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(54) METHOD OF DRIVING LIQUID CRYSTAL DISPLAY

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(57) ABSTRACT

A method of driving a liquid crystal display that is adaptive for improving uniformity in a driving method employing multiplexors of the liquid crystal display. In the method, a gate-driving signal is sequentially applied to the gate lines for a sequential scanning for each line. A data is supplied to the liquid crystal cells with the same color being adjacent to each other in a scanning interval of a first scanning line. An application sequence of a data to the liquid crystal cells with the same color being adjacent to each other in a scanning interval of a second scanning line is differentiated from that in a scanning interval of the first scanning line.

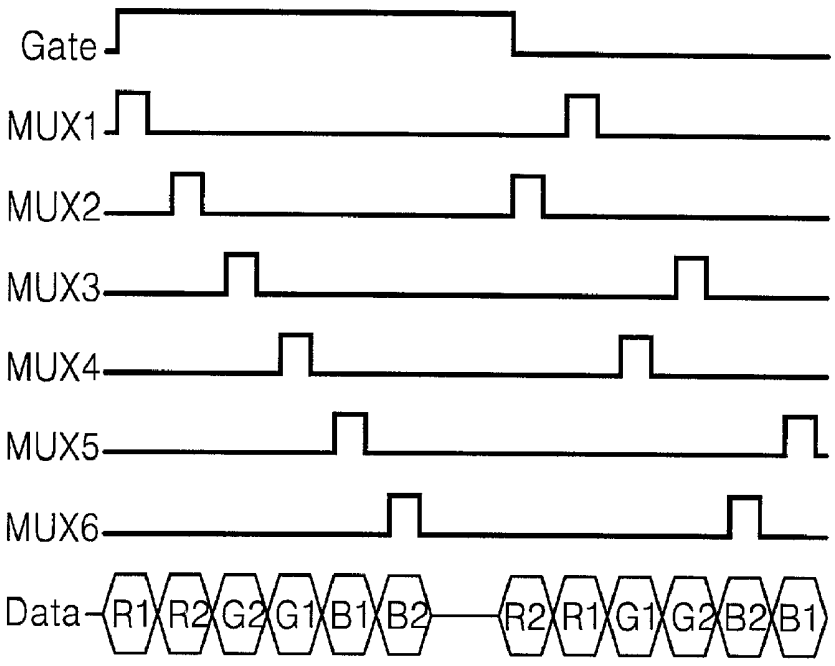


