



US 20070146273A1

(19) **United States**(12) **Patent Application Publication**
You(10) **Pub. No.: US 2007/0146273 A1**(43) **Pub. Date: Jun. 28, 2007**(54) **APPARATUS AND METHOD FOR DRIVING
LIQUID CRYSTAL DISPLAY DEVICE**(52) **U.S. Cl. 345/89**(76) **Inventor: Song Ryol You, Boeun-gun (KR)**

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Dec. 28, 2005 (KR) P2005-0131259

Publication Classification(51) **Int. Cl.**
G09G 3/36 (2006.01)(57) **ABSTRACT**

An apparatus and method for driving an LCD device is disclosed to obtain rapid response speed and to enhance picture quality, in which the apparatus includes a liquid crystal panel that includes liquid crystal cells formed in areas defined by gate and data lines; a gate driver that supplies a scan pulse to the gate lines; a timing controller that modulates source data supplied from the external to modulated data for a rapid response speed of liquid crystal cell, and generates discrimination signals by comparing source data of a current frame with uppermost and lowermost gray scales of source data based on whether source data of a current frame is the same as source data of a previous frame or not; and a data driver that converts the modulated data into a video signal by using a plurality of gamma voltages including a first modulation voltage that is higher than an maximum gamma voltage or a second modulation voltage that is lower than a minimum gamma voltage, and supplies the video signal to the data lines.

