



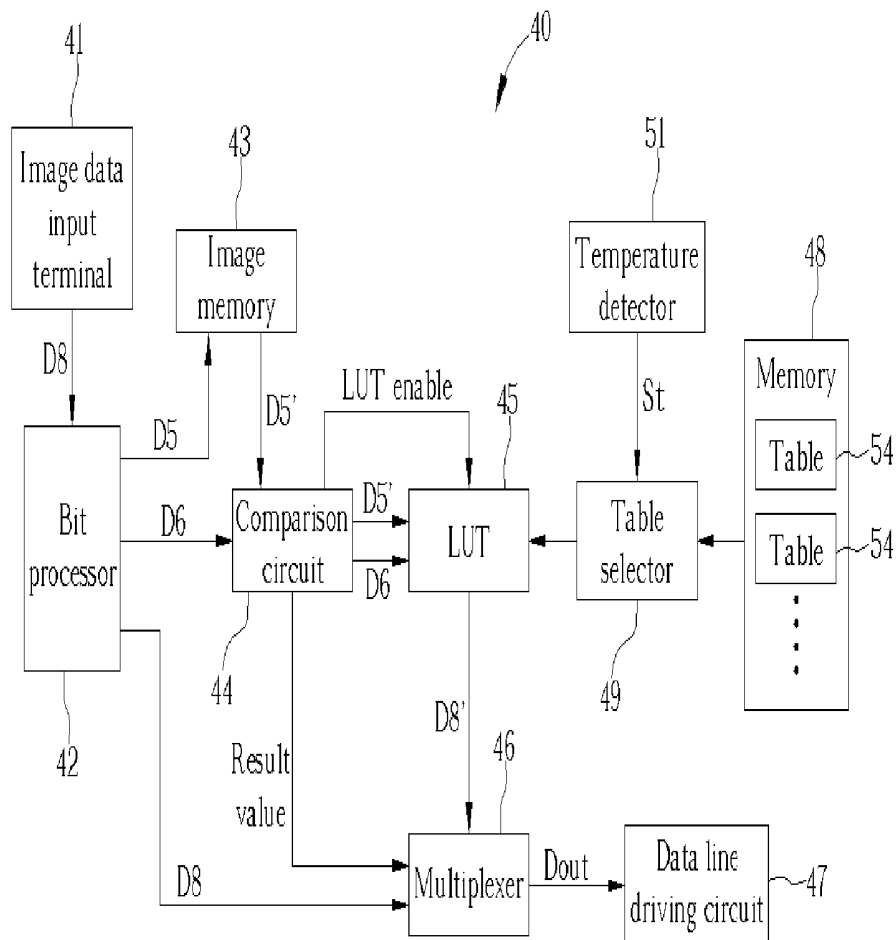
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(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2005/0073630 A1**
Chen et al. (43) **Pub. Date: Apr. 7, 2005**(54) **DRIVING CIRCUIT OF A LIQUID CRYSTAL
DISPLAY AND DRIVING METHOD
THEREOF****Publication Classification**(51) **Int. Cl.⁷** **G02F 1/1333; G09G 3/36**(52) **U.S. Cl.** **349/87**(76) Inventors: **Cheng-Jung Chen**, Miao- Li Hsien
(TW); **Yuhren Shen**, Tai-Nan City
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Hsien (TW)(57) **ABSTRACT**Correspondence Address:
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The present invention relates to a driving circuit of a liquid crystal display and a driving method thereof. The method includes receiving a M-bit image data from an image data input terminal and extracting N most significant bits (MSB) of the M-bit image data to form a N-bit image data. The N-bit image data is delayed by one frame period to form a N-bit delayed image data. The N-bit delayed image data is compared with P MSB of a current M-bit image data to determine whether to generate a first data voltage according to a first image value selected from a reference table, or to generate a second data voltage according to the current M-bit image data.

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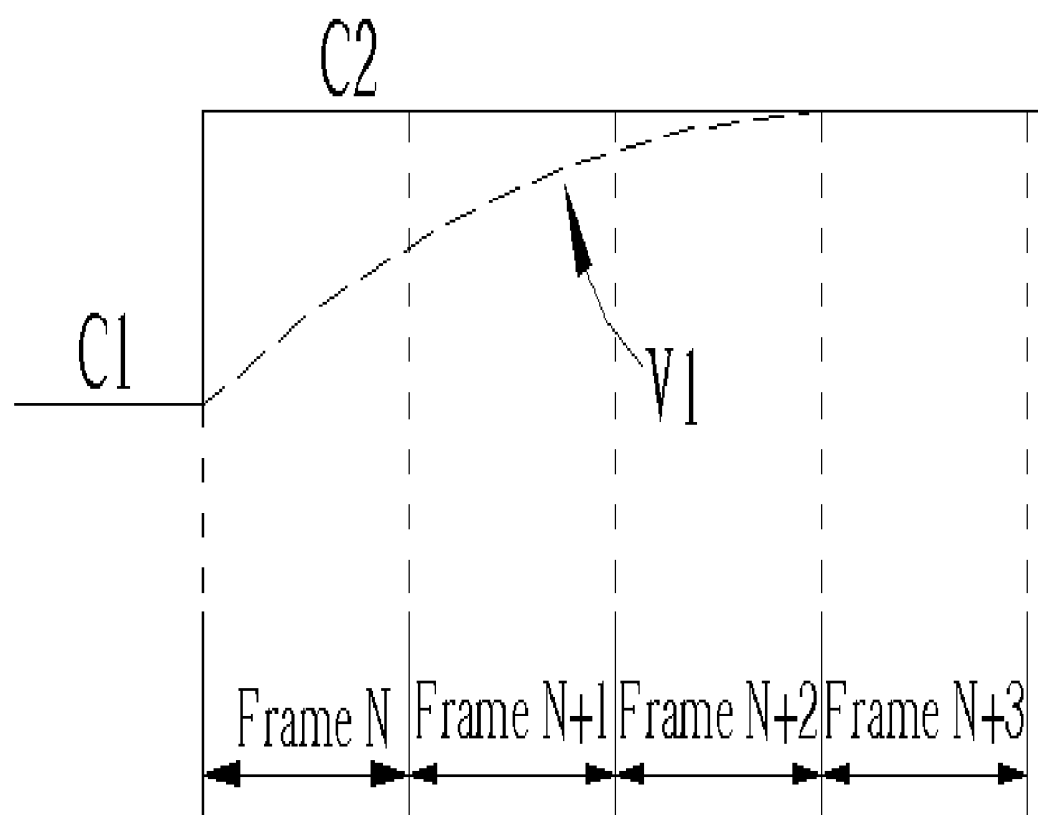