FIG.1
CONVENTIONAL ART

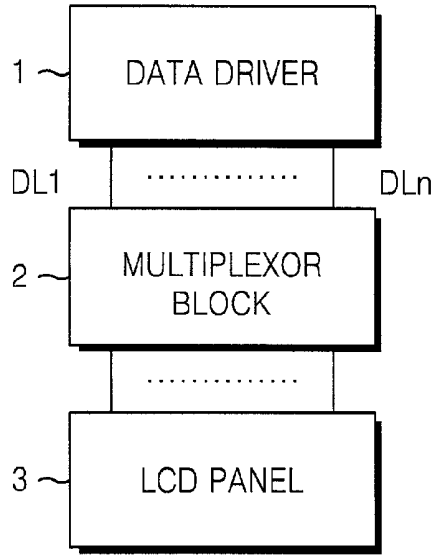


FIG.2
CONVENTIONAL ART

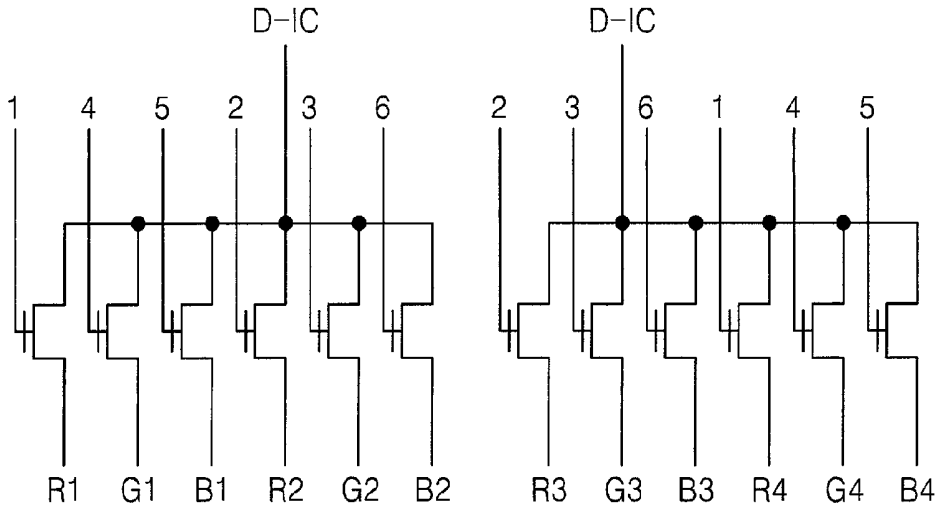


FIG.3
CONVENTIONAL ART

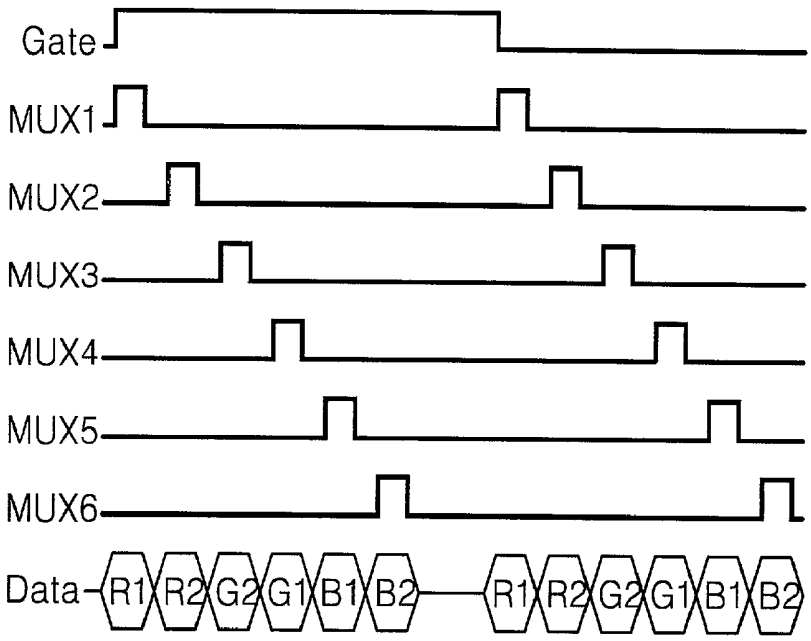


FIG. 4
CONVENTIONAL ART

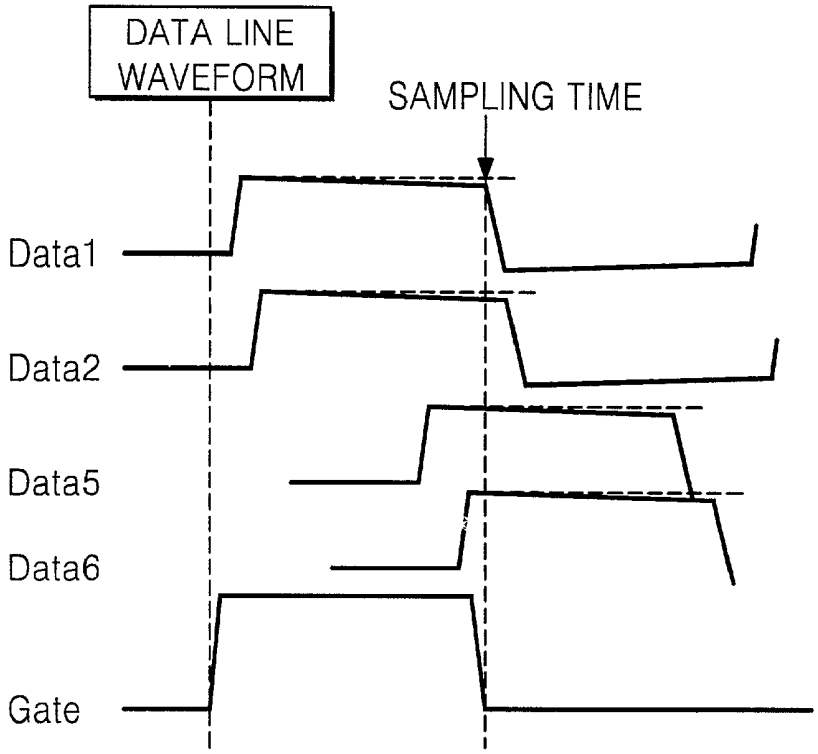


FIG.5
CONVENTIONAL ART

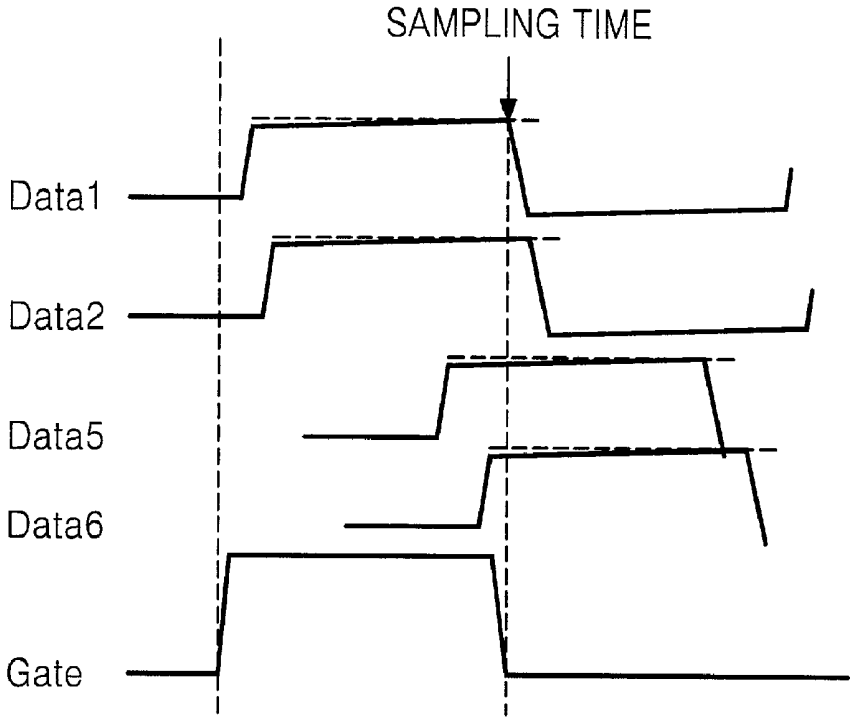


FIG.6

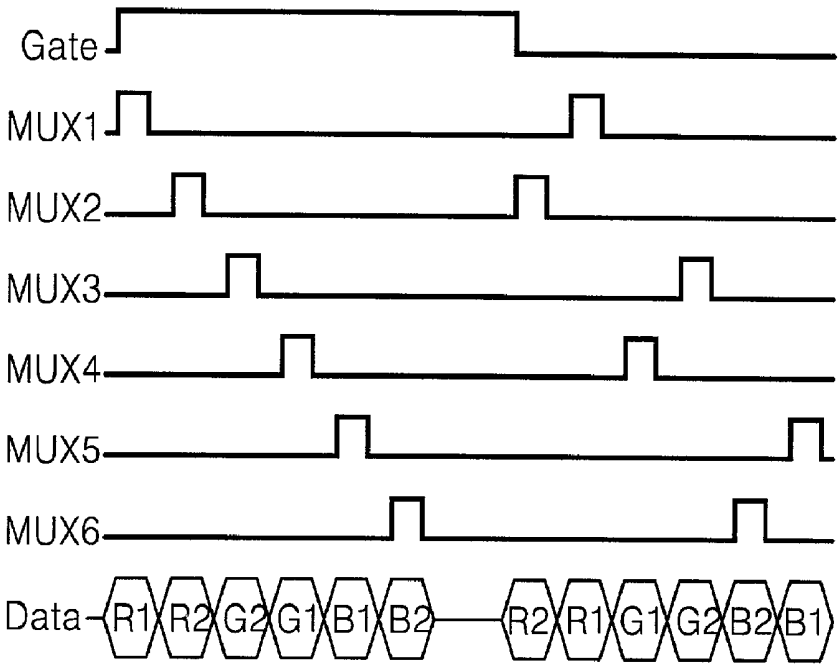

Gate
MUX1
MUX2
MUX3
MUX4
MUX5
MUX6
Data
R1