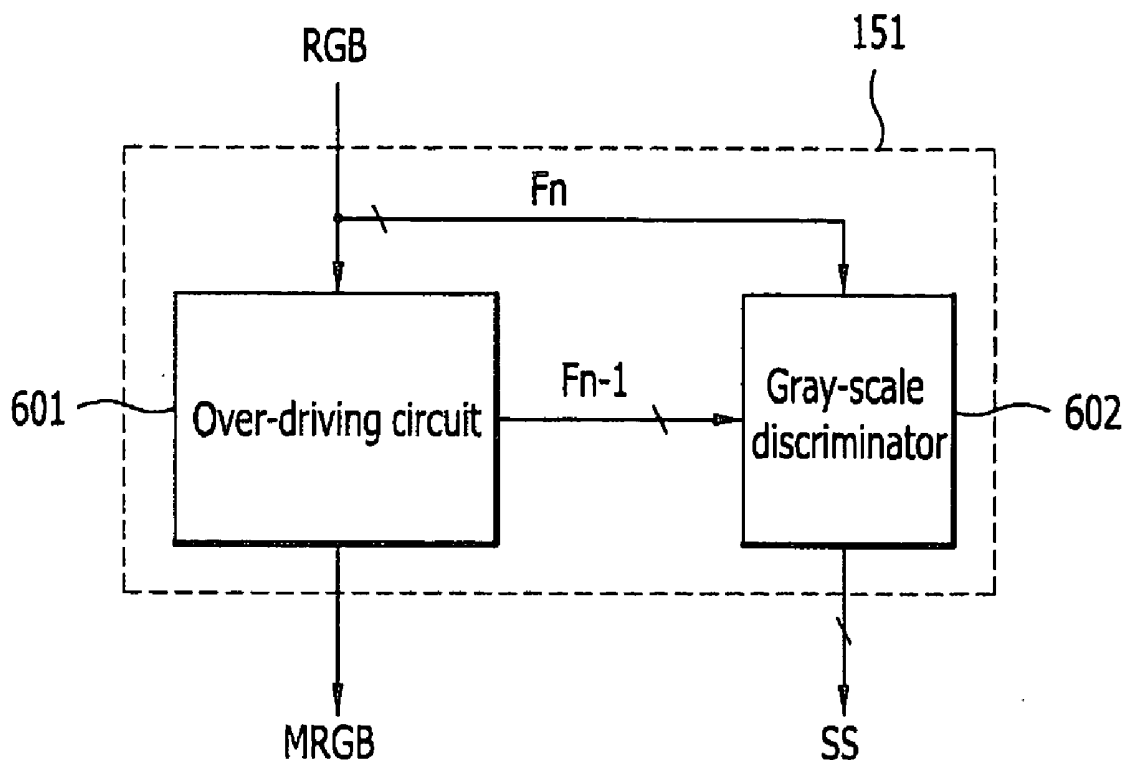


FIG. 1
Related Art

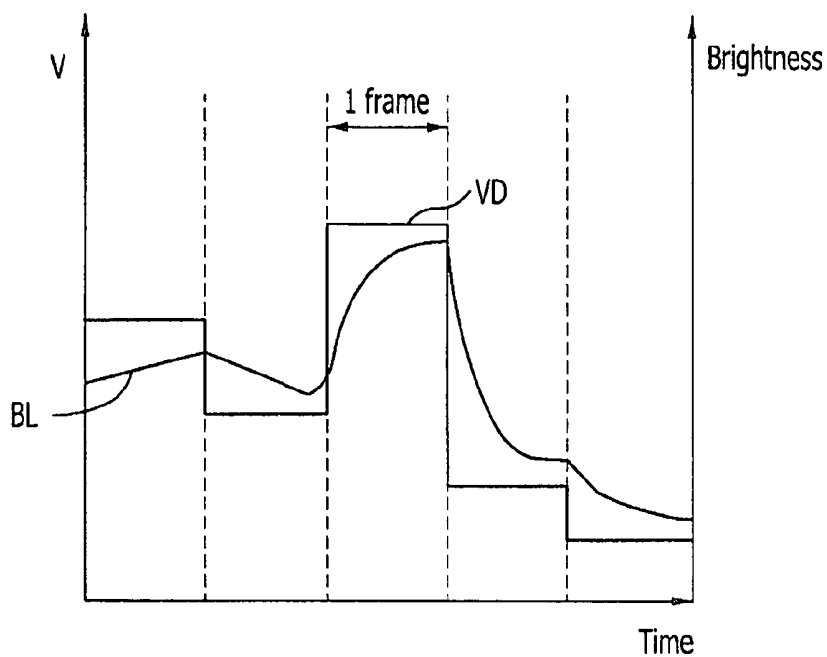


FIG. 2
Related Art

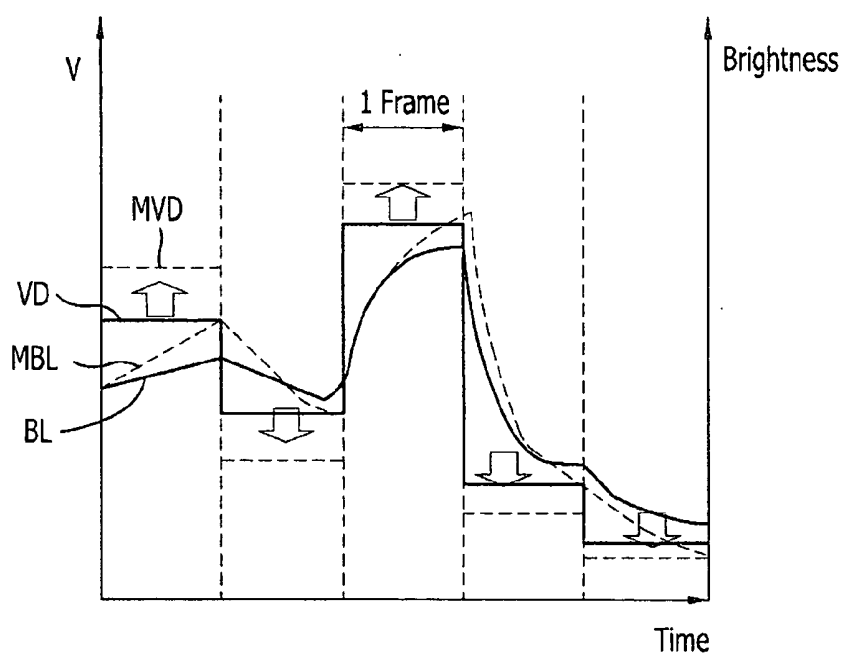


FIG. 3
Related Art

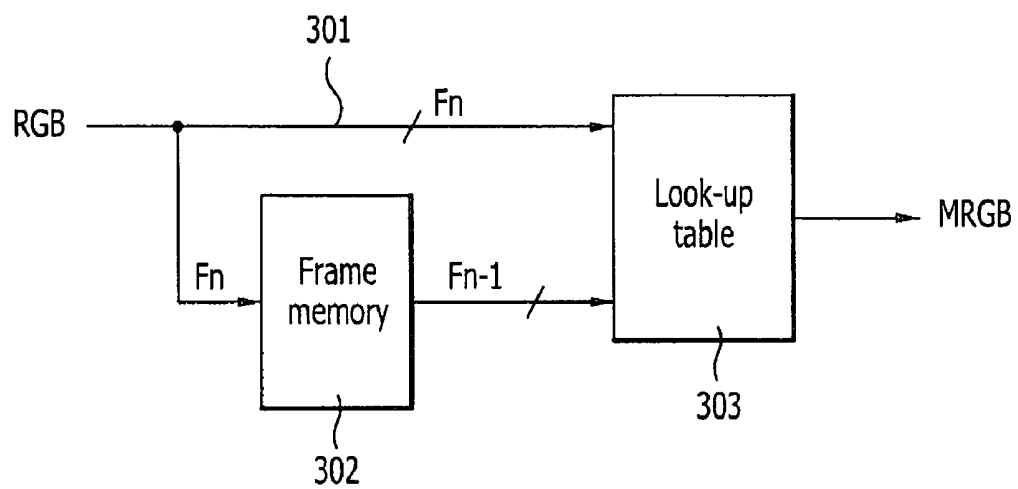


FIG. 4

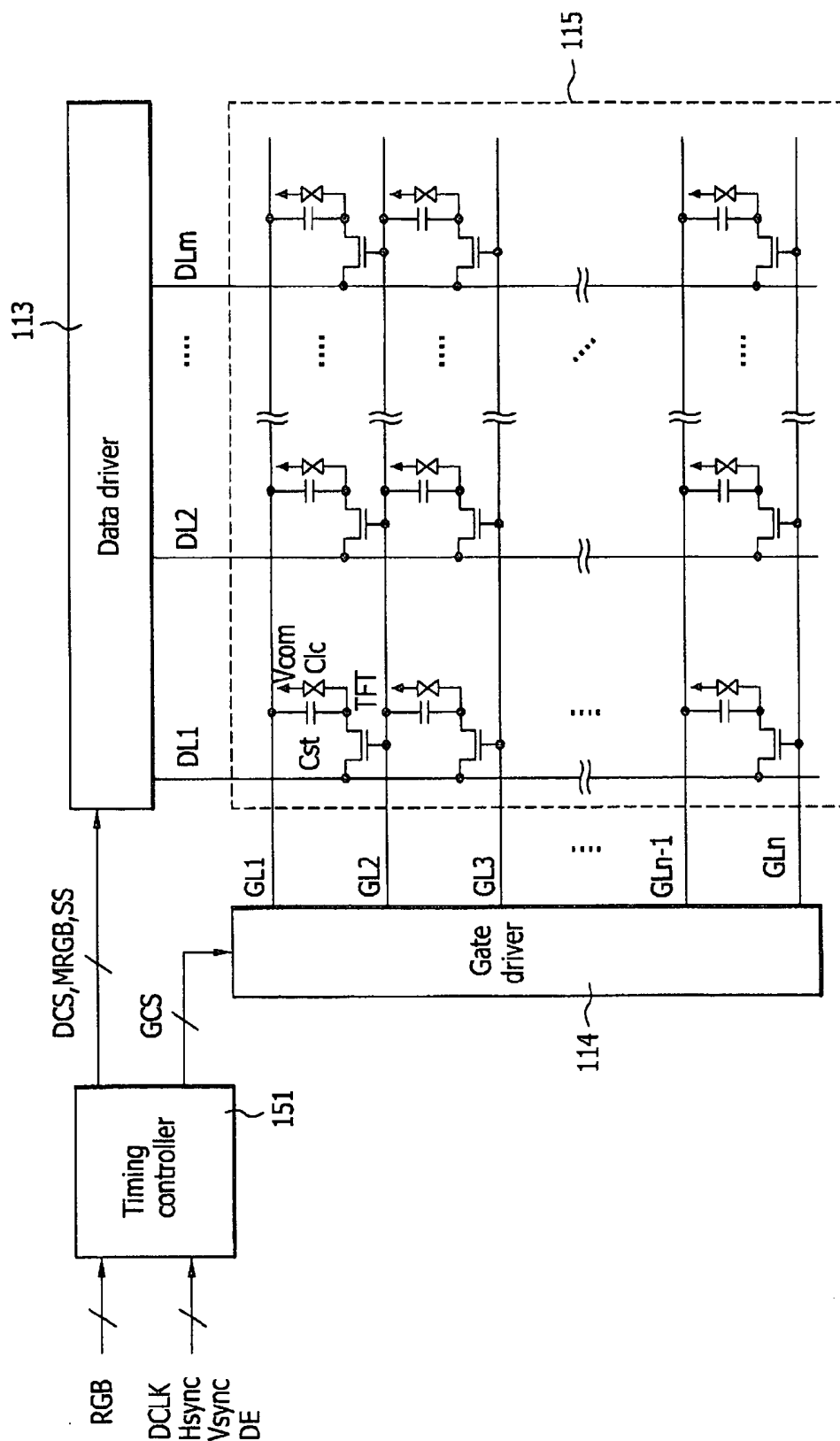


FIG. 5

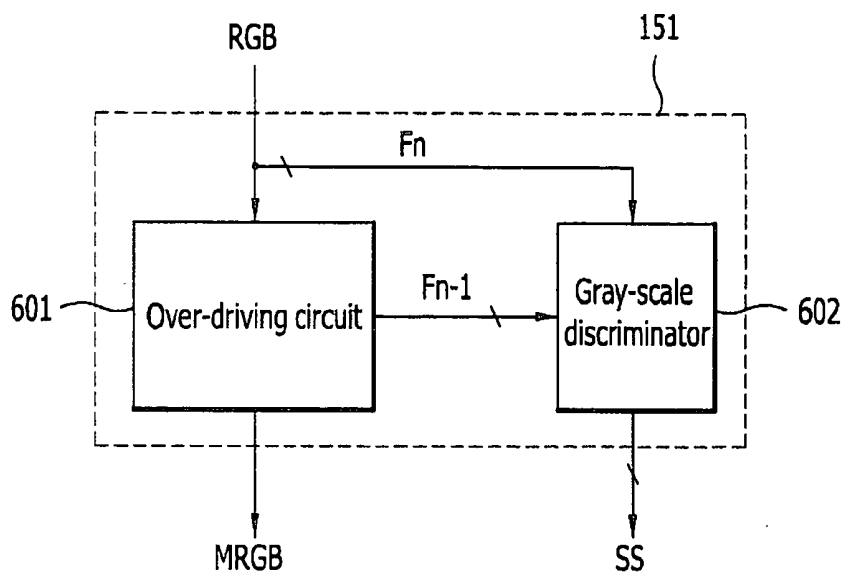


FIG. 6

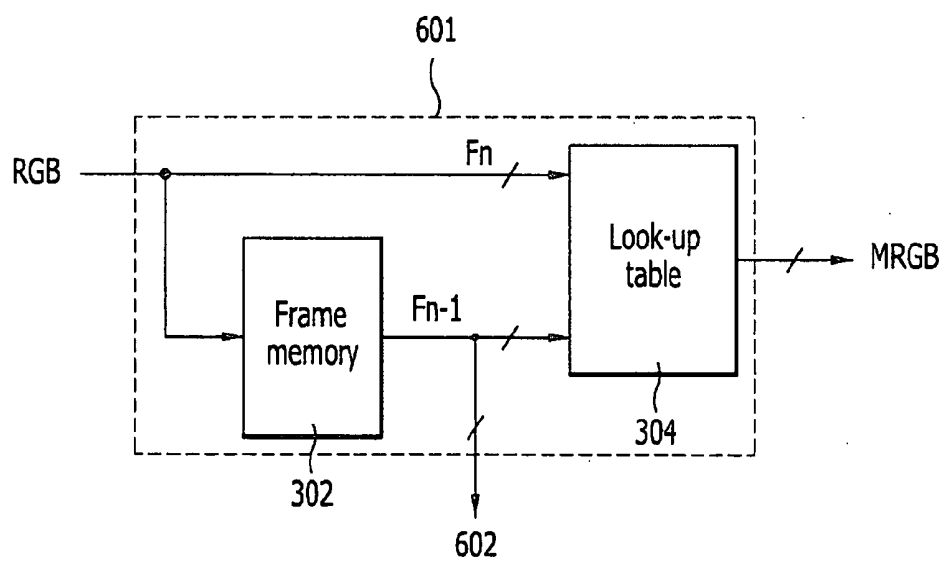


FIG. 7

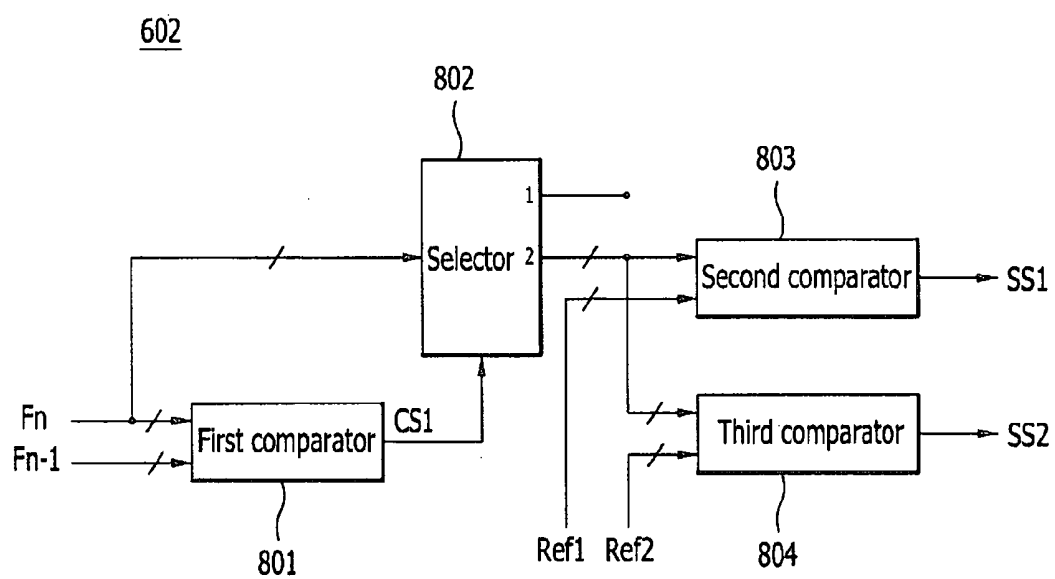


FIG. 8

113

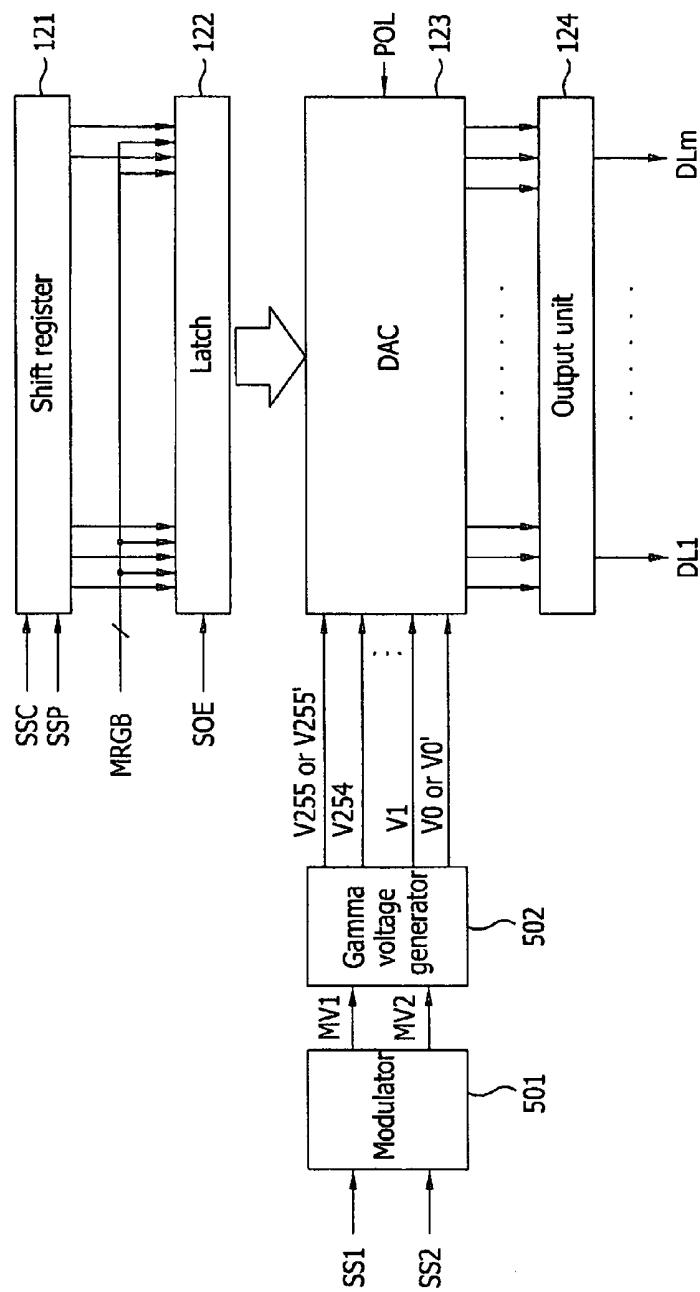


