminate the horizontal image degradation. The periodic circled blue subpixels 302 will be slightly darker (i.e for normally-black LCD) or lighter (i.e. for normally-white LCD) than other blue subpixels in the array, but since the eye is not as sensitive to blue luminance changes, the difference should be substantially less visible.

[0023] Yet another technique is to add a correction signal to any effected subpixels. If it is known which subpixels are going to have image degradation, then it is possible to add a correction signal to the image data signal. For example, most of the parasitic capacitance mentioned in this and other applications tend to lower the amount of luminance for effected subpixels. It is possible to heuristically or empirically determine (e.g. by testing patterns on particular panels) the performance characteristics of subpixels upon the panel and add back a signal to correct for the degradation. In particular to Figure 3, if it is desired to correct the small error on the circled pixels, then a correction term can be added to the data for the circled blue subpixels.

[0024] In yet another embodiment of the present invention, it is possible to design different driver chips that will further abate the effects of image degradation. As shown in **FIG. 5,** a four-phase clock, for example, is used for polarity inversion. By the use of this pattern, or patterns similar, only the blue subpixels in the array will have the same-polarity degradation. However, since all pixels are equally degraded, it will be substantially less visible to the human eye. If desired, a correction signal can be applied to compensate for the darker or lighter blue subpixels.

[0025] These drive waveforms can be generated with a data driver chip that provides for a more complex power-supply switching system than employed in the relatively simple alternate polarity reversal designs. In this two-stage data driver design, the analog signals are generated as they are done now in the first stage. However, the polarity-switching stage is driven with its own cross-connection matrix in the second stage of the data driver to provide the more complex polarity inversions indicated.

[0026] Yet another embodiment of the techniques described herein is to localize the image degradation effect on a subset of blue subpixels across the panel in both the row and column directions. For example, a "checkerboard" of blue subpixels (i.e. skipping every other blue subpixel in either the row and/or column direction) might be used to localize the image degradation signal. As noted above, the human eye - with its decreased sensitivity in blue color spatial resolution - will be less likely to notice the error. It will be appreciated that other subsets of blue subpixels could be chosen to localize the error. Additionally, a different driver chip with four or fewer phases might be possible to drive such a panel.

[0027] **FIG. 6** is a comparative example of a panel 600 comprised substantially of a subpixel repeating group 602 of even modulo. In this case, group 602 is comprised of a checkerboard of red 104 and green 106 subpixels interspersed with two columns of blue 108 subpixels. As noted, it is possible (but not mandatory) to have the blue subpixels of smaller width than the red or the green subpixels. As may be seen, two neighboring columns of blue subpixels may share a same column driver through an interconnect 604, possibly with the TFTs of the blue subpixels appropriately remapped to avoid exact data value sharing.

[0028] With standard column drivers performing 2x1 dot inversion, it can be seen that blue subpixel column 606 has the same polarity as the column of red and green subpixels to its immediate right. Although this may induce image degradation (which may be compensated for with some correction signal), it is advantageous that the degradation is localized on the dark colored (e.g. blue) subpixel column; and, hence, less visible to the human eye.

Claims

1. A liquid crystal display comprising:

   a display panel with a subpixel matrix being formed by a repetition of a smallest subpixel repeating group of red, green and blue colored subpixels comprising an even number of subpixels in a row and a column of green subpixels; and
   a driver circuit configured to send image data signals of different polarities at a given time to the display panel such that blue subpixels and only blue subpixels of the subpixel matrix are bordered on either side by column lines driven

with data signals having the same polarity at a given time.

2. The liquid crystal display of claim 1, wherein the blue subpixels being bordered on either side by column lines driven with data signals having the same polarity at a given time are configured to receive a correction signal.

3. A method of driving a liquid crystal display, the liquid crystal display comprising:

a display panel with a subpixel matrix being formed by a repetition of a smallest subpixel repeating group of red, green and blue colored subpixels comprising an even number of subpixels in a row and a column of green subpixels; and

wherein the method comprises providing image data signals of different polarities at a given time to the display panel such that blue subpixels and only blue subpixels of the subpixel matrix are bordered on either side by column lines driven with data signals having the same polarity at a given time.

4. The method of claim 3 further comprising providing a correction signal to the blue subpixels being bordered on either side by column lines driven with data signals having the same polarity at a given time.