R2
G2
G1
B1
B2
R2
R1
G1
G2
B2
B1

FIG. 7

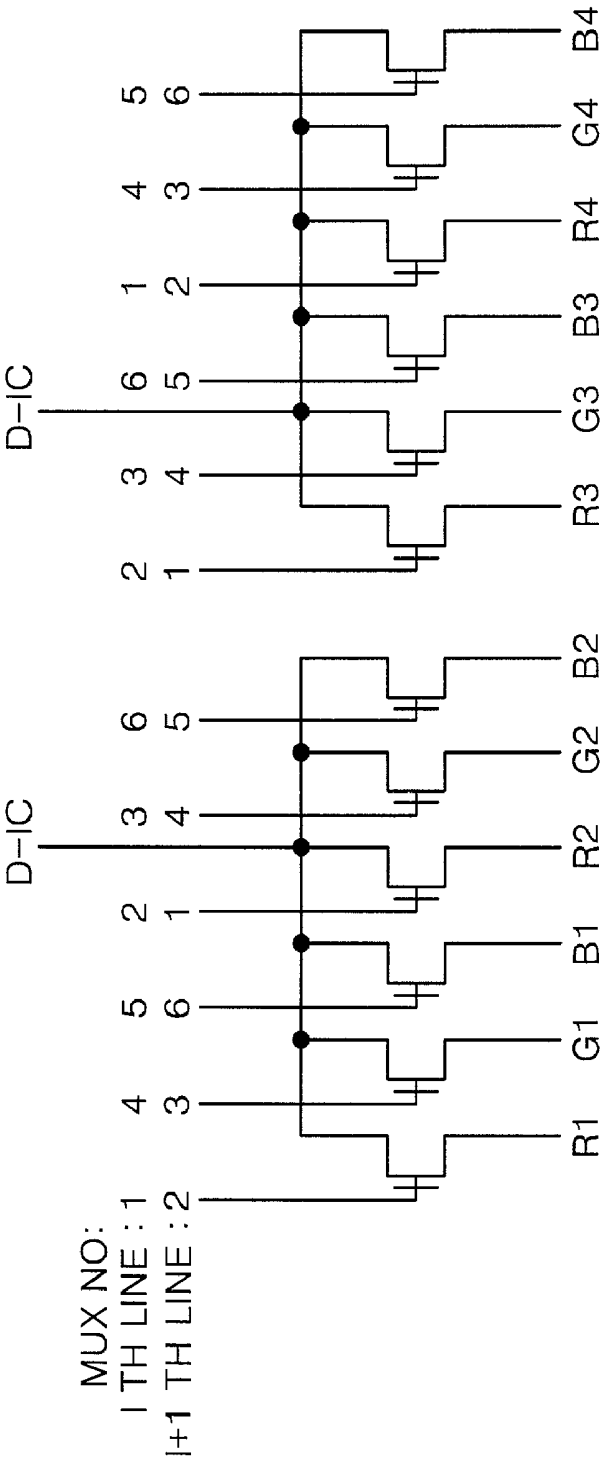

MUX NO:
I TH LINE : 1
I+1 TH LINE : 2
D-IC
4 3 5 6 2 1
R1 G1 B1 R2 G2 B2
D-IC
2 1 6 5 1 2
R3 G3 B3 R4 G4 B4

FIG.8

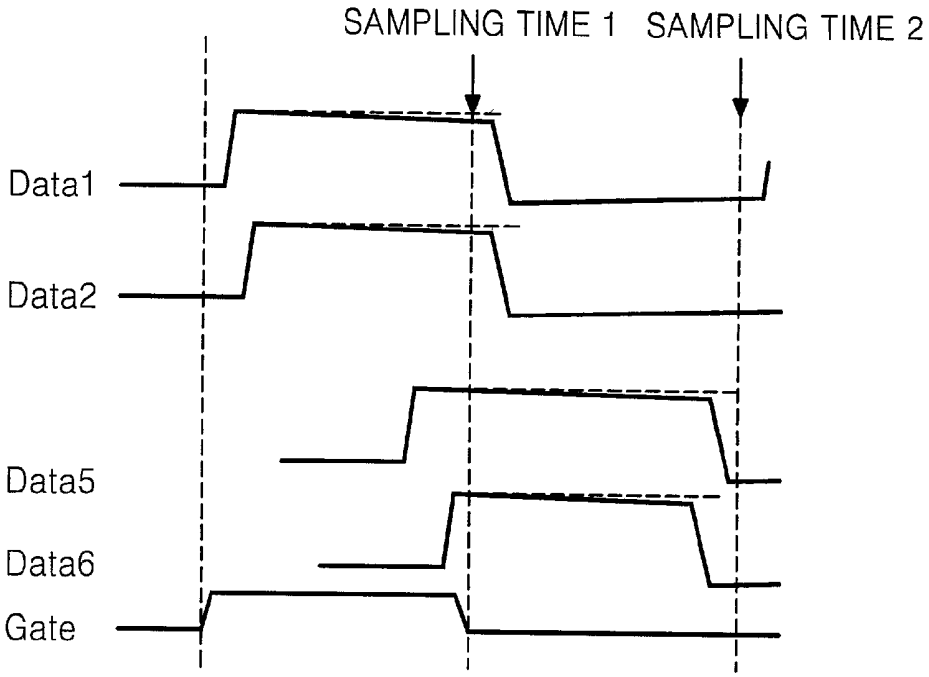

SAMPLING TIME 1
SAMPLING TIME 2
Data1
Data2
Data5
Data6
Gate

FIG.9

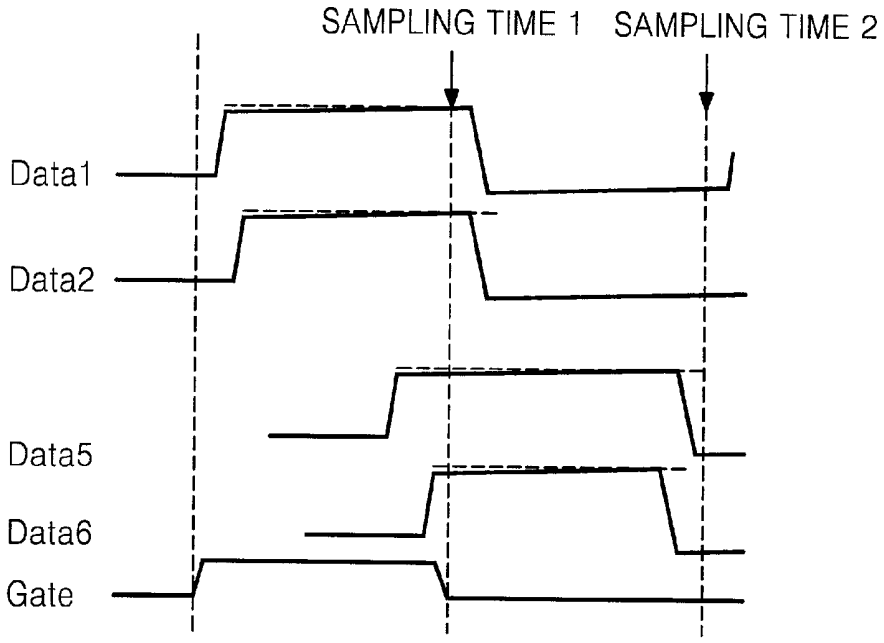
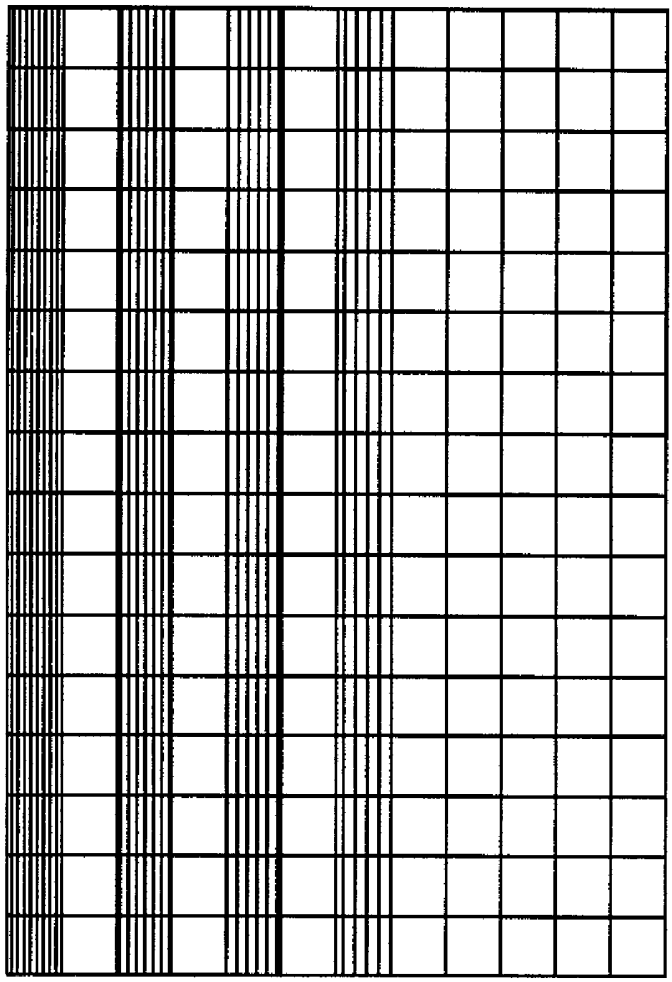
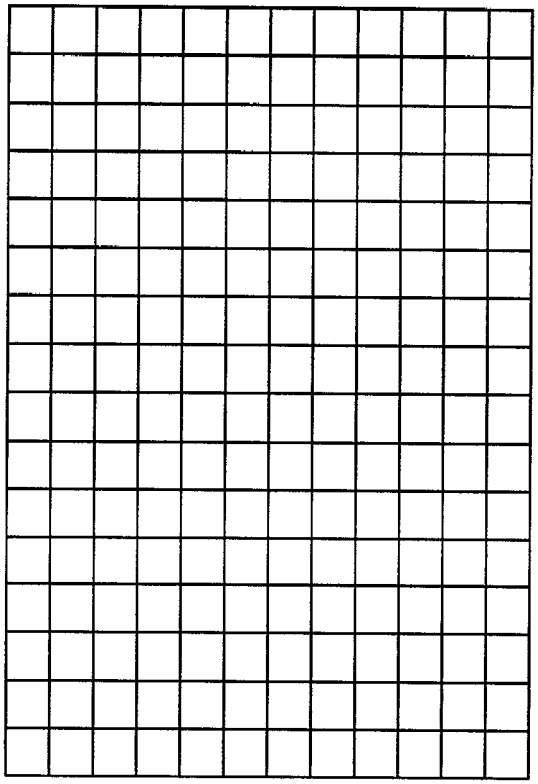