Fig. 1 Prior art

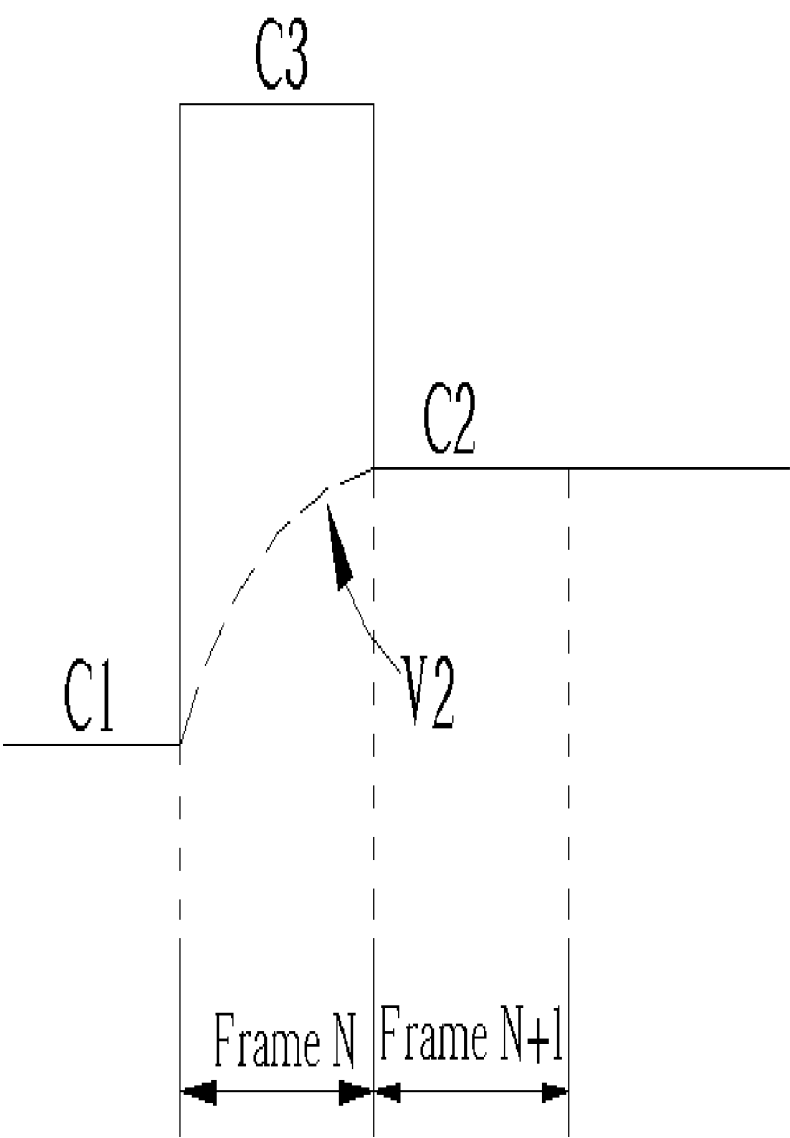


Fig. 2 Prior art

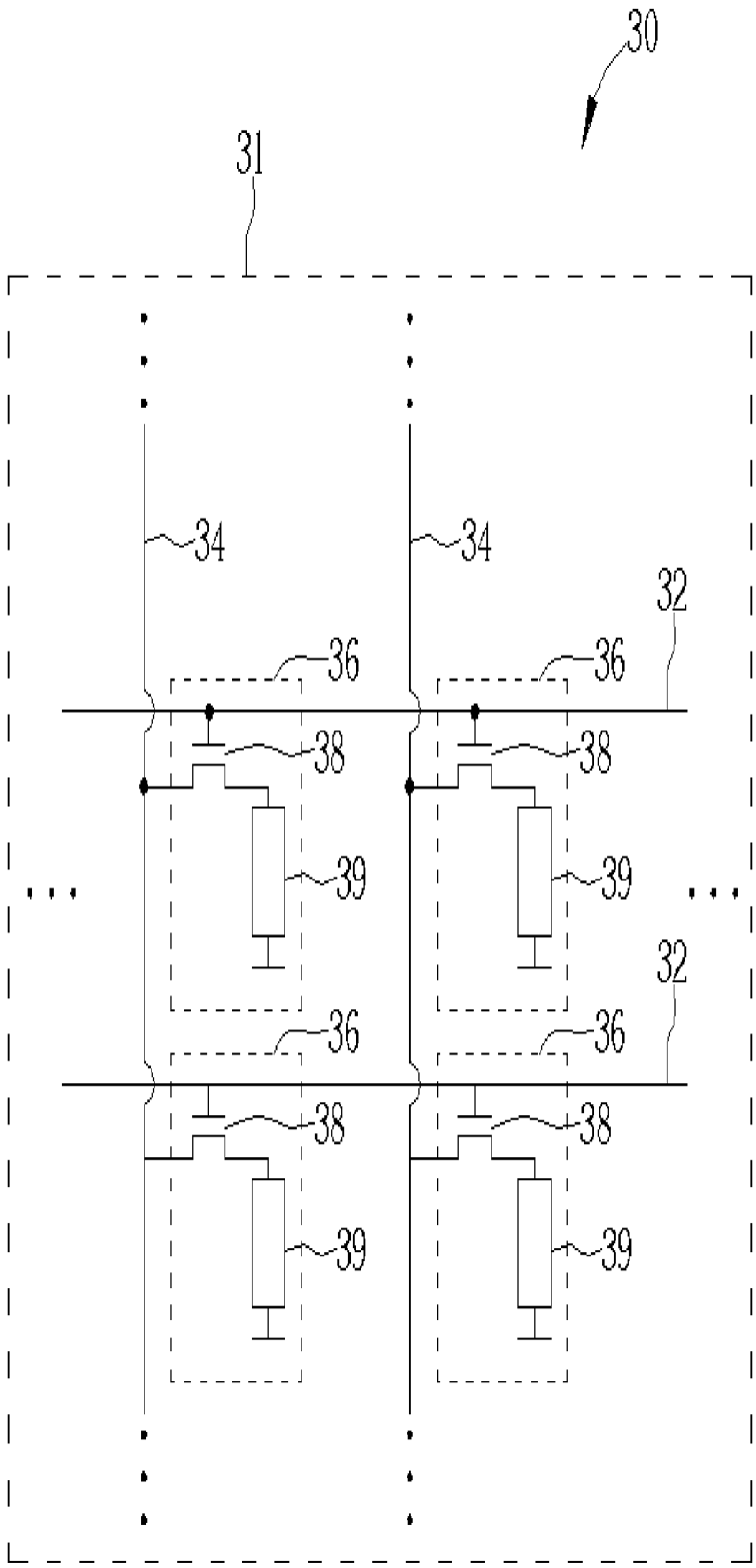


Fig. 3 Prior art

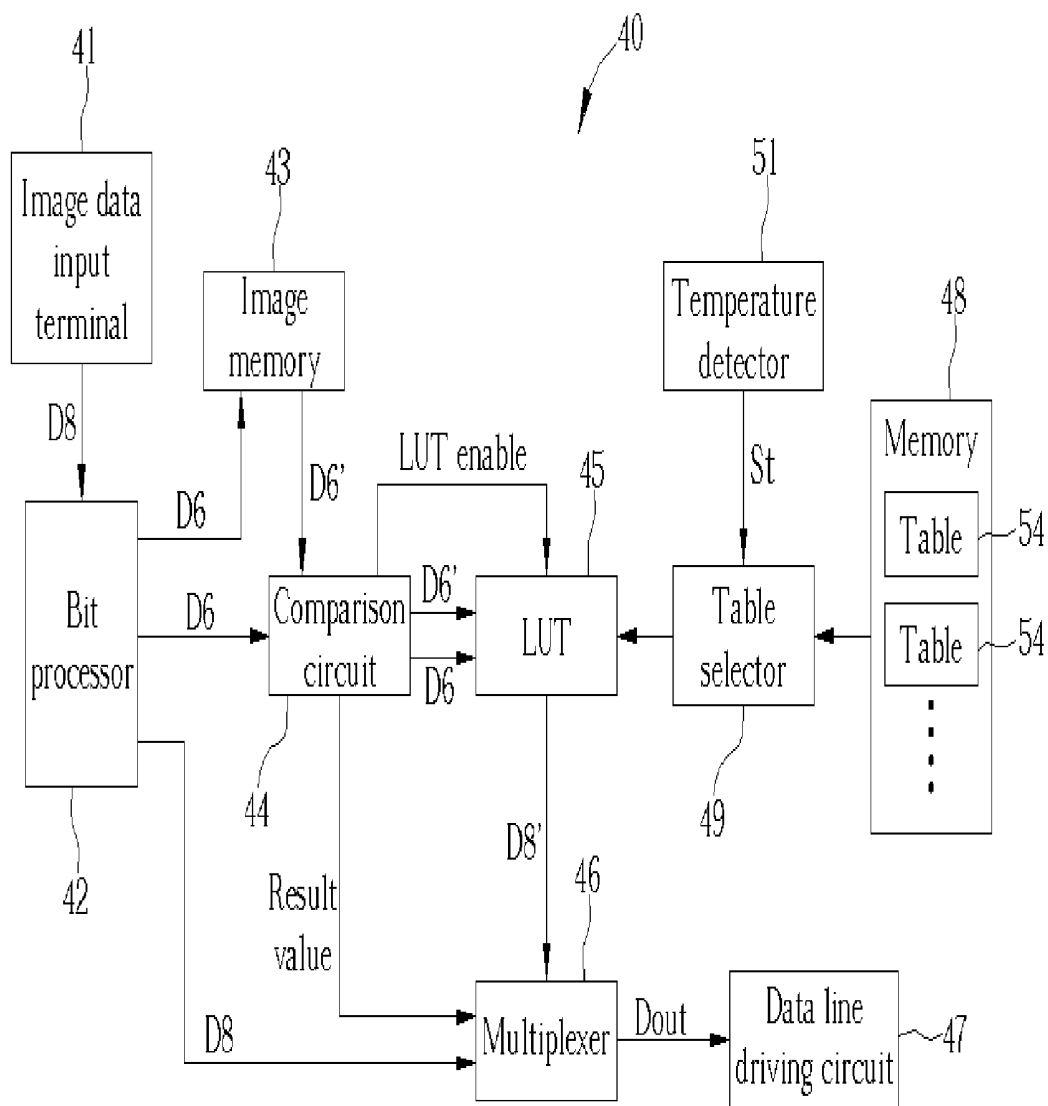


Fig. 4

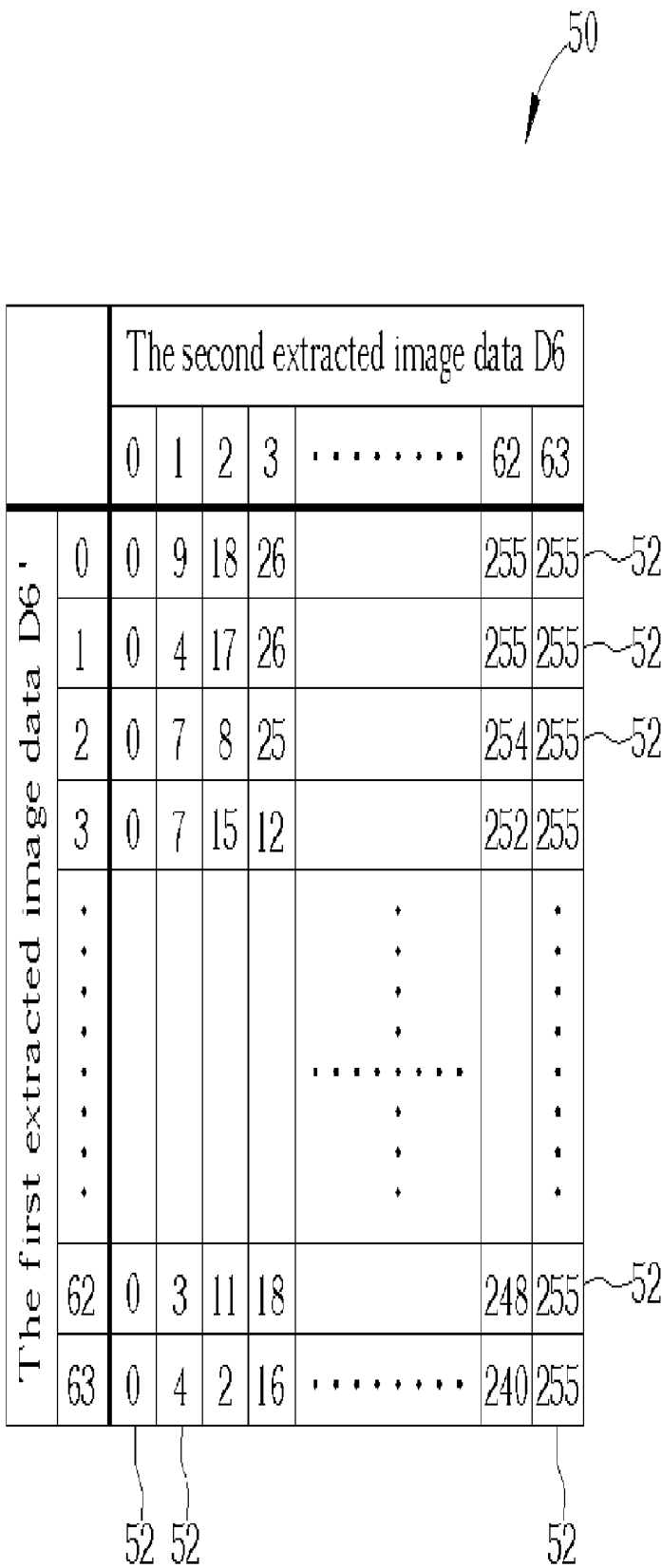


Fig. 5

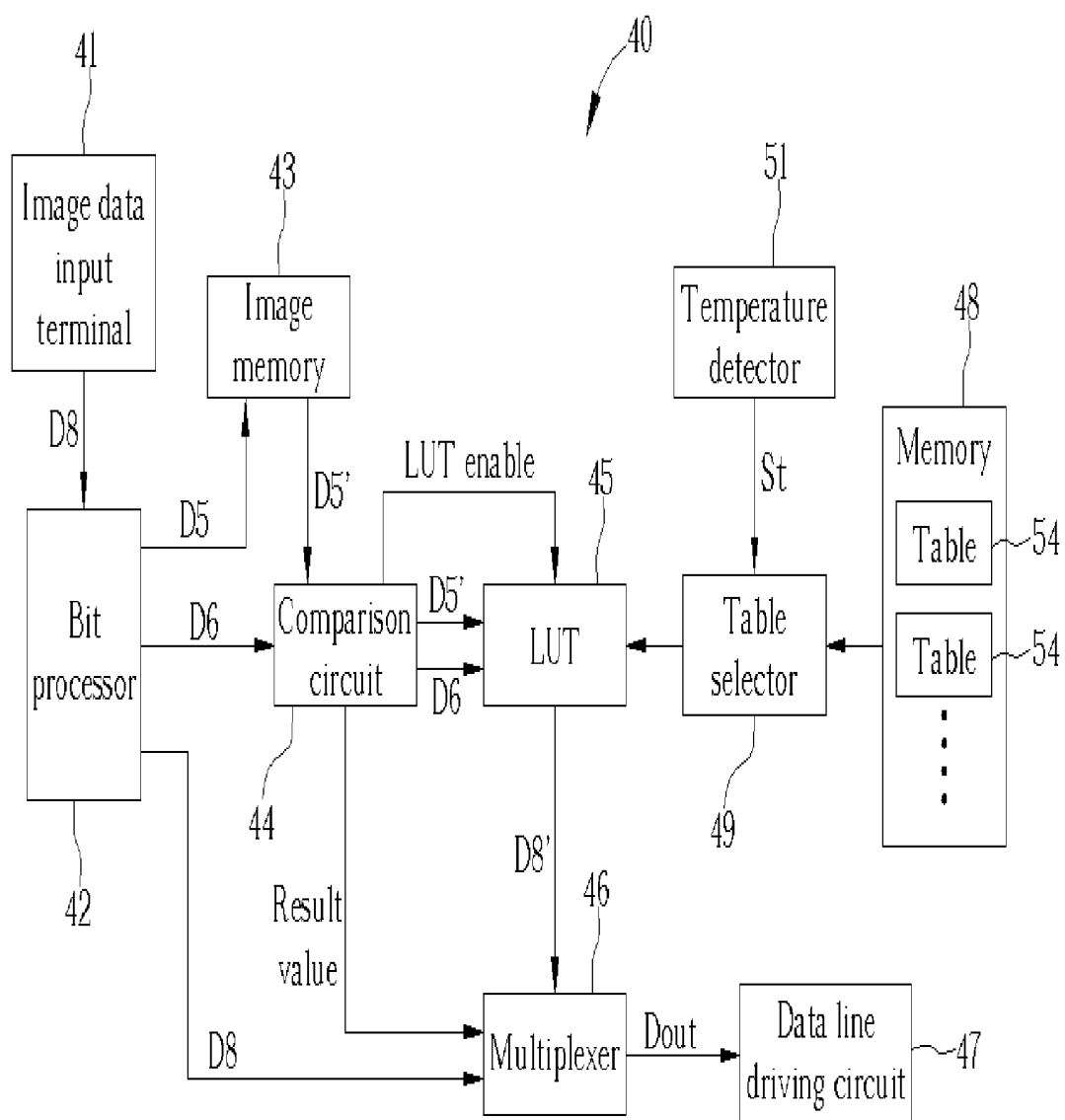


Fig. 6

70

		The second extracted image data D6							
		0	1	2	3		62	63	
The first extracted image data D5'	0	0	5	9	14		254	255	~72
	1	0	3	8	12		253	255	~72
	2	0	3	7	12		253	255	
	3	0	2	7	11		252	255	
	⋮					⋮		⋮	
	⋮					⋮		⋮	
	⋮					⋮		⋮	
	⋮					⋮		⋮	
	⋮					⋮		⋮	
	⋮					⋮		⋮	
30	0	0	5	10		251	255	~72	
31	0	0	4	9		251	255	~72	