FIG. 9

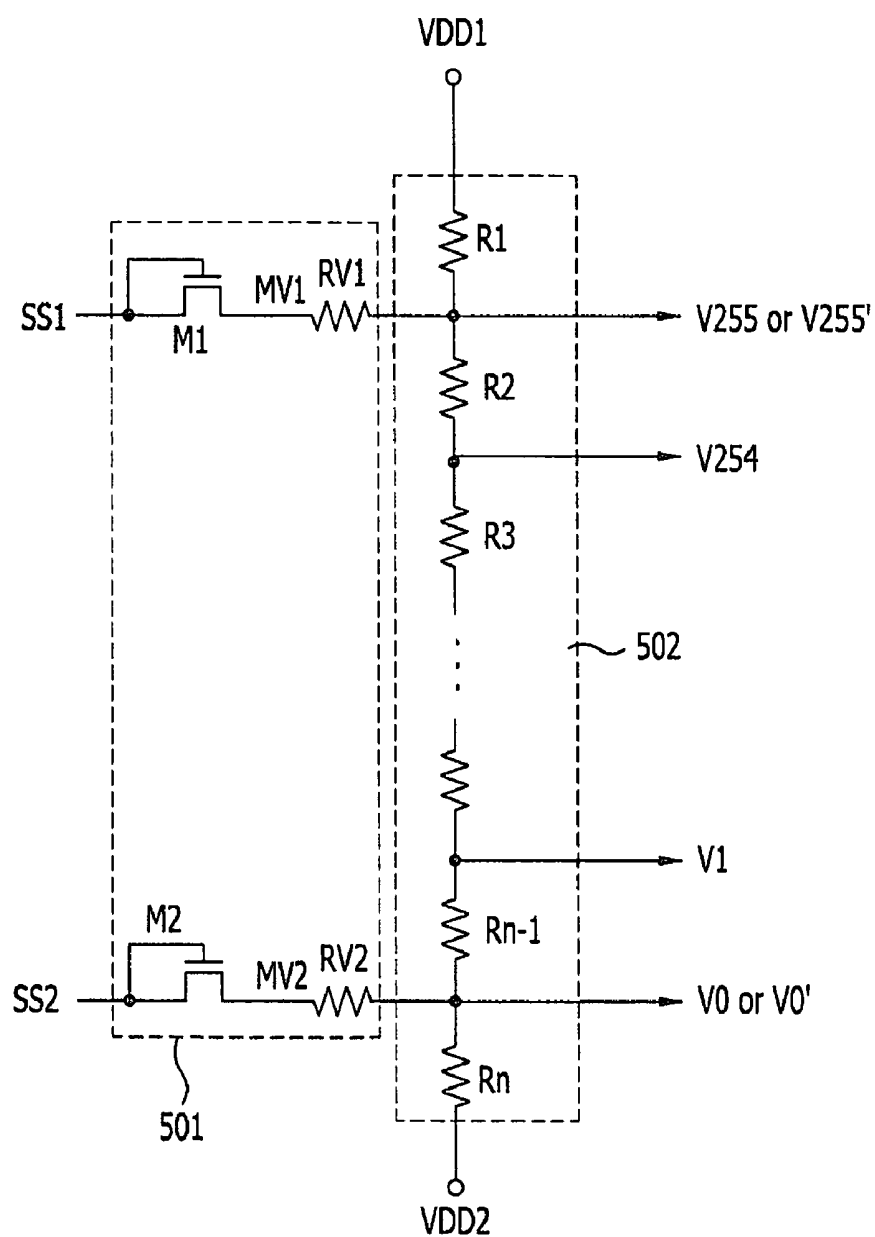


FIG. 10A

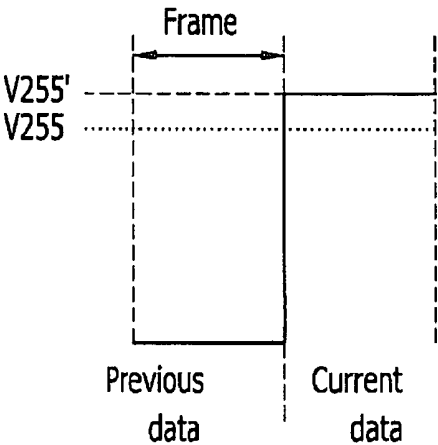
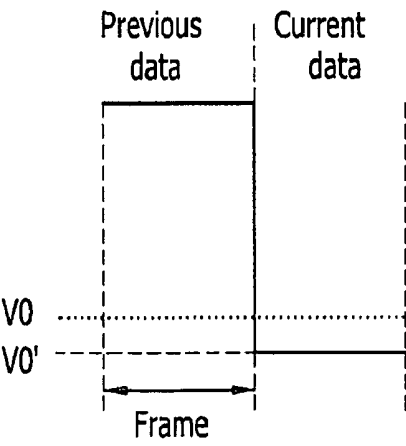


FIG. 10B



APPARATUS AND METHOD FOR DRIVING LIQUID CRYSTAL DISPLAY DEVICE

[0001] This application claims the benefit of Korean Patent Application No. P2005-131259, filed on Dec. 28, 2005, which is hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates a liquid crystal display (LCD) device, and more particularly, to an apparatus and method for driving an LCD device to provide improved picture quality.