SAMPLING TIME 1
SAMPLING TIME 2
Data1
Data2
Data5
Data6
Gate

FIG.10A
PRIOR ART



PICTURE QUALITY IN THE PRIOR ART

FIG.10B



PICTURE QUALITY IN THE PRESENT INVENTION

FIG.11A

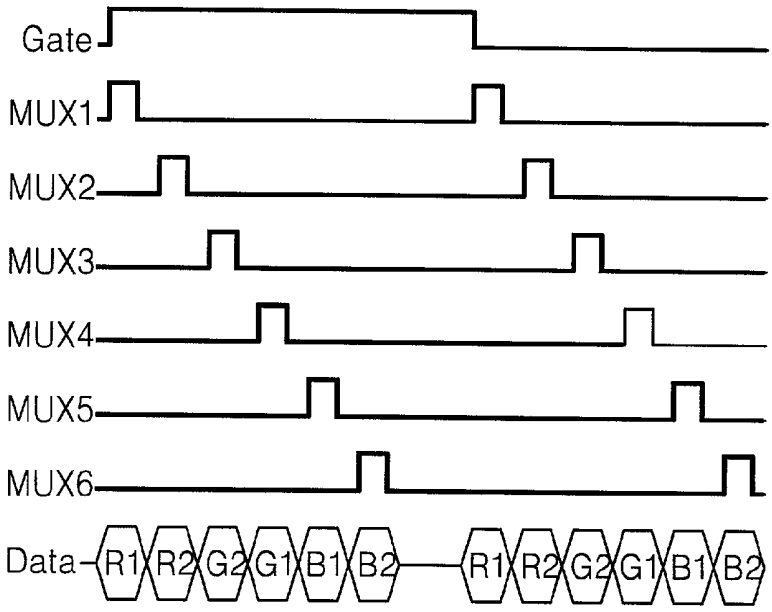


FIG.11B

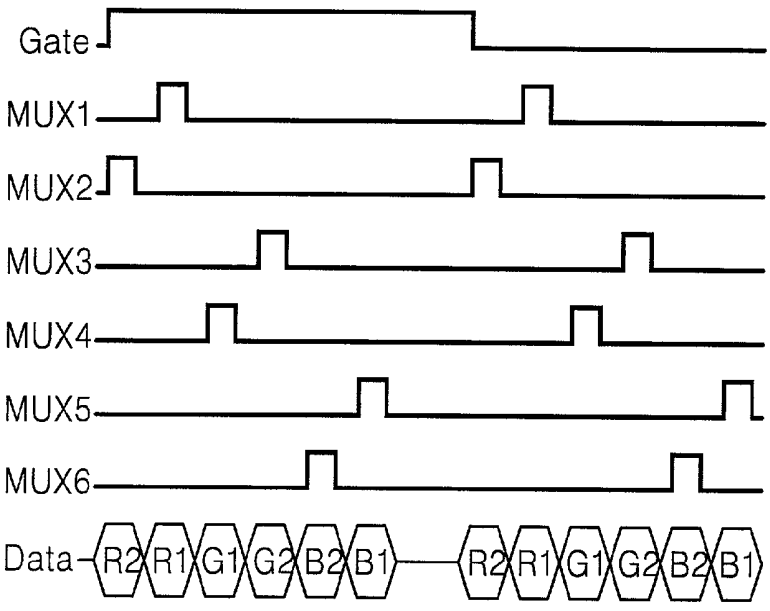


FIG.11C

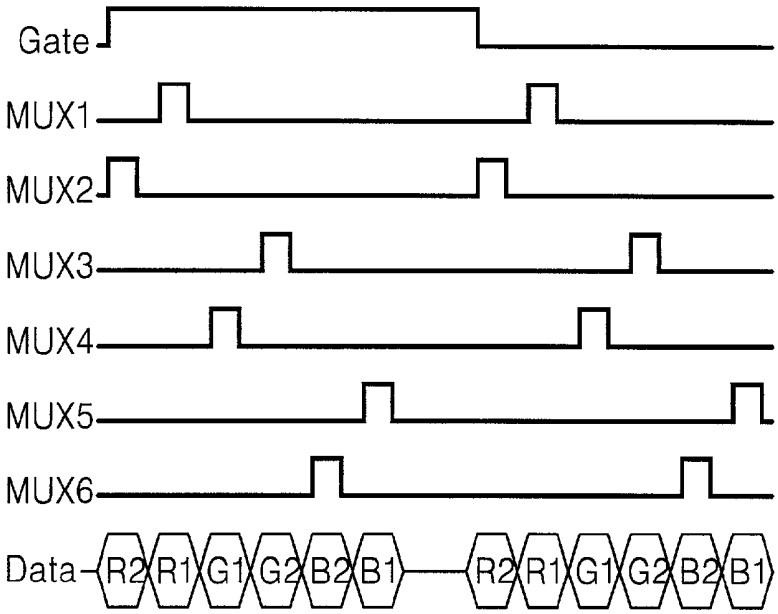


FIG.11D

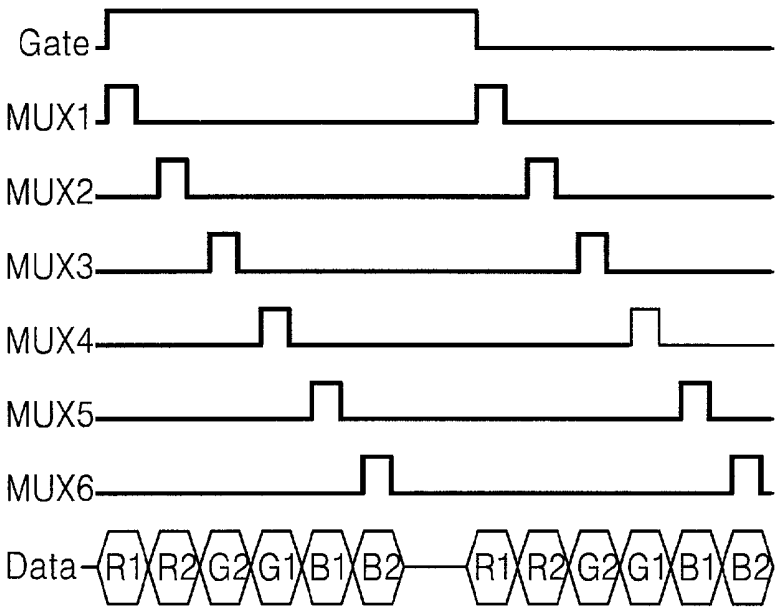
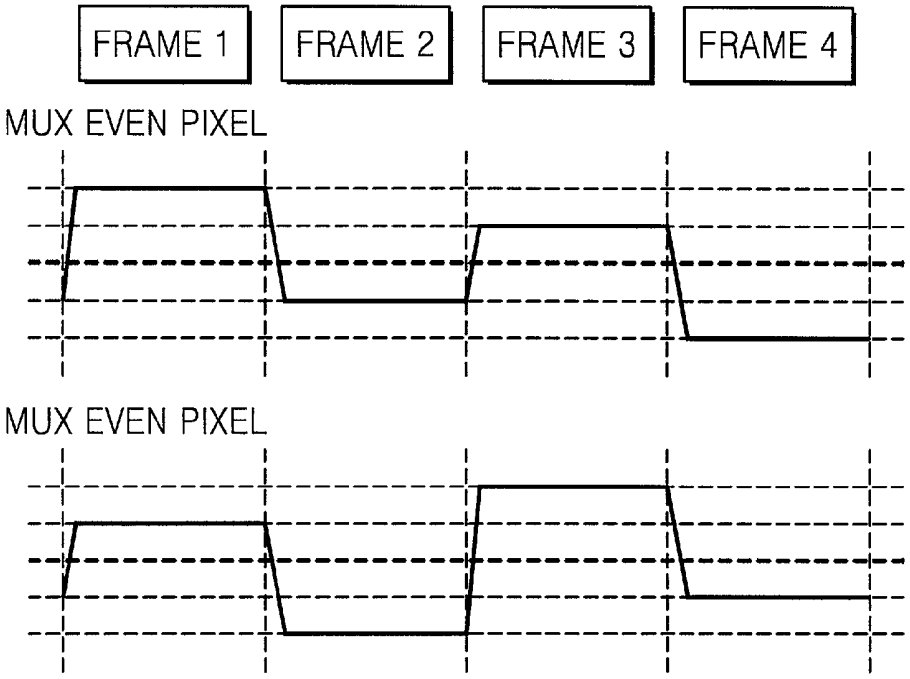


FIG.12



METHOD OF DRIVING LIQUID CRYSTAL DISPLAY

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This invention relates to a liquid crystal display, and more particularly to a method of driving a liquid crystal display that is adaptive for improving uniformity in a driving method employing multiplexors of the liquid crystal display.