72

72

72

Fig. 7

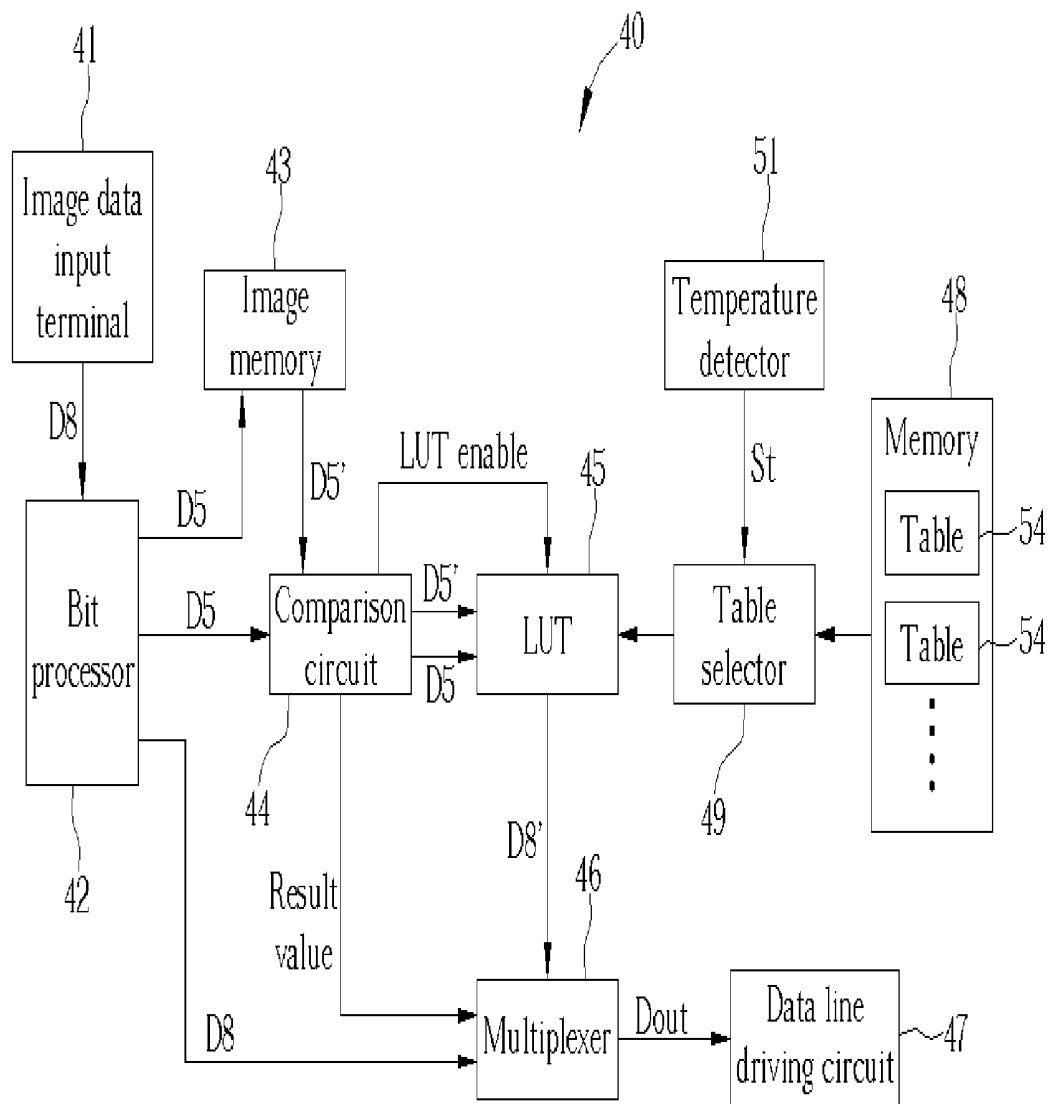


Fig. 8

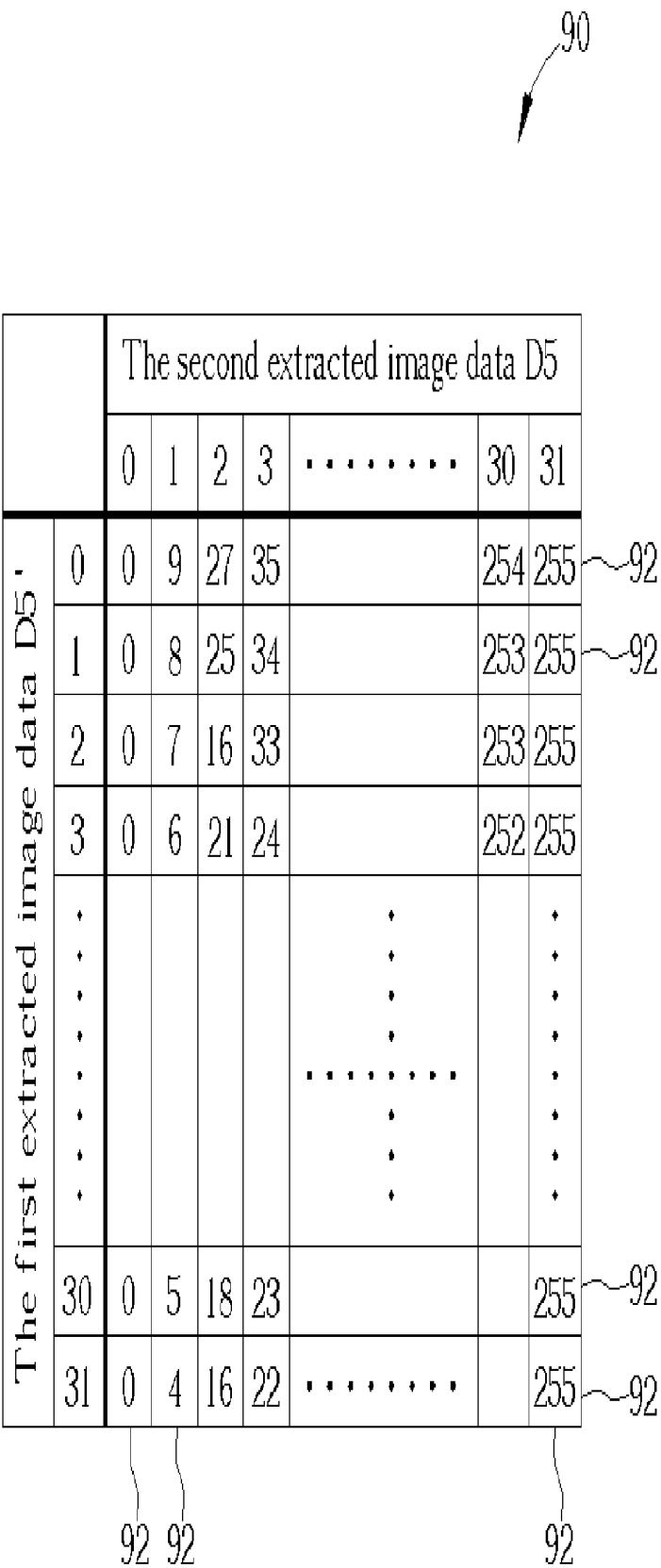


Fig. 9

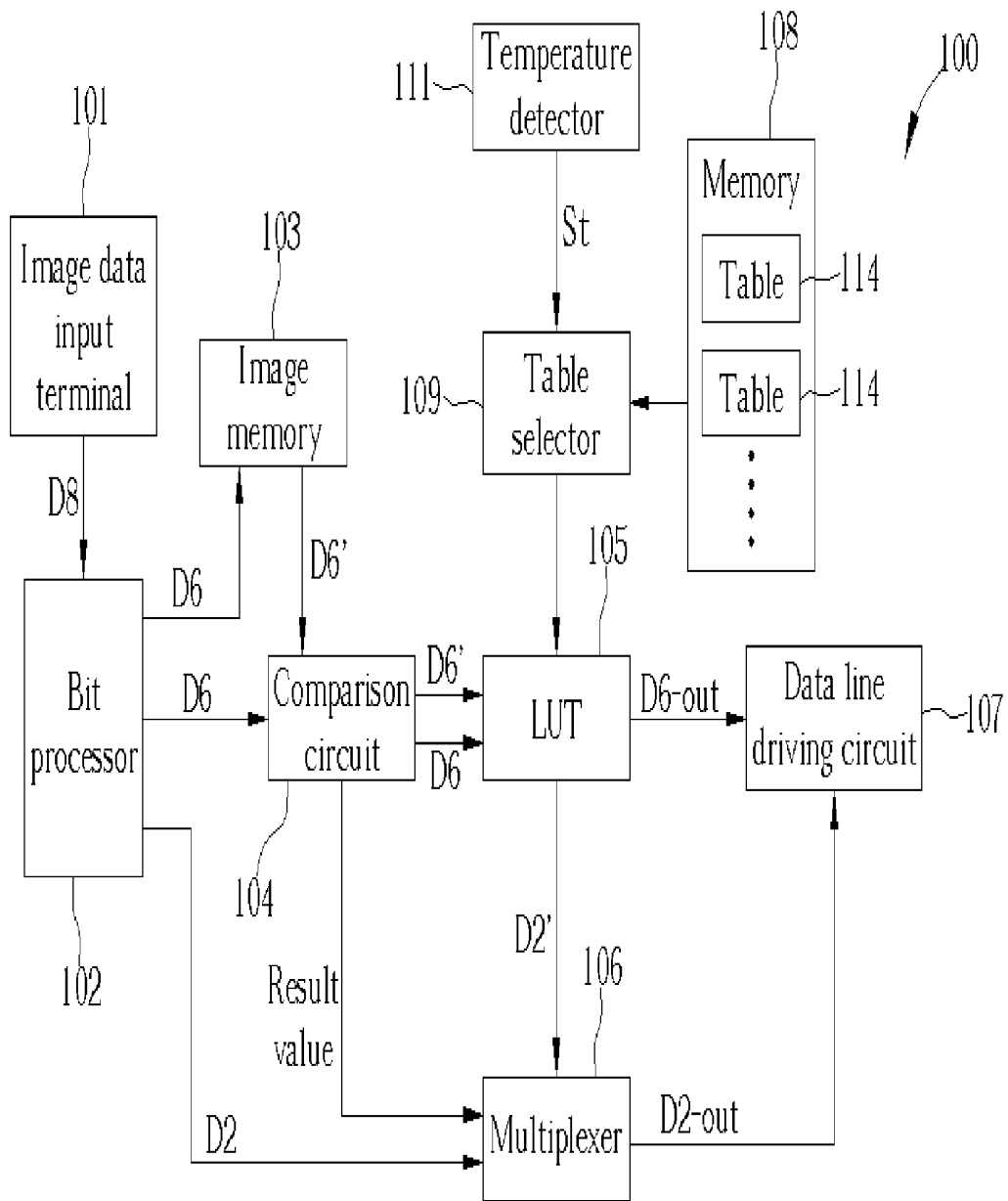


Fig. 10

DRIVING CIRCUIT OF A LIQUID CRYSTAL DISPLAY AND DRIVING METHOD THEREOF

BACKGROUND OF INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates to a driving circuit of a liquid crystal display and a driving method thereof, and more particularly, to a driving circuit and a driving method with a lookup table (LUT).

[0003] 2. Description of the Prior Art

[0004] A liquid crystal display (LCD) has advantages of lightweight, low power consumption, and low divergence, and is applied to various portable equipment, such as notebook computers and personal digital assistants (PDA). In addition, LCD monitors and LCD televisions are gaining in popularity as a substitute for traditional cathode ray tube (CRT) monitors and televisions. However, an LCD still has some disadvantages. Because of the limitations of physical characteristics, the liquid crystal molecules should be twisted and rearranged when changing input data, and the images will be delayed. For satisfying the rapid switching requirements of multimedia equipment, improving the response speed of liquid crystal is desired.

[0005] Please refer to **FIG. 1**, which is a timing diagram of the pixel voltage and the transmission rate **V1** according to a prior art LCD. In **FIG. 1**, the pixel voltage is shown with the straight lines, and the transmission rate **V1** is shown with a dotted line. In **FIG. 1**, frame **N** means a frame period, and frame **N+1**, **N+2** . . . mean the following frame periods. When the pixel voltage is switched from a data voltage **C1** to a data voltage **C2**, due to the physical characteristics of liquid crystal molecules, the liquid crystal molecules cannot be twisted to a predetermined angle within a frame period and fail to perform a predetermined transmission rate. As the curve of the transmission rate **V1** shows, the transmission rate **V1** cannot reach a predetermined transmission rate until the frame period of frame **N+2**. The delayed switch will cause blurring on the LCD.

[0006] An over-driving method is utilized to improve the delayed switch. Please refer to **FIG. 2**, which is a timing diagram of the pixel voltage and the transmission rate **V2** according to a prior art LCD using an over-driving method. When the pixel voltage is switched from the data voltage **C1** to the data voltage **C2**, an over-driving data voltage **C3** is added to accelerate the response speed of the liquid crystal molecules. Since a higher data voltage can obtain a faster response speed of the liquid crystal molecules, the data voltage **C3** higher than the data voltage **C2** can improve the delayed switch to reach the predetermined transmission rate in a frame period. As **FIG. 2** shows, the curve of the transmission rate **V2** can reach the predetermined transmission rate in frame **N**.

[0007] The U.S. published application Ser. No. 2002/0050965 discloses an over-driving method using a brief table to store the over-driving image data. The brief table only includes part of the over-driving image data for driving the pixels switched from one gray level to another. When the driving circuit receives the image data from the input terminal, a processor is used to perform an interpolation operation to expand the brief table. Hence, an extra algo-