[0004] 2. Discussion of the Related Art

[0005] Generally, LCD devices adjust light transmittance of liquid crystal cells according to a video signal to display an image. An active matrix type LCD device, which has a switching element for every liquid crystal cell, is suitable for the display of a moving image. A thin film transistor (hereinafter, referred to as a TFT) is mainly used as the switching element in the active matrix type LCD device.

[0006] However, the LCD device has a relatively low response speed due to characteristics such as the inherent viscosity and elasticity of liquid crystal, as can be seen from the following equations 1 and 2:

$$\tau_r \propto \frac{\gamma d^2}{\Delta \epsilon [V_a^2 - V_F^2]} \quad [\text{Equation 1}]$$

[0007] where τ_r is a rising time when a voltage is applied to the liquid crystal, V_a is the applied voltage, V_F is a Freederick transition voltage at which liquid crystal molecules start to be inclined, d is a liquid crystal cell gap, and γ is the rotational viscosity of the liquid crystal molecules.

$$\tau_F \propto \frac{\gamma d^2}{K} \quad [\text{Equation 2}]$$

[0008] where τ_F is a falling time when the liquid crystal is returned to its original position because of an elastic restoration force after the voltage applied to the liquid crystal is turned off, and K is the inherent elastic modulus of the liquid crystal.