[0003] 2. Description of the Related Art

[0004] Generally, a liquid crystal display (LCD) uses a pixel matrix arranged in each intersection between gate lines and data lines to thereby display a picture corresponding to a video signal such as a television signal. Each pixel consists of a liquid crystal cell controlling a transmitted light quantity in accordance with a data signal, and a thin film transistor (TFT) for switching the data signal to be applied from the data line to the liquid crystal cell. The pixel matrix is positioned between two glass substrates. The LCD includes driving integrated circuits for driving gate lines and data lines.

[0005] In the conventional LCD, a driving integrated circuit for driving the data lines applies signals to the data lines using six multiplexors.

[0006] **FIG. 1** is a block diagram showing a configuration of a conventional data driving integrated circuit for driving a liquid crystal display panel, which includes a multiplexor block **2** connected between a data driver **1** and a liquid crystal display panel **3**.

[0007] Outputs DL**1** to DLn from the data driver **1** are applied to the multiplexor block **2**. The multiplexor block **2** multiplexes an applied signal using six multiplexors (MUX's) to sequentially apply the same to the data lines of the liquid crystal display panel **3**.

[0008] Referring to **FIG. 2**, the multiplexor block **2** consists of six multiplexors connected to each output DL**1** to DLn of the data driver **1**. The output DL**1** to DLn of the data driver **1** is applied to a source terminal of each multiplexor (MUX) while a gate pulse as shown in **FIG. 3** is sequentially applied to a gate terminal of each MUX to thereby turn on the MUX's. Thus, a data signal is stored in a capacitor of the data line via a drain terminal of each MUX. Then, a data signal is charged in a pixel electrode (not shown) just until the gate pulse goes off.

[0009] **FIG. 3** shows a turned-on sequence of six MUX's for applying a gate pulse.

[0010] Referring to **FIG. 3, a** data is supplied to the first liquid crystal cell of the first and second liquid crystal cells with a first color being adjacent to each other in the first line and then is supplied to the second liquid crystal cell; a data is supplied to the fourth liquid crystal cell of the third and fourth liquid crystal cells with a second color and then is supplied to the third liquid crystal cell; and a data is supplied to the fifth liquid crystal cell of the fifth and sixth liquid crystal cells with a third color and then is supplied to the sixth liquid crystal cell. Herein, the first color is a red; the second color is a green; and the third color is a blue. In this manner, the MUX's are sequentially turned on to supply a data to each liquid crystal cell of the data lines.

[0011] Upon driving of the MUX's, a data signal is stored in a capacitor of the data line when a gate pulse is applied to each MUX while a data signal is charged in the pixel just until the gate pulse goes off. Thus, a time at which a data signal is applied from the data line of the liquid crystal display panel **3** and then is charged in the pixel electrode generates a voltage difference between the data lines **3** caused by a charge characteristic difference as shown in **FIG. 4**.

[0012] As can be seen from **FIG. 4, a** voltage difference as indicated by dotted lines is generated from voltage waveforms of Data**1** to Data**6** at a time from turning-on of the gate pulse until turning-off of the gate pulse, that is, at a sampling time. Also, a voltage difference is generated between the data lines due to a leakage current as shown in **FIG. 5**.

[0013] As can be seen from **FIG. 5, a** voltage difference as indicated by dotted lines is generated from voltage waveforms of Data**1** to Data**6** at a time from turning-on of the gate pulse until turning-off of the gate pulse, that is, at a sampling time. Accordingly, in a six-multiplexor driving scheme, a red (R) is applied in MUX**1** and MUX**2** intervals; a green (G) is applied in MUX**3** and MUX**4** intervals; and a blue (G) is applied in MUX**5** and MUX**6** intervals, in order to prevent a stripe generation caused by a coupling between the data lines upon application of a data.

[0014] A normal-temperature operation of the LCD does not cause that problem. However, a low-temperature operation or a mobility deterioration of the LCD allows a stripe shape to be generated at the liquid crystal display panel because a charge characteristic difference between the multiplexors exists, particularly, a charge time at the MUX**5** and MUX**6** is shortest. Moreover, a large leakage current raises a problem such as a poor picture quality because a time (MUX turn_on through Gate_off) at which a voltage of the data line charged via the multiplexors should be holded is differentiated depending on the MUX number. As a result, a minute voltage difference caused by a badness of line shape is generated such that it can be easily perceived by a human's eye.

SUMMARY OF THE INVENTION

[0015] Accordingly, it is an object of the present invention to provide a method of driving a liquid crystal display that is adaptive for improving uniformity in a driving method employing multiplexors of the liquid crystal display.

[0016] In order to achieve these and other objects of the invention, a method of driving a liquid crystal display according to an embodiment of the present invention includes the steps of sequentially applying a gate driving signal to gate lines for a sequential scanning for each line; supplying a data to liquid crystal cells with the same color being adjacent to each other in a scanning interval of a first scanning line; and differentiating an application sequence of a data to the liquid crystal cells with the same color being adjacent to each other in a scanning interval of a second scanning line from that in a scanning interval of the first scanning line.

[0017] The driving method further includes the steps of, at the first line, supplying a data to the first liquid crystal cell of the first and second liquid crystal cells with a first color

being adjacent to each other and thereafter supplying the data to the second liquid crystal cell; supplying a data to the fourth liquid crystal cell of the third and fourth liquid crystal cells with a second color and thereafter supplying the data to the third liquid crystal cell; and supplying a data to the fifth liquid crystal cell of the fifth and sixth liquid crystal cells with a third color and thereafter supplying the data to the sixth liquid crystal cell. Herein, first color is a red, a second color is a green, and a third color is a blue.

[0018] The driving method further includes the steps of, at the second line, supplying a data to the second liquid crystal cell and thereafter supplying the data to the first liquid crystal cell; supplying a data to the third liquid crystal cell and thereafter supplying the data to the fourth liquid crystal cell; and supplying a data to the sixth liquid crystal cell and thereafter supplying the data to the fifth liquid crystal cell.

[0019] A method of driving a liquid crystal display according to another embodiment of the present invention includes the steps of sequentially applying a gate driving signal to gate lines every frame for a sequential scanning for each frame; supplying a data to liquid crystal cells with the same color being adjacent to each other in a specific sequence at a first frame of said frames; differentiating an application sequence of a data to the liquid crystal cells with the same color being adjacent to each other at a second frame following the first frame from that that at the first frame; equalizing a data application sequence at a third frame following the second frame to that at the second frame; equalizing a data application sequence at a fourth frame following the third frame to that at the first frame; and periodically repeating a data application in said sequences at the first to fourth frames.

