



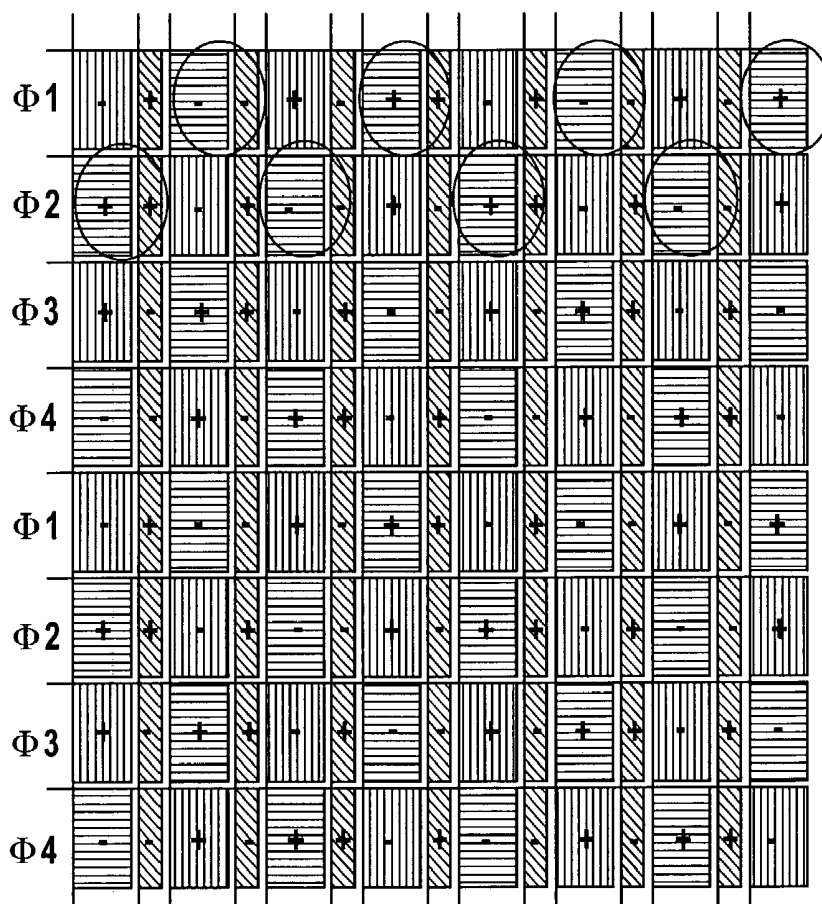
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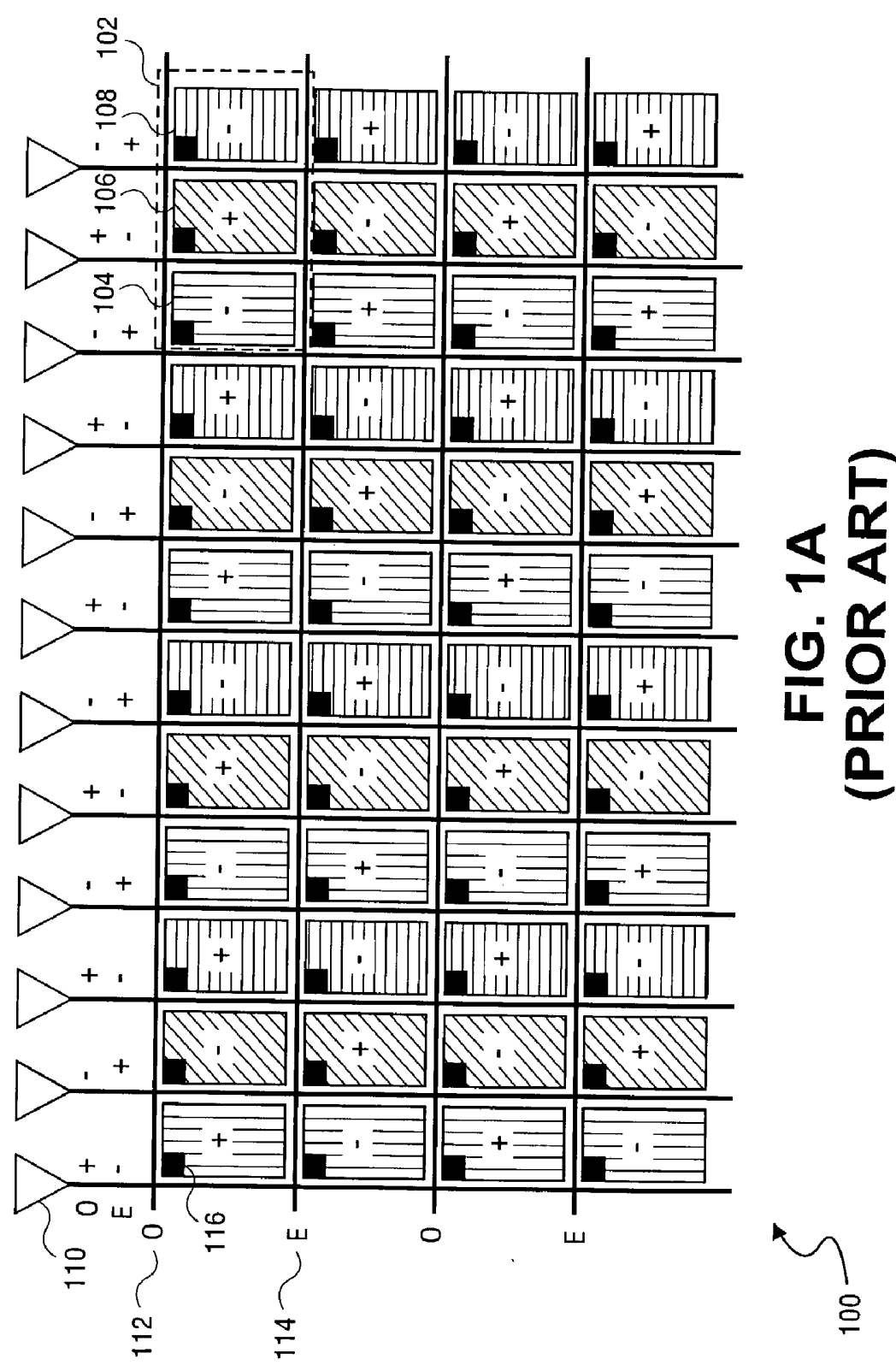
(19) **United States**(12) **Patent Application Publication**
Credelle et al.(10) **Pub. No.: US 2004/0246280 A1**(43) **Pub. Date: Dec. 9, 2004**(54) **IMAGE DEGRADATION CORRECTION IN
NOVEL LIQUID CRYSTAL DISPLAYS****Publication Classification**(51) **Int. Cl.⁷ G09G 3/36; G09G 5/10**(52) **U.S. Cl. 345/692**(76) **Inventors: Thomas Lloyd Credelle, Morgan Hill,
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CLAIRVOYANTE, INC.**874 GRAVENSTEIN HIGHWAY SOUTH,
SUITE 14****SEBASTOPOL, CA 95472 (US)**(57) **ABSTRACT**