[0009] In a twisted nematic (TN) mode, although the response speed of the liquid crystal may be different according to the physical properties and cell gap of the liquid crystal, it is common that the rising time is 20 to 80 ms and the falling time is 20 to 30 ms. Because this liquid crystal response speed is longer than one frame period (16.67 ms in National Television Standards Committee (NTSC)) of a moving image, the response of the liquid crystal proceeds to the next frame before a voltage being charged on the liquid crystal reaches a desired level, as shown in FIG. 1, resulting in motion blurring in which an afterimage is left in the eyeplane.

[0010] With reference to FIG. 1, a related art LCD device cannot express a desired color and brightness for display of

a moving image in that, when data VD is changed from one level to another level, the corresponding display brightness level BL is unable to reach a desired value due to a slow response of the liquid crystal display device. As a result, the motion blurring occurs in the moving image, causing degradation in contrast ratio and, in turn, degradation in display quality.

[0011] In order to solve the low response speed of the liquid crystal display device, U.S. Pat. No. 5,495,265 and PCT International Publication No. WO 99/09967 has proposed a method for modulating data according to a variation therein using a look-up table (referred to hereinafter as an 'over-driving method'). This over-driving method is adapted to modulate data on the basis of a principle as illustrated in FIG. 2.

[0012] With reference to FIG. 2, the related art over-driving method includes modulating input data VD and applying the modulated data MVD to a liquid crystal cell to obtain a desired brightness level MBL. In this over-driving method, in order to obtain the desired brightness level corresponding to the luminance of the input data in one frame period, the response of a liquid crystal is rapidly accelerated by increasing $|V_a^2 - V_F^2|$ Equation 1 on the basis of a variation in the input data.

[0013] Accordingly, a related art liquid crystal display device using the over-driving method is able to compensate for a slow response of a liquid crystal by modulation of a data value to relax motion blurring in a moving image to display a picture with a desired color and brightness.

[0014] For this, a related art over-driving circuit includes a frame memory 302 connected to a bus line 301, and a look-up table 303 connected in common to output terminals of the bus line 301 and the frame memory 302, as illustrated in FIG. 3.

[0015] The frame memory 302 stores data (RGB) from the bus line 301 for one frame period and supplies the stored data (RGB) to the look-up table 303. The look-up table 303 compares data (RGB) of a current frame (Fn) from the bus line 301 with data (RGB) of a previous frame (Fn-1) from the frame memory 302, and selects modulated data (MRGB) corresponding to the comparison result.

[0016] However, the related art over-driving method has the following disadvantages.

[0017] In the related art over-driving method, in case of 8-bit data, it cannot be driven by a voltage which is higher than a value corresponding to gray scale 255 of the uppermost gray scale. Accordingly, if the gray scale is changed from gray 0 of the lowermost gray scale to gray 255, the LCD device is driven by the voltage corresponding to the gray scale 255 without modulating a data voltage to a higher voltage than the value corresponding to the gray scale 255.

[0018] In the related art over-driving method, it is difficult to obtain the rapid response of liquid crystal for the lowermost or uppermost gray scale. Thus, it is difficult to improve the picture quality.

SUMMARY OF THE INVENTION

[0019] Accordingly, the present invention is directed to an apparatus and method for driving an LCD device that substantially obviates one or more problems due to limitations and disadvantages of the related art.

[0020] An advantage of the present invention is to provide an apparatus and method for driving an LCD device to improve picture quality.

[0021] Additional advantages and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0022] To achieve these and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, an apparatus for driving an LCD device comprises a liquid crystal panel including liquid crystal cells formed in areas defined by gate and data lines; a gate driver to supply a scan pulse to the gate lines; a timing controller to modulate source data supplied from an external source to generate modulated data and to generate discrimination signals by comparing source data of a current frame with uppermost and lowermost gray levels of source data if source data of a current frame is the different from source data of a previous frame; and a data driver to convert the modulated data into a video signal using a plurality of gamma voltages including a first modulation voltage that is higher than a maximum gamma voltage or a second modulation voltage that is lower than a minimum gamma voltage and to supply the video signal to the data lines.

[0023] In another aspect of the present invention, a method for driving an LCD device having a liquid crystal panel including a plurality of liquid crystal cells formed in areas defined by gate and data lines comprises modulating source data supplied from an external source to modulated data; generating a discrimination signal by comparing source data of a current frame with uppermost and lowermost gray scales of source data if source data of a current frame is different from source data of a previous frame; supplying a scan pulse to the gate lines; converting the modulated data to a video signal by using a plurality of gamma voltages including a first modulation voltage that is higher than a maximum gamma voltage or a second modulation voltage that is lower than a minimum gamma voltage, according to the discrimination signal; and supplying the converted video signal to the data lines in synchronization with the scan pulse.