rithm is needed in the conventional over-driving method and the algorithm will slow down the response speed.

SUMMARY OF INVENTION

[0008] It is therefore a primary objective of the claimed invention to provide a driving circuit of a liquid crystal display and a driving method thereof to solve the above-mentioned problem.

[0009] According to the claimed invention, a driving circuit of a liquid crystal display and a driving method thereof are disclosed. The liquid crystal display includes a liquid crystal panel. The liquid crystal panel has a plurality of scan lines, a plurality of data lines, and a plurality of pixels. Each pixel is connected to a corresponding scan line and a corresponding data line, and each pixel has a switching device connected to the corresponding scan line and the corresponding data line. The driving circuit includes a scan line driving circuit, an image data input terminal, a bit processor, an image memory, a comparison circuit, a lookup table (LUT), a multiplexer, and a data line driving circuit.

[0010] The claimed driving method includes continuously providing scan voltages to the scan lines and the bit processor receiving an **M**-bit image data from an image data input terminal. The **N** most significant bits (MSB) of the **M**-bit image data is extracted to form an **N**-bit image data, with **N** being smaller than **M**. The **N**-bit image data is delayed by a frame period to form an **N**-bit delayed image data. **P** MSB of a current **M**-bit image data are compared with the **N**-bit delayed image data to determine a result value. If the result value equals a first result value, a first image value is selected from a reference table in accordance with the **P** MSB and the **N**-bit delayed image data and a first data voltage is formed according to the first image value, the first data voltage being provided to the corresponding data line. If the result value equals a second result value, a second data voltage is formed in accordance with the current **M**-bit image data and the second data voltage is provided to the corresponding data line.

[0011] In addition, if the result value equals a second result value, the driving method can also select a second image value from a reference table in accordance with the **P** MSB and the **N**-bit delayed image data and form a second data voltage in accordance with (**M-Q**)MSB of the second image value and **Q** least significant bits (LSB) of the current **M**-bit image data, and then provide the second data voltage to the corresponding data line.

[0012] The claimed invention extracts MSB of the image data to perform the over-driving method without increasing memory. The image process and transmission can be accelerated without increasing hardware cost.

[0013] These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0014] **FIG. 1** is a timing diagram of pixel voltage and transmission rate according to prior art.

[0015] **FIG. 2** is another timing diagram of pixel voltage and transmission rate according to prior art using an over-driving method.

[0016] FIG. 3 is a diagram of liquid crystal display.