[0020] The driving method further includes the steps of, at the first frame, supplying a data to the first liquid crystal cell of the first and second liquid crystal cells with a first color being adjacent to each other and thereafter supplying the data to the second liquid crystal cell; supplying a data to the fourth liquid crystal cell of the third and fourth liquid crystal cells with a second color and thereafter supplying the data to the third liquid crystal cell; and supplying a data to the fifth liquid crystal cell of the fifth and sixth liquid crystal cells with a third color and thereafter supplying the data to the sixth liquid crystal cell. Herein, the first color is a red, a second color is a green, and a third color is a blue.

[0021] The driving method further includes the steps of, at the second frame, supplying a data to the second liquid crystal cell and thereafter supplying the data to the first liquid crystal cell; supplying a data to the third liquid crystal cell and thereafter supplying the data to the fourth liquid crystal cell; and supplying a data to the sixth liquid crystal cell and thereafter supplying the data to the fifth liquid crystal cell.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] These and other objects of the invention will be apparent from the following detailed description of the embodiments of the present invention with reference to the accompanying drawings, in which:

[0023] **FIG. 1** is a schematic block diagram showing a configuration of a conventional driving apparatus for data lines of a liquid crystal display panel;

[0024] **FIG. 2** is a circuit diagram of the multiplexor block shown in **FIG. 1**;

[0025] **FIG. 3** is a waveform diagram representing turning-on periods of the multiplexors;

[0026] **FIG. 4** is a waveform diagram representing a voltage difference between the data lines caused by a leakage current;

[0027] **FIG. 5** is a waveform diagram representing a voltage difference between the data lines caused by a charge characteristic difference;

[0028] **FIG. 6** is a waveform diagram representing turning-on periods of multiplexors of line inversion system according to an embodiment of the present invention;

[0029] **FIG. 7** is a circuit diagram showing a configuration of a multiplexor block according to an embodiment of the present invention;

[0030] **FIG. 8** is a waveform diagram representing a voltage difference between the data lines caused by a leakage current;

[0031] **FIG. 9** is a waveform diagram representing a voltage difference between the data lines caused by a charge characteristic difference;

[0032] **FIG. 10A** and **FIG. 10B** are graphs for comparing a picture quality in the present invention with that in the prior art;

[0033] **FIG. 11A** to **FIG. 11D** are waveform diagrams representing turning-on periods of multiplexors of frame inversion system according to another embodiment of the present invention; and

[0034] **FIG. 12** is a waveform diagram representing voltage signals for each of odd-numbered and even-numbered pixels of the multiplexors to be applied to the liquid crystal display.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0035] **FIG. 6** is a waveform diagram representing a turning-on sequence of multiplexors of line inversion system according to an embodiment of the present invention.

[0036] Referring to **FIG. 6**, at the first line, a data is supplied to the first liquid crystal cell of the first and second liquid crystal cells with a first color being adjacent to each other and then is supplied to the second liquid crystal cell; a data is supplied to the fourth liquid crystal cell of the third and fourth liquid crystal cells with a second color and then is supplied to the third liquid crystal cell; and a data is supplied to the fifth liquid crystal cell of the fifth and sixth liquid crystal cells with a third color and then is supplied to the sixth liquid crystal cell. Further, at the second line, a data is supplied to the second liquid crystal cell and then supplied to the first liquid crystal cell; a data is supplied to the third liquid crystal cell and then supplied to the fourth liquid crystal cell; and a data is supplied to the sixth liquid crystal cell and then supplied to the fifth liquid crystal cell. Herein, the first color is a red; the second color is a green; and the third color is a blue. In this manner, the MUX's are sequentially turned on to supply a data to each liquid crystal cell of the data lines.

[0037] Referring to **FIG. 7**, each output DL1 to DLn of the data driver **1** are applied to a source terminal of each MUX while a gate pulse as shown in **FIG. 6** is sequentially applied to a gate terminal of each MUX, to thereby turn on the MUX's. Thus, a data signal is stored in a capacitor of the data line via a drain terminal of each MUX. Then, a data signal is charged in a pixel electrode (not shown) just until the gate pulse goes off.

[0038] Upon driving of the MUX's, a data signal is stored in a capacitor of the data line when a gate pulse is applied to each MUX while a data signal is charged in the pixel just until the gate pulse goes off. Thus, a time at which a data signal is applied from the data line of the liquid crystal display panel **3** and then is charged in the pixel electrode generates a voltage difference between the data lines **3** caused by a charge characteristic difference as shown in **FIG. 8**.

[0039] As can be seen from **FIG. 8, a** voltage difference as indicated by dotted lines is generated from voltage waveforms of Data**1** to Data**6** at a time from turning-on of the gate pulse until turning-off of the gate pulse, that is, at a sampling time **1**, and also a minute voltage difference is generated at a sampling time **2**. Further, a voltage difference is generated between the data lines due to a lack of charge as shown in **FIG. 9**.

[0040] As can be seen from **FIG. 9, a** voltage difference caused by a lack of charge as indicated by dotted lines is generated from voltage waveforms of Data**1** to Data**6** at a time from turning-on of the gate pulse until turning-off of the gate pulse, that is, at the sampling time **1** and the sampling time **2**.

[0041] If a turning-on sequence of six MUX's for each line is changed as shown in **FIG. 6**, however, then a sequence of the MUX's for each gate line becomes different to eliminate a poor picture caused by a generation of stripes.

[0042] In particular, in the high-resolution screen, an average brightness of the adjacent pixels is perceived by a human's eye, so that it becomes possible to obtain a clear picture as shown **FIG. 10B** even though a voltage difference between the data lines is generated due to a charge badness and a leakage current, etc.

[0043] This can be seen from **FIG. 10A** and **FIG. 10B** in which a picture quality in the prior art is compared with that in the present invention. The conventional driving method as shown in **FIG. 10A** displays vertical stripes at the liquid crystal display panel due to a difference in a voltage charged in the pixel electrode, whereas the present driving method as shown in **FIG. 10B** removes vertical stripes displayed on the liquid crystal display panel in the prior art by changing a turning-on sequence of the MUX's.

[0044] **FIG. 11A** to **FIG. 11D** show signal waveforms from multiplexors of frame inversion system according to another embodiment of the present invention.