Systems and methods are disclosed to correct for image degraded signals on a liquid crystal display panel are disclosed. Panels that comprise a subpixel repeating group having an even number of subpixels in a first direction may have parasitic capacitance and other signal errors due to imperfect dot inversion schemes thereon. Techniques for signal correction and localizing of errors onto particular subpixels are disclosed.

(21) **Appl. No.: 10/456,839**(22) **Filed: Jun. 6, 2003** $\Phi 1$ - + - - + - + + - - - + + - $\Phi 2$ + + - + - - + + + - - - - + $\Phi 3$ + - + + - + - - + + + + - - + $\Phi 4$ - - + - + + - - - + + + - -



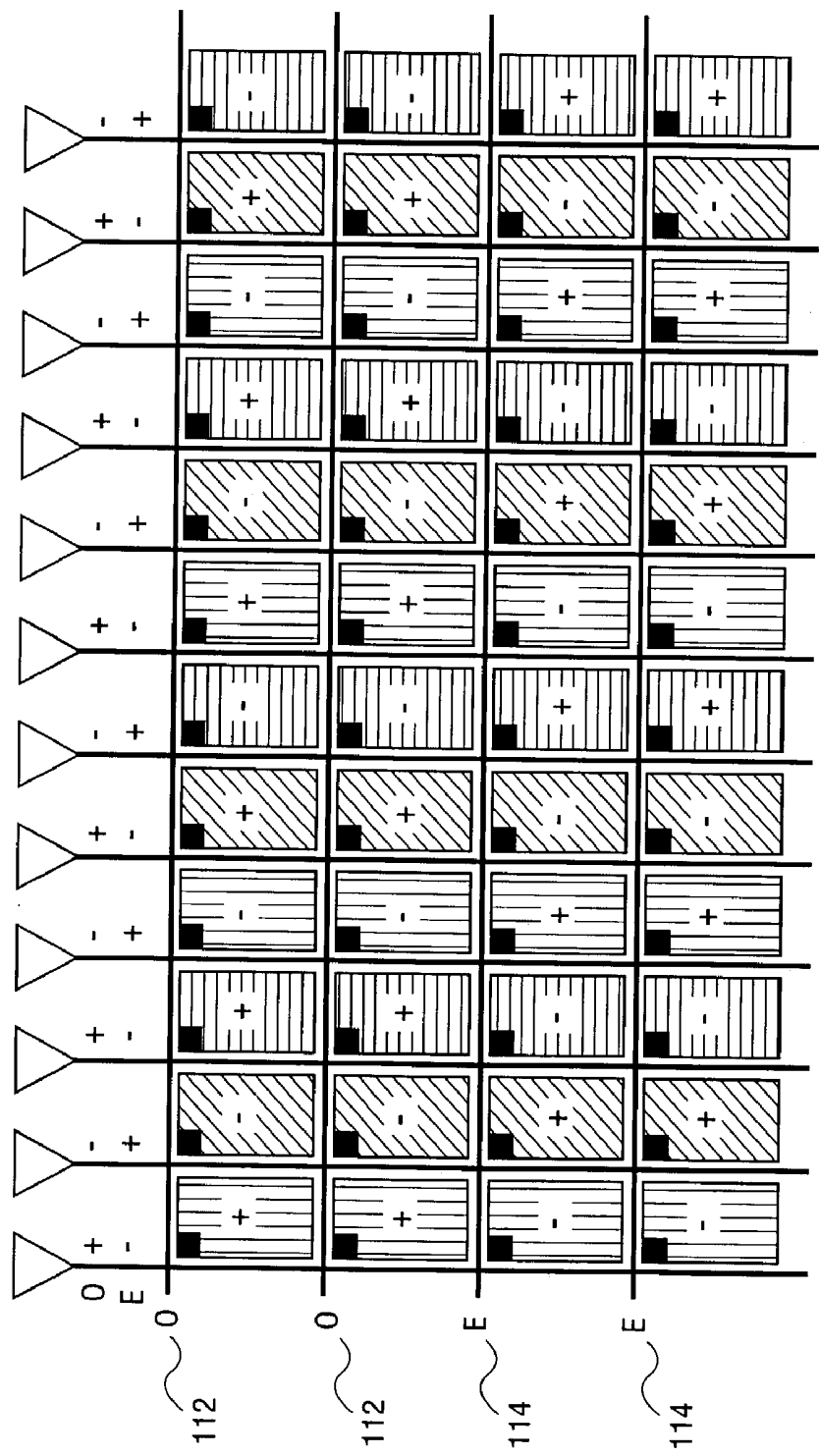
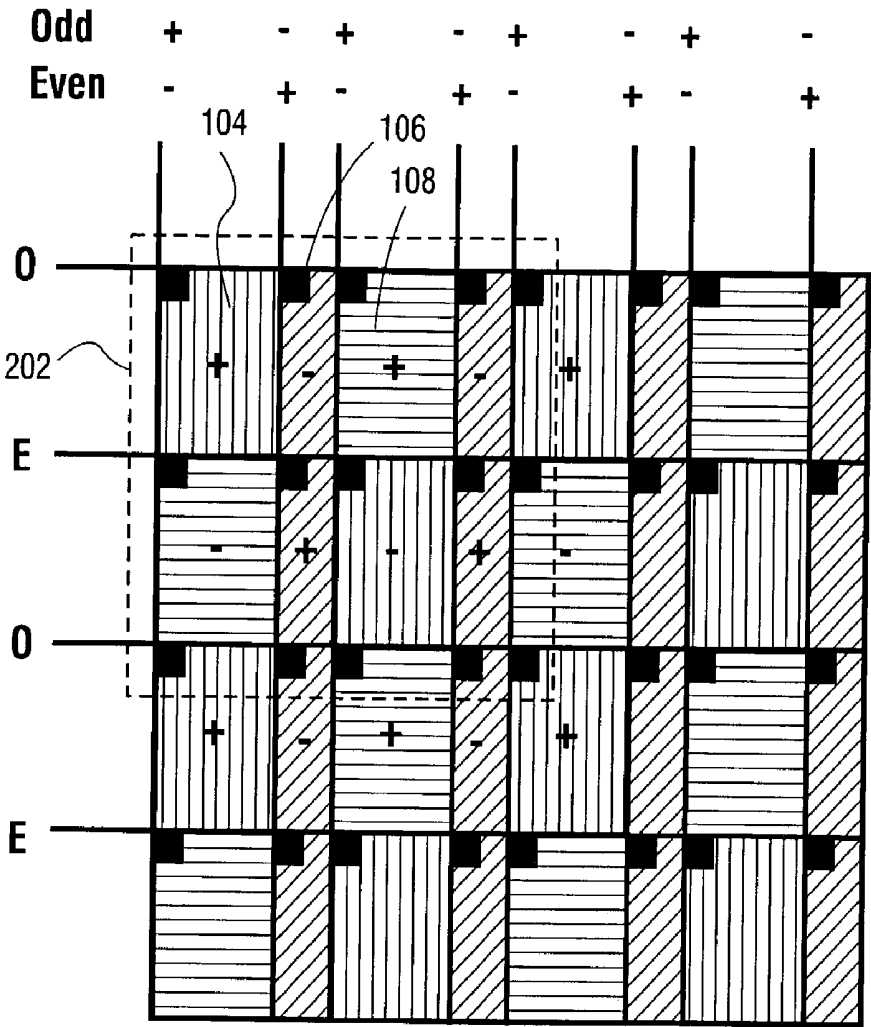