[0017] FIG. 4 is a block diagram of one embodiment of the present invention.

[0018] FIG. 5 is a reference table used for the lookup table in FIG. 4.

[0019] FIG. 6 is a block diagram of another application of the present invention.

[0020] FIG. 7 is a reference table used for the lookup table in FIG. 6.

[0021] FIG. 8 is a block diagram of another application of the present invention.

[0022] FIG. 9 is a reference table used for the lookup table in FIG. 8.

[0023] FIG. 10 is a block diagram of another embodiment of the present invention.

DETAILED DESCRIPTION

[0024] Please refer to FIG. 3, which is a diagram of a general LCD 30. The LCD 30 comprises a liquid crystal panel 31, and the liquid crystal panel 31 comprises a plurality of scan lines 32, a plurality of data lines 34, and a plurality of pixels 36. Each pixel 36 is connected to a corresponding scan line 32 and a corresponding data line 34, and each pixel 36 has a switching device 38 and a pixel electrode 39. The switching device 38 is connected to the corresponding scan line 32 and the corresponding data line 34.

[0025] The driving method of the LCD 30 provides scan voltages to the scan lines 32 to open the switching devices 38, and data voltages are provided to the data lines 34 and transferred to the pixel electrodes 39 through the switching devices 38. When scan voltages are provided to the scan lines 32 to open the switching devices 38, data voltages on the data lines 34 will charge the pixel electrodes 39 through the switch devices 38, and twist the liquid crystal molecules. When scan voltages on the scan lines 32 are removed to close the switching devices 38, the electrical connections between the data lines 34 and the pixel 36 will be cut and the pixel electrodes 39 will remain charged. The scan lines 32 control the switching devices 38 to repeatedly open and close, and thus the pixel electrodes 39 can be repeatedly charged. Different data voltages will cause different twisting angles and show different transmission rates. Hence, the LCD 30 displays different images.

[0026] Please refer to FIG. 4, which is a block diagram of the first embodiment. A driving circuit 40 is utilized for driving the LCD 30 in FIG. 3. The driving circuit 40 comprises an image data input terminal 41, a bit processor 42, an image memory 43, a comparison circuit 44, a lookup table (LUT) 45, a multiplexer 46, a data line driving circuit 47, a memory 48, a table selector 49, and a temperature detector 51. In this embodiment, the image memory 43 is a 16-bit (5,6,5 or 5,5,5) memory having the necessary circuitry to read/write the memory cells. The image data input terminal 41 transfers 3 image data (RGB) to the bit processor 42, and each image data is 8 bits for controlling the gray levels of the pixel 30. Each color has 256 (2^8) gray levels, so the 3 image data need 24 bits (8×3) to determine a RGB image. For using the 16-bit image memory 43 in this

embodiment, the bit processor 42 is used to extract most significant bits (MSB) of the 3 RGB image data. For example, extracting 5 MSB of the R image data, 6 MSB of the G image data, and 5 MSB of the B image data, and storing the extracted data in the image memory 43. It is of course possible that 5 or other quantities MSB can be extracted from 3 RGB image data as long as the total extracted bits are not more than 16.

[0027] In this embodiment, one of the 3 RGB image data is representative to explain the present invention. The image data input terminal 41 transfers an 8-bit image data D8 to the bit processor 42. The bit processor 42 processes the 8-bit image data D8 and outputs a 6-bit second extracted image data D6 and a current 8-bit image data D8. The second extracted image data D6 is the 6 MSB extracted from the current 8-bit image data D8 by the bit processor 42, and the second extracted image data D6 is stored in the image memory 43 to delay a frame period. After delayed a frame period, the second extracted image data D6 is outputted as a first extracted image data D6. In FIG. 4, the first extracted image data D6 and the second extracted image data D6 received by the comparison circuit 44 belong to different frame cycles as they differ one frame period.

[0028] The bit processor 42 transfers the second extracted image data D6 to the comparison circuit 44 and transfers the current 8-bit image data D8 to the multiplexer 46. The image memory 43 transfers the first extracted image data D6 to the comparison circuit 44. The first extracted image data D6 and the second extracted image data D6 are compared in the comparison circuit 44. A result value of 0 or 1 is determined after comparing the first extracted image data D6 and the second extracted image data D6. The result value 0 means that the first extracted image data D6 and the second extracted image data D6 are the same, and the result value 1 means that they are different. Since the first extracted image data D6 and the second extracted image data D6 are extracted from two different 8-bit image data D8, the result value 0 means that the differences between these two 8-bit image data D8 is less than 4.

[0029] For example, if the values of the first extracted image data D6 and the second extracted image data D6 are both 2 (000010), the result value of the comparison circuit 44 is 0, and the two corresponding 8-bit image data D8 are 8~11 (00001000~00001011). When the result value is 0, the pixel 36 does not need the over-driving control. On the other hand, if the result value is 1, the difference between these two 8-bit image data D8 is at least 4 and the pixel 36 needs the over-driving control. For example, if the value of the first extracted image data D6 is 2 (000010) and the value of the second extracted image data D6 is 5 (000101), the two corresponding 8-bit image data D8 are 8~11 (00001000~00001011) and 20~23 (00010100~00010111). In this situation, the pixel 36 needs the over-driving control.

[0030] The lookup table 45 comprises a reference table, and the lookup table 45 is operated in accordance with the reference table. Please refer to FIG. 5, which illustrates a reference table 50 of the lookup table 45 in FIG. 4. The reference table 50 is recorded with ($2^6 \times 2^6$) or ($2^5 \times 2^5$) 8-bit image data values 52, and each image data value 52 corresponds to different first extracted image data D6 and second extracted image data D6. When the result value is 1, meaning the first extracted image data D6 and the second

extracted image data D6 are different, the first extracted image data D6 and the second extracted image data D6 are transferred to the lookup table 45. Then the lookup table 45 selects a corresponding 8-bit image data value 52 from the reference table 50 as a first image value D8 according to the first extracted image data D6 and the second extracted image data D6, and transfers the first image value D8 to the multiplexer 46.

[0031] For example, when the value of the first extracted image data D6 is 2 (000010) and the value of the second extracted image data D6 is 3 (000011), the lookup table 45 selects 25 (00011001) from the reference table 50 as the first image value D8, and transfers the first image value D8 to the multiplexer 46.

[0032] In addition, the result value of the comparison circuit 44 is transferred to the multiplexer 46 to control the operation of the multiplexer 46. If the result value is 0, the multiplexer 46 will output the current 8-bit image data D8. If the result value is 1, the multiplexer 46 will output the over-driving image data D8. The output Dout of the multiplexer 46 is transferred to the data line driving circuit 47, and the data line driving circuit 47 produces a corresponding data voltage in accordance with the output Dout (D8 or D8) of the multiplexer 46. The data voltage is applied to the corresponding data line 34 to control the pixel 36.

[0033] For example, if the values of the first extracted image data D6 and the second extracted image data D6 are both 2 (000010) and the value of the current 8-bit image data D8 is 10 (00001010), the output Dout of the multiplexer 46 will be 10 (00001010) and the data line driving circuit 47 will produce a first data voltage corresponding to the output Dout. If the value of the first extracted image data D6 is 2 (000010) and the value of the second extracted image data D6 is 63 (111111), the over-driving image data D8 outputted by the lookup table 45 will be 255 (11111111), the output Dout will be 255, and the data line driving circuit 47 will produce a second data voltage corresponding to the output Dout.

[0034] FIG. 6 shows a similar embodiment of the present invention. In this situation, the bit processor 42 extracts different MSBs of the 8-bit image data D8. For example, 5 and 6 MSBs of the 8-bit image data D8 are extracted to be the first extracted image data D5 and the second extracted image data D6 respectively. As with the previous embodiment, the comparison circuit 44 compares the first extracted image data D5 and the second extracted image data D6 and determines the result value. When comparing the first extracted image data D5 and the second extracted image data D6, the comparison circuit fills the least significant bits (LSB) of the first extracted image data D5 with 0 and compares the filled first extracted image data D5 with the second extracted image data D6. For example, if the first extracted image data D5 is 7 (00111) and the second extracted image data D6 is 10 (001010), the LSB of the first extracted image data D5 is filled with 0 so that the filled first extracted image data D5 becomes 14 (001110). Then, 14 (001110) is compared with 10 (001010). Again, if the result value is 0, the pixel 36 does not need the over-driving control. If the result value is 1, the pixel 36 needs the over-driving control.