[0045] Referring to **FIG. 11A** to **FIG. 11**D, at the first frame, a data is supplied to the first liquid crystal cell of the first and second liquid crystal cells with a first color being adjacent to each other and then is supplied to the second liquid crystal cell; a data is supplied to the fourth liquid crystal cell of the third and fourth liquid crystal cells with a second color and then is supplied to the third liquid crystal cell; and a data is supplied to the fifth liquid crystal cell of the fifth and sixth liquid crystal cells with a third color and then is supplied to the sixth liquid crystal cell. Further, at the second frame, a data is supplied to the second liquid crystal cell and then supplied to the first liquid crystal cell; a data is supplied to the third liquid crystal cell and then supplied to the fourth liquid crystal cell; and a data is supplied to the sixth liquid crystal cell and then supplied to the fifth liquid crystal cell. In the mean time, a data application sequence of the third frame is identical to that of the second frame while a data application sequence of the fourth frame is identical to that of the first frame. Herein, the first color is a red; the second color is a green; and the third color is a blue.

[0046] As described above, a data is periodically applied to the liquid crystal cells at four frames, so that vertical stripes displayed on the liquid crystal display panel in the prior art can be removed to thereby obtain a clean picture.

[0047] **FIG. 12** is a waveform diagram of signals applied to the odd-numbered and even-numbered liquid crystal cells of the LCD by means of the MUX's.

[0048] If a turning-on sequence of the MUX's is changed every frame as shown in **FIG. 2**, then the signals has a strong effective voltage upon averaging of the first to fourth frames. Even though a difference in voltages charged in the pixel electrode within each frame occurs, they are averaged on a time basis to obtain a visually uniform picture. In this case, a repetition of four frames aims at preventing a generation of direct current offset voltage from each pixel.

[0049] As a result, a method of driving the LCD according to the present invention changes a turning-on sequence of the MUX's every frame or every line, thereby reducing a voltage unbalance between the data lines that may be generated due to a charge characteristic difference and a leakage current by a so-called averaging effect.

[0050] As described above, according to the present invention, a turning-on sequence of the multiplexors is changed every frame or every line in consideration of a poor picture quality, such as a stripe-shape display, caused by a characteristic difference between the multiplexors in the prior art upon low-temperature operation or deterioration of mobility, so that vertical stripes generated on the liquid crystal display panel can be removed to thereby permit a picture expression with no distortion.

[0051] Although the present invention has been explained by the embodiments shown in the drawings described above, it should be understood to the ordinary skilled person in the art that the invention is not limited to the embodiments, but rather that various changes or modifications thereof are possible without departing from the spirit of the invention. Accordingly, the scope of the invention shall be determined only by the appended claims and their equivalents

What is claimed is:

1. A method of driving a liquid crystal display having liquid crystal cells arranged between gate lines and data lines in a matrix type, said method comprising the steps of:

sequentially applying a gate-driving signal to the gate lines for a sequential scanning for each line;

supplying a data to the liquid crystal cells with the same color being adjacent to each other in a scanning interval of a first scanning line; and

differentiating an application sequence of a data to the liquid crystal cells with the same color being adjacent to each other in a scanning interval of a second scanning line from that in a scanning interval of the first scanning line.

2. The method as claimed in claim 1, further comprising the steps of:

at the first line, supplying a data to the first liquid crystal cell of the first and second liquid crystal cells with a first color being adjacent to each other and thereafter supplying the data to the second liquid crystal cell;

supplying a data to the fourth liquid crystal cell of the third and fourth liquid crystal cells with a second color and thereafter supplying the data to the third liquid crystal cell; and

supplying a data to the fifth liquid crystal cell of the fifth and sixth liquid crystal cells with a third color and thereafter supplying the data to the sixth liquid crystal cell.

3. The method as claimed in claim 2, wherein the first color is a red, a second color is a green, and a third color is a blue.

4. The method as claimed in claim 2, further comprising the steps of:

at the second line, supplying a data to the second liquid crystal cell and thereafter supplying the data to the first liquid crystal cell;

supplying a data to the third liquid crystal cell and thereafter supplying the data to the fourth liquid crystal cell; and

supplying a data to the sixth liquid crystal cell and thereafter supplying the data to the fifth liquid crystal cell.

5. The method as claimed in claim 4, wherein the first color is a red, a second color is a green, and a third color is a blue.

6. A method of driving a liquid crystal display having liquid crystal cells arranged between gate lines and data lines in a matrix type that employs a polarity inversion for each frame, said method comprising the steps of:

sequentially applying a gate-driving signal to the gate lines every frame for a sequential scanning for each frame;

supplying a data to the liquid crystal cells with the same color being adjacent to each other in a specific sequence at a first frame of said frames;

differentiating an application sequence of a data to the liquid crystal cells with the same color being adjacent to each other at a second frame following the first frame from that that at the first frame;

equalizing a data application sequence at a third frame following the second frame to that at the second frame;

equalizing a data application sequence at a fourth frame following the third frame to that at the first frame; and

periodically repeating a data application in said sequences at the first to fourth frames.

7. The method as claimed in claim 6, further comprising the steps of:

at the first frame, supplying a data to the first liquid crystal cell of the first and second liquid crystal cells with a first color being adjacent to each other and thereafter supplying the data to the second liquid crystal cell;

supplying a data to the fourth liquid crystal cell of the third and fourth liquid crystal cells with a second color and thereafter supplying the data to the third liquid crystal cell; and

supplying a data to the fifth liquid crystal cell of the fifth and sixth liquid crystal cells with a third color and thereafter supplying the data to the sixth liquid crystal cell.

8. The method as claimed in claim 7, wherein the first color is a red, a second color is a green, and a third color is a blue.

9. The method as claimed in claim 7, further comprising the steps of:

at the second frame, supplying a data to the second liquid crystal cell and thereafter supplying the data to the first liquid crystal cell;

supplying a data to the third liquid crystal cell and thereafter supplying the data to the fourth liquid crystal cell; and

supplying a data to the sixth liquid crystal cell and thereafter supplying the data to the fifth liquid crystal cell.

10. The method as claimed in claim 9, wherein the first color is a red, a second color is a green, and a third color is a blue.

* * * * *

专利名称(译)	驱动液晶显示器的方法		
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摘要(译)

一种驱动液晶显示器的方法，该方法适用于改善采用液晶显示器多路复用器的驱动方法的均匀性。在该方法中，将栅极驱动信号顺序地施加到栅极线，以对每条线进行顺序扫描。在第一扫描线的扫描间隔中将数据提供给具有相同颜色的液晶单元。在第二扫描线的扫描间隔中，具有相同颜色的相同颜色的液晶单元的数据的应用顺序与第一扫描线的扫描间隔中的数据的应用顺序不同。