Patentansprüche

1. Flüssigkristallanzeige, die aufweist:

einen Bildschirm mit einer Subpixelmatrix, die durch Wiederholen einer kleinsten Subpixelwiederholgruppe aus rot-, grün- und blaufarbenen Subpixeln mit einer geraden Anzahl von Subpixeln in einer Zeile und einer Spalte mit grünen Subpixeln gebildet ist, und

eine Treiberschaltung, die so zum Senden von Bilddatensignalen unterschiedlicher Polaritäten zu einem festgelegten Zeitpunkt an den Bildschirm ausgebildet ist, dass blaue Subpixel und nur blaue Subpixel der Subpixelmatrix zu beiden Seiten von Spaltenleitungen eingefasst sind, die zu einem festgelegten Zeitpunkt mit Datensignalen gleicher Polarität angesteuert werden.

2. Flüssigkristallanzeige nach Anspruch 1, worin die blauen Subpixel, die zu beiden Seiten von Spaltenleitungen eingefasst sind, die zu einem festgelegten Zeitpunkt mit Datensignalen gleicher Polarität angesteuert werden, zum Empfangen eines Korrektursignals ausgebildet sind.

3. Verfahren zum Ansteuern einer Flüssigkristallanzeige, wobei die Flüssigkristallanzeige aufweist:

einen Bildschirm mit einer Subpixelmatrix, die durch Wiederholen einer kleinsten Subpixelwiederholgruppe aus rot-, grün- und blaufarbenen Subpixeln mit einer geraden Anzahl von Subpixeln in einer Zeile und einer Spalte mit grünen Subpixeln gebildet ist, und

wobei das Verfahren ein Versorgen des Bildschirms mit Bilddatensignalen unterschiedlicher Polarität zu einem festgelegten Zeitpunkt so umfasst, dass blaue Subpixel und nur blaue Subpixel der Subpixelmatrix zu beiden Seiten von Spaltenleitungen eingefasst sind, die zu einem festgelegten Zeitpunkt mit Datensignalen gleicher Polarität angesteuert werden.

4. Verfahren nach Anspruch 3, das ferner ein Versorgen der blauen Subpixel, die zu beiden Seiten von Spaltenleitungen eingefasst sind, die zu einem festgelegten Zeitpunkt mit Datensignalen gleicher Polarität angesteuert werden, mit einem Korrektursignal umfasst.

Revendications

1. Affichage à cristaux liquides comprenant :

un écran d'affichage avec une matrice de sous-pixels qui est formée par une répétition d'un plus petit groupe répétitif de sous-pixels contenant des sous-pixels de couleur rouge, verte et bleue comprenant un nombre pair de sous-pixels dans une ligne et une colonne de sous-pixels verts ; et un circuit pilote configuré de manière à envoyer des signaux de données d'image de différentes polarités, à un instant donné, à l'écran d'affichage, de sorte que des sous-pixels bleus et uniquement des sous-pixels bleus de la matrice de sous-pixels sont bordés de chaque côté par des lignes de colonnes pilotées au moyen de signaux de données présentant la même polarité à un instant donné.

2. Affichage à cristaux liquides selon la revendication 1, dans lequel les sous-pixels bleus bordés de chaque côté par des lignes de colonnes pilotées au moyen de signaux de données présentant la même polarité à un instant donné sont configurés de manière à recevoir un signal de correction.

3. Procédé de commande d'un affichage à cristaux liquides, l'affichage à cristaux liquides comprenant :

un écran d'affichage avec une matrice de sous-pixels qui est formée par une répétition d'un plus

petit groupe répétitif de sous-pixels contenant des sous-pixels de couleur rouge, verte et bleue comprenant un nombre pair de sous-pixels dans une ligne et une colonne de sous-pixels verts ; et dans lequel le procédé comporte l'étape consistant à fournir des signaux de données d'image de différentes polarités, à un instant donné, à l'écran d'affichage, de sorte que des sous-pixels bleus et uniquement des sous-pixels bleus de la matrice de sous-pixels sont bordés de chaque côté par des lignes de colonnes pilotées au moyen de signaux de données présentant la même polarité à un instant donné.