[0035] In addition, when comparing the first extracted image data D5 and the second extracted image data D6, the

comparison circuit 44 can delete the LSB of the second extracted image data D6 and compare the first extracted image data D5 with the modified second extracted image data D6. For example, if the first extracted image data D5 is 7 (00111) and the second extracted image data D6 is 10 (001010), the LSB of the second extracted image data D6 is deleted, and the modified second extracted image data D6 is 5 (00101). Then, 7 (00111) is compared with 5 (00101). Similarly, if the result value is 0, the pixel 36 does not need the over-driving control. If the result value is 1, the pixel 36 needs the over-driving control.

[0036] In this embodiment, the reference table used in the lookup table 45 is different. Please refer to FIG. 7, which is a reference table 70 used for the lookup table 45 in this situation. The reference table 70 is recorded with $(2^5 \times 2^6)$ 8-bit image data values 72. When the result value is 1, meaning that the first extracted image data D5 and the second extracted image data D6 are different, the first extracted image data D5 and the second extracted image data D6 are transferred to the lookup table 45. Then the lookup table 45 selects a corresponding 8-bit image data value 72 from the reference table 70 as a first image value D8 according to the first extracted image data D5 and the second extracted image data D6, and transfers the first image value D8 to the multiplexer 46.

[0037] For saving power, the comparison circuit 44 can further output a LUT enable signal to the lookup table 45. When the result value is 1, the LUT enable signal will turn on the lookup table 45. When the result value is 0, the LUT enable signal will turn off the lookup table 45.

[0038] In this embodiment, the bit processor 42 extracts N and P MSBs of the 8-bit image data D8 to form the first extracted image data and the second extracted image data. As described above, the combination of (N,P) is (6,6) or (5,6), and can be other suitable values such as (5,5). Please refer to FIG. 8 and FIG. 9. FIG. 8 is a block diagram of an embodiment where (N,P) is (5,5), and FIG. 9 is a reference table 90 used for the lookup table 45 in FIG. 8. The operation where (N,P) is (5,5) is similar to that where (N,P) is (6,6), and the only difference is whether 5 or 6 MSBs of the 8-bit image data D8 is extracted. When (N,P) is (5,5), the first extracted image data D5 and the second extracted image data D5 are both 5-bit image data, and the reference table 90 is stored with $(2^5 \times 2^5)$ 8-bit image data 92. The lookup table 45 selects a corresponding 8-bit image data value 92 from the reference table 90 according to the first extracted image data D5 and the second extracted image data D5 to control the followed operation of the data line driving circuit 47.

[0039] FIG. 10 is a block diagram of another embodiment of the present invention. The driving circuit 100 is also used for driving the LCD 30 in FIG. 3. The driving circuit 100 also comprises an image data input terminal 101, a bit processor 102, an image memory 103, a comparison circuit 104, a lookup table (LUT) 105, a multiplexer 106, a data line driving circuit 107, a memory 108, a table selector 109, and a temperature detector 111. Functions of all elements (except where stated otherwise) are the same as those of the corresponding elements in the driving circuit 40. In this embodiment, the image memory 103 is also a 16-bit memory. The image data input terminal 101 transfers 3 image data (RGB) to the bit processor 102, and each image data is 8 bits.

[0040] In this embodiment, one of the 3 RGB image data is also representative to explain the present invention. The

image data input terminal **101** transfers an 8-bit image data **D8** to the bit processor **102**. The bit processor **102** processes the 8-bit image data **D8** and outputs a 6-bit second extracted image data **D6** and a 2-bit third extracted image data **D2**. The second extracted image data **D6** is delayed a frame period and is outputted as a first extracted image data **D6**. The producing and transferring methods of the first extracted image data **D6** and the second extracted image data **D6** are the same as those in the previous embodiments. The bit processor **102** extracts 2 LSB of the 8-bit image data **D8** to form the third extracted image data **D2**, and the third extracted image data **D2** is transferred to the multiplexer **106**.

[0041] The first extracted image data **D6** and the second extracted image data **D6** are also compared in the comparison circuit **104**, and a result value 0 or 1 is determined. In this embodiment, the comparison process and the definition of the result value are all same as those in the previous embodiments. The comparison circuit **104** transfers the first extracted image data **D6** and the second extracted image data **D6** to the lookup table **105**, and transfers the result value to the multiplexer **106**. Similarly to the previous embodiments, the bit numbers of the first extracted image data **D6** and the second extracted image data **D6** are the same or different. When **D6** and **D6** are different, the lookup table **105** selects the over-driving image data from the reference table **50**, **70**, or **90**.

[0042] When the lookup table **105** is operated, the lookup table **105** selects a 8-bit over-driving image data from the reference table **50**, **70**, or **90** according to the first extracted image data **D6** and the second extracted image data **D6**, and extracts 2 LSB **D2** and 6 MSB **D6-out** of the 8-bit over-driving image data. Consider an example, when the value of the first extracted image data **D6** is 2 (000010) and the value of the second extracted image data **D6** is 3 (000011). The lookup table **105** selects 25 (00011001) from the reference table **50** (FIG. 5) as the 8-bit over-driving image value, and extracts 2 LSB (01) and 6 MSB (000110) of the 8-bit over-driving image value (00011001) to separately transfer to the multiplexer **106** and the data line driving circuit **107** as **D2** and **D6-out**. Similarly, the result value is transferred to the multiplexer **106** to control its operation. If the result value is 0, the multiplexer **106** will output the 2 LSB **D2** of the current 8-bit image data **D8**. If the result value is 1, the multiplexer **106** will output **D2** of the lookup table **105**. The output **D2-out** of the multiplexer **106** is transferred to the data line driving circuit **107**, and the data line driving circuit **107** produces a corresponding data voltage in accordance with the output **D2-out** (**D2** or **D2**) of the multiplexer **106** and the output **D6-out** of the lookup table **105**. The data voltage is applied to a corresponding data line **34** to control the pixel **36**.

[0043] For example, if the first extracted image data **D6** and the second extracted image data **D6** are both 2 (000010) and the current 8-bit image data **D8** is 11 (00001011), the lookup table **105** will select the over-driving image data **52** which has a value of 8 (00001000) from the reference table **50**. The output **D2** is 0 (00) and the output **D6-out** is 2 (000010), and the output **D2-out** of the multiplexer **106** equals the third extracted image data **D2** (11). The data line driving circuit **107** produces a corresponding first data voltage in accordance with the 2 LSB **D2** of the current 8-bit image data **D8** and the 6 MSB **D6-out** of the over-driving

image data **52** which has the value of 8 (00001000). If the first extracted image data **D6** is 2 (000010) and the second extracted image data **D6** is 63 (111111), the lookup table **105** will select the over-driving image data **52** whose value is 255 (11111111) from the reference table **50**. The output **D2** is 3 (11) and the output **D6-out** is 63 (111111), and the data line driving circuit **107** produces a corresponding second data voltage in accordance with the over-driving image data **52** which value is 255.

[0044] When the liquid crystal molecules of the LCD **30** are twisted, the response time differs with the temperature of the liquid crystal panel **31**. For the best performance of the LCD **30**, the driving circuits **40** and **100** select a suitable reference table according to the temperature of the liquid crystal panel **31**. As FIG. 4 and FIG. 10 show, the memory **48** and **108** comprise a plurality of tables **54** and **114**, and each table **54** or **114** corresponds to different temperatures of the liquid crystal panel **31**. When the driving circuit **40** or **100** is operated, the temperature detector **51**, **111** will detect the temperature of the liquid crystal panel **31** and produce a temperature compensation signal **St**. The temperature compensation signal **St** is transferred to a table selector **49**, **109** to determine a suitable reference table, and the selected reference table is transferred to the lookup table **45**, **105** for outputting the image data **D8** or **D2**.

[0045] In the above embodiments, the circuit devices, the extracting method, the delaying method, the comparison method and the reference tables are all similar. The difference is that the 8-bit values in the reference tables are directly outputted to the multiplexer in the first embodiments, and the 8-bit values of the reference tables are divided into 2 LSB and 6 MSB and are separately outputted to the multiplexer and the data line driving circuit in the embodiment shown in FIG. 10. Furthermore, the LSB and MSB in the present invention are not limited in 6-bit, 5-bit, or 2-bit, and can be other values.