FIG. 1B
(PRIOR ART)



200

FIG. 2

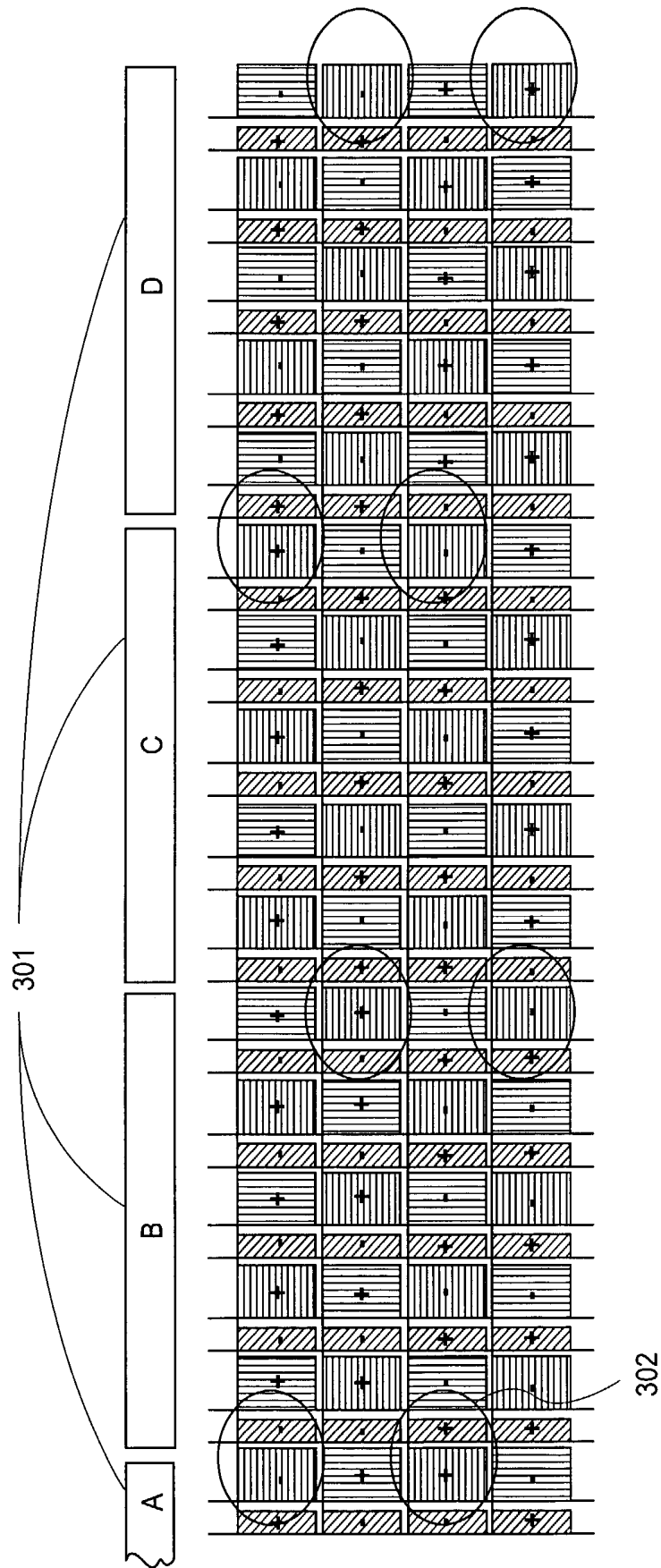


FIG. 3

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

FIG. 4

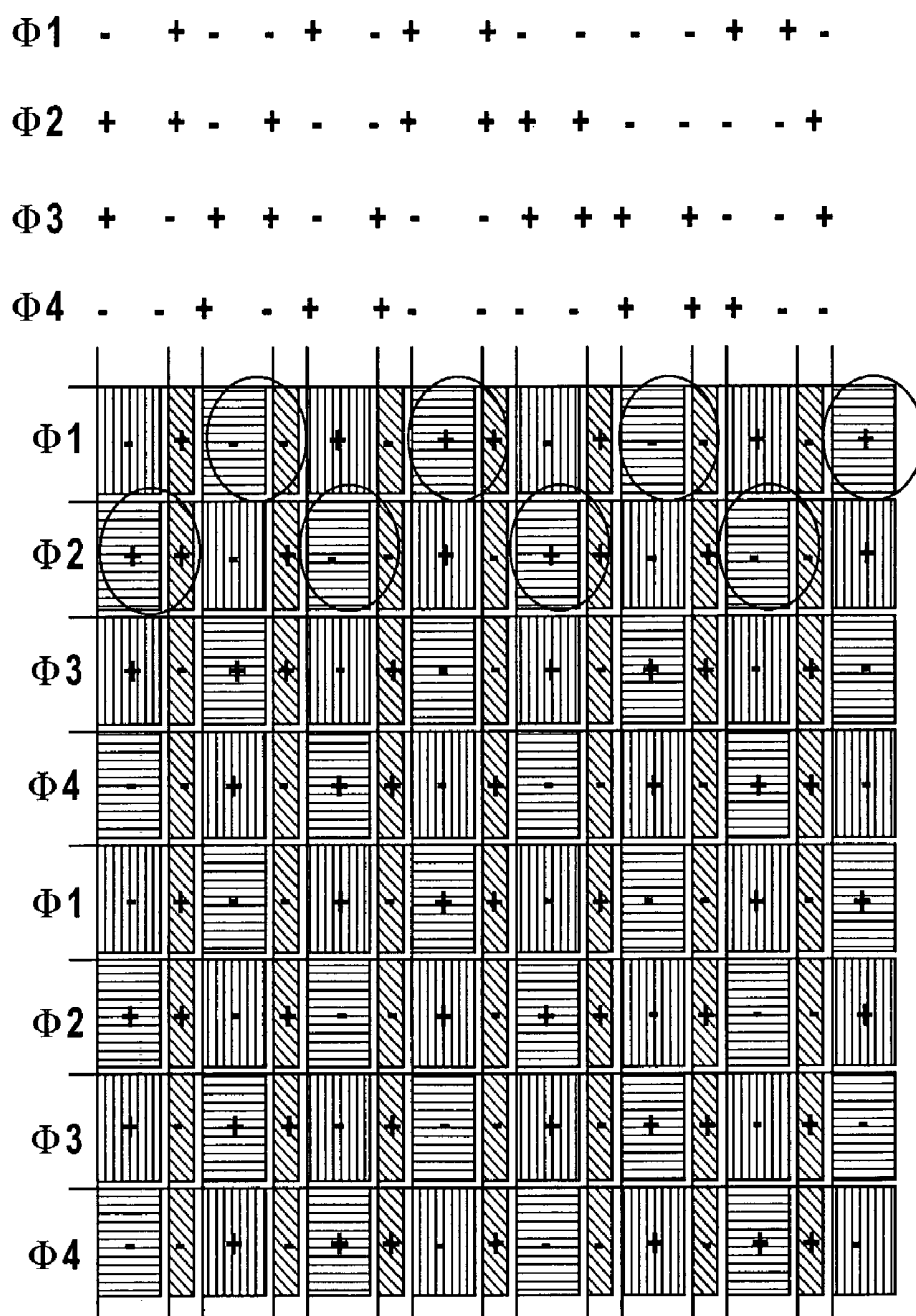


FIG. 5

IMAGE DEGRADATION CORRECTION IN NOVEL LIQUID CRYSTAL DISPLAYS

RELATED APPLICATIONS

[0001] The present application is related to commonly owned (and filed on even date) U.S. patent applications: (1) U.S. patent application Ser. No. _____ entitled "DISPLAY PANEL HAVING CROSSOVER CONNECTIONS EFFECTING DOT INVERSION"; (2) U.S. patent application Ser. No. _____ entitled "SYSTEM AND METHOD OF PERFORMING DOT INVERSION WITH STANDARD DRIVERS AND BACKPLANE ON NOVEL DISPLAY PANEL LAYOUTS"; (3) U.S. patent application Ser. No. _____ entitled "SYSTEM AND METHOD FOR COMPENSATING FOR VISUAL EFFECTS UPON PANELS HAVING FIXED PATTERN NOISE WITH REDUCED QUANTIZATION ERROR"; (4) U.S. patent application Ser. No. _____ entitled "DOT INVERSION ON NOVEL DISPLAY PANEL LAYOUTS WITH EXTRA DRIVERS"; and (5) U.S. patent application Ser. No. _____ entitled "LIQUID CRYSTAL DISPLAY BACKPLANE LAYOUTS AND ADDRESSING FOR NON-STANDARD SUBPIXEL ARRANGEMENTS," which are hereby incorporated herein by reference.