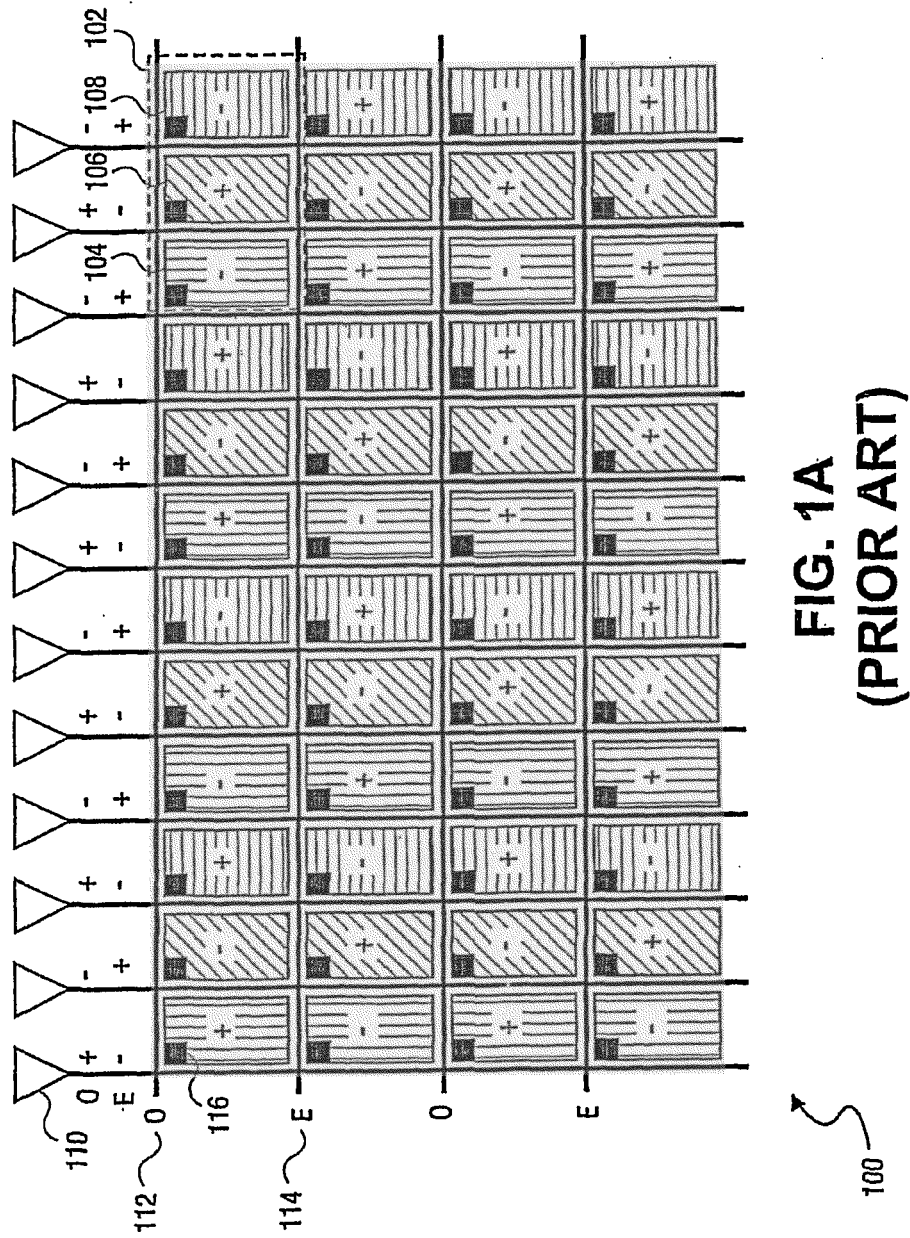**4.** Procédé selon la revendication 3, comprenant en outre l'étape consistant à fournir un signal de correction aux sous-pixels bleus bordés de chaque côté par des