[0046] In contrast to the prior art, the reference tables in the present invention are built by actually measuring the over-driving voltages needed for properly driving the liquid crystal panel in a frame period. The reference tables include all of the over-driving image data that drives the pixels from any gray level to another, so the processor used to expand the brief table is not needed, and the efficiency can be improved. Additionally, the driving circuit and the driving method of the present invention extract LSB or MSB of a general bit length, so the management of the image memory can be more convenient and efficient.

[0047] Those skilled in the art will readily observe that numerous modifications and alterations of the device may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

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

- a liquid crystal panel, the liquid crystal panel comprising:
- a plurality of scan lines;
- a plurality of data lines; and
- a plurality of pixels, each pixel is connected to a corresponding scan line and a corresponding data line, and

each pixel has a switching device connected to the corresponding scan line and the corresponding data line;

the driving method comprising:

- (a) continuously providing scan voltages to the scan lines;
- (b) receiving an M-bit image data from an image data input terminal;
- (c) extracting N most significant bits (MSB) of the M-bit image data to form an N-bit image data, N is smaller than M;
- (d) delaying the N-bit image data by a frame period to form an N-bit delayed image data;
- (e) comparing P MSB of a current M-bit image data with the N-bit delayed image data to determine a result value;
- (f) if the result value equals a first result value, selecting a first image value from a reference table in accordance with the P MSB and the N-bit delayed image data and forming a first data voltage according to the first image value, and providing the first data voltage to the corresponding data line; and
- (g) if the result value equals a second result value, forming a second data voltage in accordance with the current M-bit image data and providing the second data voltage to the corresponding data line.

2. The driving method of claim 1 further comprising:

- (h) producing a temperature compensation signal in accordance with temperature of the liquid crystal panel; and
- (i) selecting the reference table used in step (f) from a plurality of tables in accordance with the temperature compensation signal.

3. The driving method of claim 1 wherein the reference table is recorded with $(2^N 33 2^P)$ image data values.

4. The driving method of claim 1 wherein P is greater than N.

5. The driving method of claim 1 wherein P equals N.

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

a liquid crystal panel, the liquid crystal panel comprising:

- a plurality of scan lines;
- a plurality of data lines; and

a plurality of pixels, each pixel is connected to a corresponding scan line and a corresponding data line, and each pixel has a switching device connected to the corresponding scan line and the corresponding data line;

the driving method comprises:

- (a) continuously providing scan voltages to the scan lines;
- (b) receiving an M-bit image data from an image data input terminal;
- (c) extracting N most significant bits (MSB) from the M-bit image data to form an N-bit image data, N is smaller than M;

(d) delaying the N-bit image data by a frame period to form an N-bit delayed image data;

(e) comparing P MSB of a current M-bit image data with the N-bit delayed image data to determine a result value;

(f) if the result value equals a first result value, selecting a first image value from a reference table in accordance with the P MSB and the N-bit delayed image data and forming a first data voltage according to the first image value, and providing the first data voltage to the corresponding data line; and

(g) if the result value equals a second result value, selecting a second image value from a reference table in accordance with the P MSB and the N-bit delayed image data and forming a second data voltage in accordance with (M-Q)MSB of the second image value and Q least significant bits (LSB) of the current M-bit image data, and then providing the second data voltage to the corresponding data line.

7. The driving method of claim 6 further comprising:

(h) producing a temperature compensation signal in accordance with temperature of the liquid crystal panel; and

(i) selecting the reference table used in step (f) from a plurality of tables in accordance with the temperature compensation signal.

8. The driving method of claim 6 wherein the reference table is recorded with $(2^N 33 2^P)$ image data values.

9. The driving method of claim 6 wherein P is greater than N.

10. The driving method of claim 6 wherein P equals N.

11. A driving circuit for driving a liquid crystal display, the liquid crystal display comprising:

a liquid crystal panel, the liquid crystal panel comprising:

- a plurality of scan lines;
- a plurality of data lines; and

a plurality of pixels, each pixel is connected to a corresponding scan line and a corresponding data line, and each pixel has a switching device connected to the corresponding scan line and the corresponding data line;

the driving circuit comprising:

a scan line driving circuit for continuously providing scan voltages to the scan lines;

an image data input terminal for receiving an M-bit image data;

a bit processor for extracting N most significant bits (MSB) from the M-bit image data to form an N-bit image data, N is smaller than M;

an image memory for storing the N-bit image data and delaying the N-bit image data by a frame period;

a comparison circuit for comparing P MSB of a current M-bit image data with the N-bit delayed image data to determine a result value;

- a lookup table (LUT) for outputting an image value in accordance with the P MSB and the N-bit delayed image data;
 - a multiplexer for outputting the image value or outputting the M-bit image data in accordance with the result value; and
 - a data line driving circuit for forming a data voltage in accordance with output of the multiplexer, and providing the data voltage to the corresponding data line.
- 12.** The driving circuit of claim 11 further comprising:
- a temperature detector for detecting temperature of the liquid crystal panel, and producing a temperature compensation signal in accordance with temperature of the liquid crystal panel;
 - a memory for storing a plurality of tables; and
 - a selector for selecting a reference table from the plurality of tables stored in the memory in accordance with the temperature compensation signal, and transferring the selected reference table to the LUT to make the LUT output the image value in accordance with the selected reference table.
- 13.** The driving circuit of claim 11 wherein the reference table is recorded with $(2^N \times 2^P)$ image data values.
- 14.** The driving circuit of claim 11 wherein P is greater than N.
- 15.** The driving circuit of claim 11 wherein P equals N.
- 16.** A driving circuit for driving a liquid crystal display, the liquid crystal display comprising:
- a liquid crystal panel, the liquid crystal panel comprising:
 - a plurality of scan lines;
 - a plurality of data lines; and
 - a plurality of pixels, each pixel is connected to a corresponding scan line and a corresponding data line, and each pixel has a switching device connected to the corresponding scan line and the corresponding data line;
- the driving circuit comprises:
- a scan line driving circuit for continuously providing scan voltages to the scan lines;
 - a image data input terminal for receiving an M-bit image data;
 - a bit processor for extracting N most significant bits (MSB) from the M-bit image data to form an N-bit image data, N is smaller than M;
 - an image memory for storing the N-bit image data and delaying the N-bit image data by a frame period;
 - a comparison circuit for comparing P MSB of a current M-bit image data with the N-bit delayed image data to determine a result value;
 - a lookup table (LUT) for outputting an image value in accordance with the P MSB and the N-bit delayed image data;
 - a multiplexer for outputting Q least significant bits (LSB) of the image value or outputting Q LSB of the M-bit image data in accordance with the result value; and
 - a data line driving circuit for producing a data voltage in accordance with output of the multiplexer and (M-Q) MSB of the image value, and providing the data voltage to the corresponding data line.
- 17.** The driving circuit of claim 16 further comprising:
- a temperature detector for detecting temperature of the liquid crystal panel, and producing a temperature compensation signal in accordance with temperature of the liquid crystal panel;
 - a memory for storing a plurality of tables; and
 - a selector for selecting a reference table from the plurality of tables stored in the memory in accordance with the temperature compensation signal, and transferring the selected reference table to the LUT to make the LUT output the image value in accordance with the selected reference table.
- 18.** The driving circuit of claim 16 wherein the reference table is recorded with $(2^N \times 2^P)$ image data values.
- 19.** The driving circuit of claim 16 wherein P is greater than N.
- 20.** The driving circuit of claim 16 wherein P equals N.

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专利名称(译)	液晶显示器的驱动电路及其驱动方法		
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摘要(译)

本发明涉及一种液晶显示器的驱动电路及其驱动方法。该方法包括从图像数据输入端接收M位图像数据并提取M位图像数据的N个最高有效位(MSB)以形成N位图像数据。N比特图像数据被延迟一个帧周期以形成N比特延迟图像数据。将N比特延迟图像数据与当前M比特图像数据的P MSB进行比较, 以根据从参考表中选择的第一图像值确定是否产生第一数据电压, 或者根据当前M比特图像数据产生第二数据电压。当前的M位图像数据。