BACKGROUND

[0002] In commonly owned U.S. Patent Applications: (1) U.S. patent application Ser. No. 09/916,232 ("the '232 application"), entitled "ARRANGEMENT OF COLOR PIXELS FOR FULL COLOR IMAGING DEVICES WITH SIMPLIFIED ADDRESSING," filed Jul. 25, 2001; (2) U.S. patent application Ser. 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 Oct. 22, 2002;

[0003] (3) U.S. patent application Ser. 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 Oct. 22, 2002; (4) U.S. patent application Ser. No. 10/243,094 ("the '094 application"), entitled "IMPROVED FOUR COLOR ARRANGEMENTS AND EMITTERS FOR SUB-PIXEL RENDERING," filed Sep. 13, 2002; (5) U.S. patent application Ser. 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 Oct. 22, 2002; (6) U.S. patent application Ser. No. 10/278,393 ("the '393 application"), entitled "COLOR DISPLAY HAVING HORIZONTAL SUB-PIXEL ARRANGEMENTS AND LAYOUTS," filed Oct. 22, 2002; (7) U.S. patent application Ser. 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 Jan. 16, 2003, novel sub-pixel arrangements are therein disclosed for improving the

cost/performance curves for image display devices and herein incorporated by reference.

[0004] These improvements are particularly pronounced when coupled with sub-pixel rendering (SPR) systems and methods further disclosed in those applications and in commonly owned U.S. patent applications: (1) U. S. patent application Ser. No. 10/051,612 ("the '612 application"), entitled "CONVERSION OF RGB PIXEL FORMAT DATA TO PENTILE MATRIX SUB-PIXEL DATA FORMAT," filed Jan. 16, 2002; (2) U.S. patent application Ser. No. 10/150,355 ("the '355 application"), entitled "METHODS AND SYSTEMS FOR SUB-PIXEL RENDERING WITH GAMMA ADJUSTMENT," filed May 17, 2002; (3) U.S. patent application Ser. No. 10/215,843 ("the '843 application"), entitled "METHODS AND SYSTEMS FOR SUB-PIXEL RENDERING WITH ADAPTIVE FILTERING," filed Aug. 8, 2002; (4) U.S. patent application Ser. No. 10/379,767 entitled "SYSTEMS AND METHODS FOR TEMPORAL SUB-PIXEL RENDERING OF IMAGE DATA" filed Mar. 4, 2003; (5) U.S. patent application Ser. No. 10/379,765 entitled "SYSTEMS AND METHODS FOR MOTION ADAPTIVE FILTERING," filed Mar. 4, 2003; (6) U.S. patent application Ser. No. 10/379,766 entitled "SUB-PIXEL RENDERING SYSTEM AND METHOD FOR IMPROVED DISPLAY VIEWING ANGLES" filed Mar. 4, 2003; (7) U.S. patent application Ser. No. 10/409,413 entitled "IMAGE DATA SET WITH EMBEDDED PRE-SUBPIXEL RENDERED IMAGE" filed Apr. 7, 2003, which are hereby incorporated herein by reference.

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 1×1 dot inversion scheme.

[0007] **FIG. 1B** shows a conventional RGB stripe panel having a 1×2 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.

DETAILED DESCRIPTION

[0012] 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.

[0013] **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.

[0014] 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. 1×1 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 1×1 dot inversion scheme.

[0015] **FIG. 1B** depicts another conventional RGB stripe panel having another dot inversion scheme—i.e. 1×2 dot inversion. Here, the polarity scheme changes over the course of two rows—as opposed to every row, as in 1×1 dot inversion. In both dot inversion schemes, a few observations are noted: (1) in 1×1 dot inversion, every two physically adjacent subpixels (in both the horizontal and vertical direction) are of different polarity; (2) in 1×2 dot inversion, every two physically adjacent subpixels in the horizontal direction are of different polarity; (3) across any given row, each successive colored subpixel has an opposite polarity to its neighbor. Thus, for example, two successive red subpixels along a row will be either (+, −) or (−, +). Of course, in 1×1 dot inversion, two successive red subpixels along a column will have opposite polarity; whereas in 1×2 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.