lignes de colonnes pilotées au moyen de signaux de données présentant la même polarité à un instant donné.
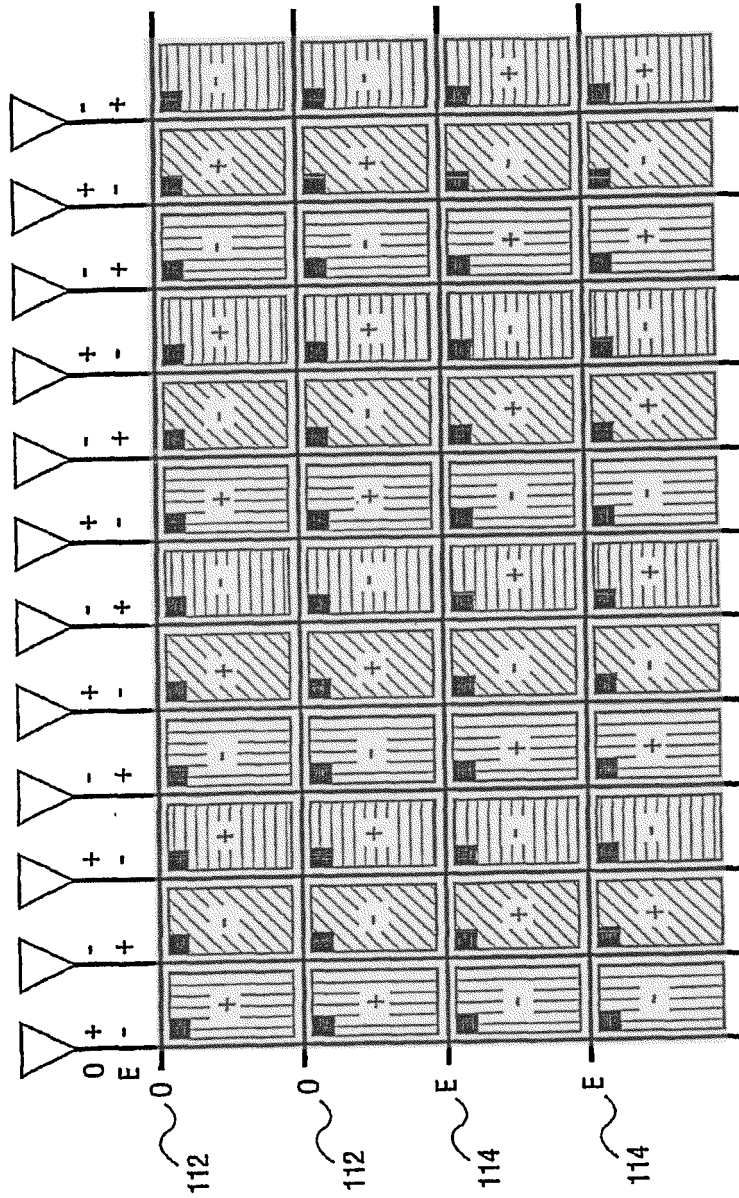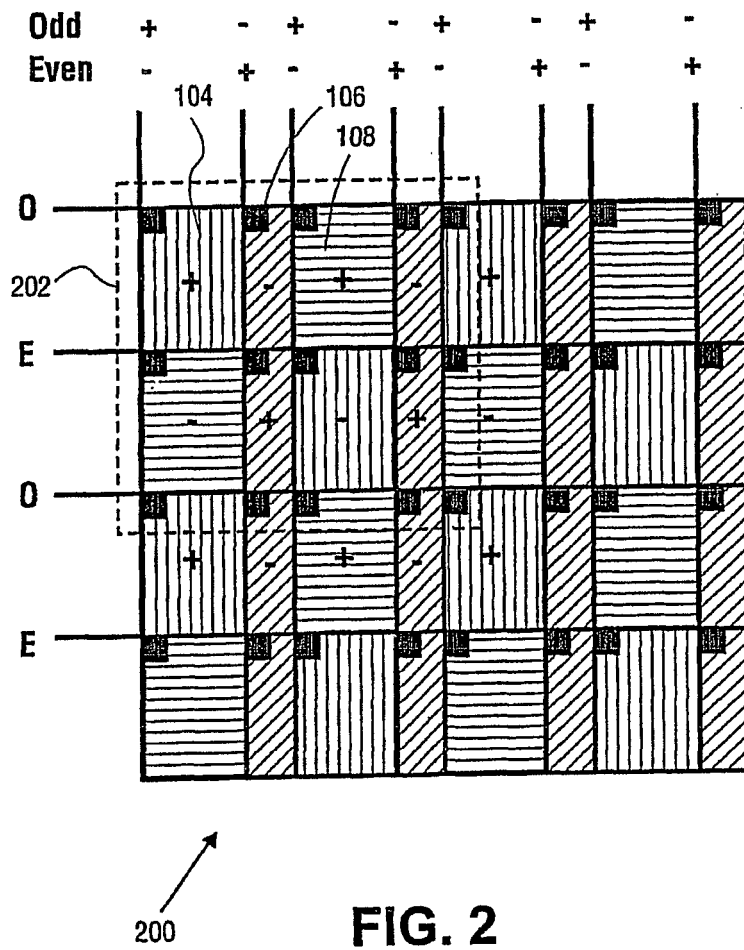
FIG. 1A
(PRIOR ART)

FIG. 1B
(PRIOR ART)

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FIG. 2
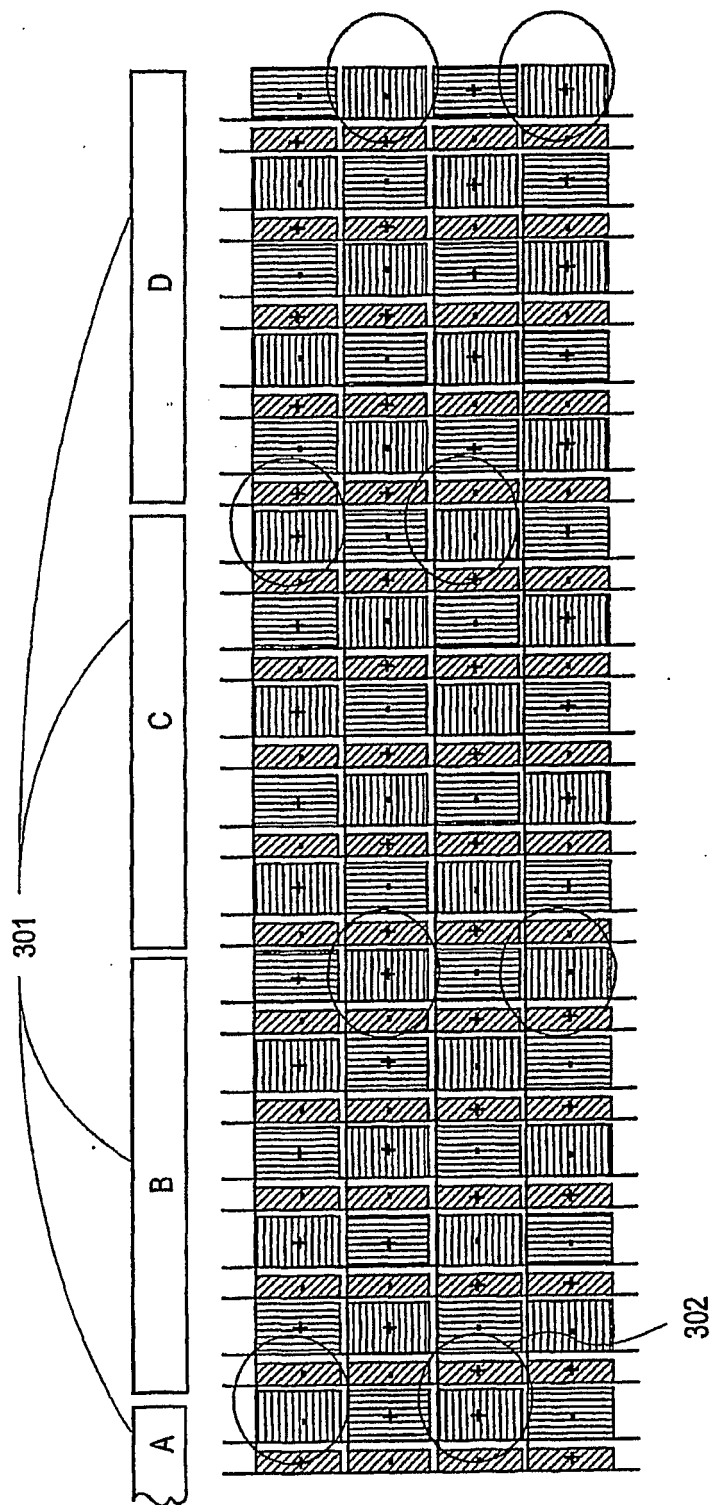
FIG. 3

	301A	301B	301C	301D	
1	+ -	- +	- +	+ -	• • • •
2	- +	- +	+ -	+ -	• • • •
3	- +	+ -	+ -	- +	• • • •
4	+ -	+ -	- +	- +	• • • •