[0016] **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 1×1 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—for 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). It will be appreciated that the embodiments described herein are equally applicable to all such even modulus repeat groupings.

[0017] 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 subpixels 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.

[0018] In one even modulo design embodiment, 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.

[0019] **FIG. 3** shows an even modulo pixel layout which utilizes 2×1 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 −, −, +, +,

[0020] 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.

[0021] 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.

[0022] 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 FIG. 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.

[0023] 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.

[0024] 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.

[0025] 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.

What is claimed is:

1. A liquid crystal display comprising:
 - a panel substantially comprising a subpixel repeating group comprising an even number of subpixels in a first direction; and
 - a driver circuit sending image data and polarity signals to the panel, wherein the driver circuit sends a correction signal to a plurality of subpixels which have a substantially consistent luminance error.
2. The liquid crystal display of claim 1, wherein the polarity signal are a dot inversion scheme.
3. The liquid crystal display of claim 2, wherein the polarity signal is a 1x1 dot inversion scheme.

4. The liquid crystal display of claim 2, wherein the polarity signal is a 1x2 dot inversion scheme.

5. The liquid crystal display of claim 1, wherein the polarity signal is a four phase dot inversion scheme.

6. The liquid crystal display of claim 1, wherein the plurality of subpixels having substantially consistent luminance errors are blue colored subpixels.

7. In a liquid crystal display comprising a panel, the panel substantially comprising a subpixel repeating group comprising an even number of subpixels in a first direction, method for correcting image degradation in said panel, the method comprising:

determining subpixels which have a substantially consistent luminance error;

determining a correction signal to apply to the subpixels; and

adding said correction signal to said image data signal to the subpixels.

8. The method of claim 7, wherein determining subpixels further comprises:

measuring the error displayed by a subpixel with a test signal.

9. The method of claim 7 wherein determining a correction signal further comprises:

empirically testing a correction signal and verifying if said correction signal substantially corrects the error.

10. A liquid crystal display comprising:

a panel substantially comprising a subpixel repeating group comprising an even number of subpixels in a first direction; and

a plurality of two-phase driver chips sending image data and polarity signals to the panel, wherein phases of driver chips are selected such that any parasitic effects placed upon any subpixels at boundaries of the driver chips are placed substantially upon blue subpixels.

11. The liquid crystal display of claim 10, wherein a correction signal is sent to a plurality of the subpixels that have parasitic effects.

12. A liquid crystal display comprising:

a panel substantially comprising a subpixel repeating group comprising an even number of subpixels in a first direction; and

a driver circuit having at least two phases, the driver circuit sending image data and polarity signals to said panel, wherein phases of the driver circuits are selected such that any parasitic effects placed upon any subpixels are placed substantially upon blue subpixels.

13. The liquid crystal display of claim 12, wherein a correction signal is sent to a plurality of the subpixels that have parasitic effects.

14. The liquid crystal display of claim 12, wherein the subpixels are all of blue subpixels of the panel.

15. The liquid crystal display of claim 12, wherein the subpixels are a subset of all of blue subpixels of the panel.

* * * * *

专利名称(译)	新型液晶显示器中的图像劣化校正		
公开(公告)号	US20040246280A1	公开(公告)日	2004-12-09
申请号	US10/456839	申请日	2003-06-06
[标]申请(专利权)人(译)	CREDELLE THOMAS LLOYD STEWART ROGER GREEN		
申请(专利权)人(译)	CREDELLE THOMAS LLOYD STEWART ROGER GREEN		
当前申请(专利权)人(译)	CREDELLE THOMAS LLOYD STEWART ROGER GREEN		
[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 G09G2320/0233 G09G2300/0452 G09G2320/0204 G09G2320/0209 G09G3/3685		
外部链接	Espacenet USPTO		

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。