FIG. 4

FIG. 5

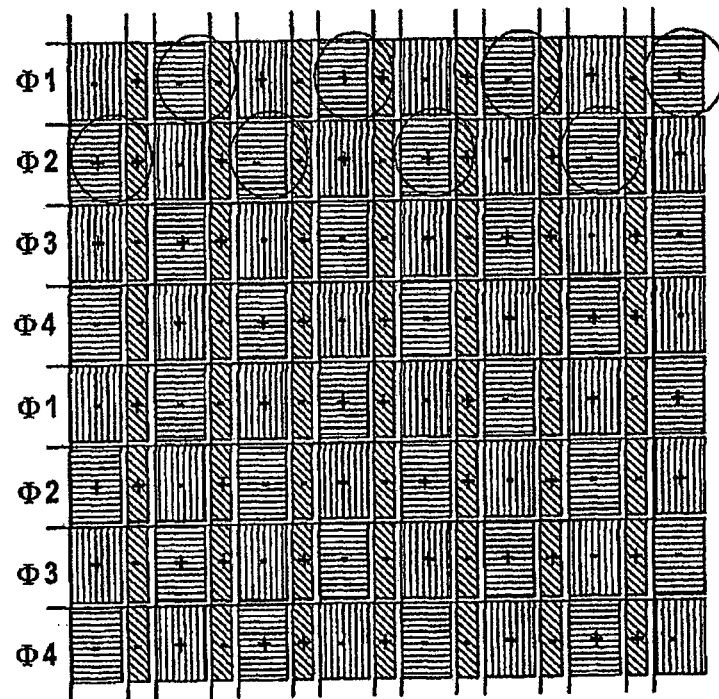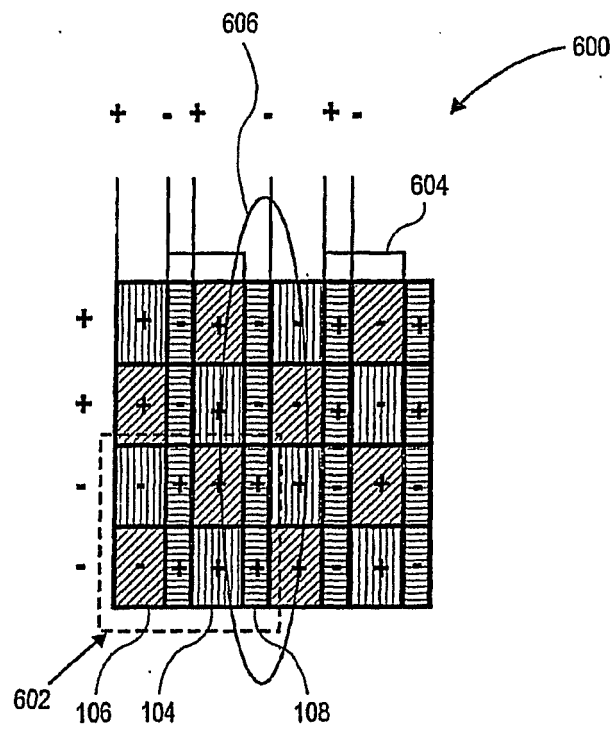**FIG. 6**

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

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- US 10456806 B **[0003]**
- US 10456838 B **[0003]**
- US 20030090581 A **[0003]**

专利名称(译)	具有分裂绿色子像素的新型液晶显示器中的图像劣化最小化		
公开(公告)号	EP2267693B1	公开(公告)日	2015-01-21
申请号	EP2010185588	申请日	2004-06-04
[标]申请(专利权)人(译)	三星电子株式会社		
申请(专利权)人(译)	SAMSUNG ELECTRONICS CO.，LTD.		
当前申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
[标]发明人	CREDELLE THOMAS LLOYD STEWART ROGER GREEN		
发明人	CREDELLE, THOMAS, LLOYD STEWART, ROGER, GREEN		
IPC分类号	G09G3/36 G09G5/00 G09G5/02 G09G5/10 H04N3/14		
CPC分类号	G09G3/3607 G09G3/3614 G09G3/3648 G09G3/3685 G09G2300/0452 G09G2320/0204 G09G2320/0209 G09G2320/0233		
代理机构(译)	博尔特WADE TENNANT		
优先权	10/696236 2003-10-28 US 10/456839 2003-06-06 US		
其他公开文献	EP2267693A3 EP2267693A2		
外部链接	Espacenet		

摘要(译)

公开了用于校正液晶显示面板上的图像劣化信号的系统和方法。包括在第一方向上具有偶数个子像素的子像素重复组的面板可能由于其上的不完美的点反转方案而具有寄生电容和其他信号误差。公开了用于信号校正和将错误定位到特定子像素上的技术。

FIG. 1A
(PRIOR ART)