[0024] In another aspect of the present invention, a method of generating a gamma voltage in a liquid crystal display device includes comparing a source data of a current frame with source data of a previous frame; generating a first comparison signal if the source data of the current frame is different from source data of the previous frame and generating a second comparison signal if the source data of the current frame is the same as the source data of the previous frame; outputting the source data of the current frame in response to the first comparison signal; comparing source data of the current frame with the a first reference value and a second reference value; outputting a first discrimination signal if the source data of the current frame is the same as the first reference value and outputting a second discrimination value if the source data of the current frame is the same as a second reference value; and generating a first gamma voltage value in response to the first discrimination

signal and generating a second gamma voltage value in response to the second discrimination signal.

[0025] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0027] FIG. 1 is a graph illustrating a response speed of an LCD device according to the related art;

[0028] FIG. 2 is a graph illustrating a response speed of an LCD device to which an over-driving method is applied;

[0029] FIG. 3 is a block diagram illustrating an over-driving circuit according to the related art;

[0030] FIG. 4 illustrates a driving apparatus of an LCD device according to an embodiment of the present invention;

[0031] FIG. 5 is a block diagram illustrating a timing controller of FIG. 4;

[0032] FIG. 6 is a block diagram illustrating an over-driving circuit of FIG. 5;

[0033] FIG. 7 is a block diagram illustrating a gray scale discriminator of FIG. 5;

[0034] FIG. 8 is a block diagram illustrating a data driver of FIG. 4;

[0035] FIG. 9 illustrates a modulator and a gamma voltage generator of FIG. 8; and

[0036] FIGS. 10A and 10B are waveform diagrams illustrating a method for driving an LCD device according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0037] Reference will now be made in detail to embodiments of the present invention, 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.

[0038] Hereinafter, an apparatus and method for driving an LCD device according to the present invention will be explained with reference to the accompanying drawings.

[0039] FIG. 4 illustrates an apparatus for driving an LCD device according to an embodiment of the present invention.

[0040] Referring to FIG. 4, the apparatus for driving the LCD device according to an embodiment of the present invention includes a liquid crystal panel 115 that includes a plurality of gate lines (GL1 to GLn) and a plurality of data lines (DL1 to DLm) arranged substantially perpendicular to each other, and a plurality of thin film transistors adjacent to crossings of the gate and data lines; a timing controller 151 that modulates source data (RGB) supplied from an external source to modulated data (MRGB) for a quicker response speed of liquid crystal cell and generates discrimination signals (SS) after comparing source data (RGB) of a current frame with uppermost and lowermost gray scales of source data (RGB) based on whether source data (RGB) of a current frame is the same as source data (RGB) of a previous frame; a gate driver 114 that supplies a scan pulse to the gate lines

(GL1 to GLn) under control of the timing controller 151; and a data driver 113 that converts the modulated data (MRGB) to video signals using a plurality of gamma voltages including a first modulation voltage that is higher than a maximum gamma voltage or a second modulation voltage that is lower than a minimum gamma voltage and supplies the video signals to the data lines (DL1 to DLm).

[0041] The liquid crystal panel 115 also includes a plurality of liquid crystal cells (Clc) and respective thin film transistors TFT arranged at respective crossings of the gate lines (GL1 to GLn) and data lines (DL1 to DLm) in a matrix type. Each thin film transistor provided in each of the liquid crystal cells supplies the video signal provided from the data lines (DL1 to DLm) to the liquid crystal cell (Clc) in response to a scan signal provided from the gate line (GL). Also, each liquid crystal cell includes a storage capacitor (Cst) to maintain a voltage of the liquid crystal cell (Clc) substantially uniformly. The storage capacitor (Cst) may be formed between a pixel electrode of the liquid crystal cell (Clc) and the prior gate line, and/or between a pixel electrode of the liquid crystal cell (Clc) and a common electrode line.

[0042] The timing controller 151 controls the data and gate drivers 113 and 114 by generating a data control signal (DCS) for controlling the data driver 113, and a gate control signal (GCS) for controlling the gate driver 114 with synchronized signals (Vsync, Hsync, DE, DCLK) inputted from an external source.

[0043] Also, the timing controller 151 generates the modulated data (MRGB) and discrimination signal (SS) and supplies the data driver 113 with the modulated data (MRGB) and discrimination signal (SS).

[0044] For this, as illustrated in FIG. 5, the timing controller 151 may include an over-driving circuit 601 that generates the modulated data and a gray-scale discriminator 602 that generates the discrimination signal (SS).

[0045] As illustrated in FIG. 6, the over-driving circuit 601 is provided with a frame memory 302 and a look-up table 304. The frame memory 302 stores source data (RGB) inputted from an external source for one frame period. In this case, the source data (RGB) stored in the frame memory 302 is supplied to the look-up table 304 and the gray-scale discriminator 602.

[0046] The look-up table 304 compares source data (RGB) of a current frame (Fn) inputted from the external source with source data (RGB) of a previous frame (Fn-1) inputted from the frame memory 302 and generates modulated data (MRGB) for a rapid response speed of liquid crystal.

[0047] The gray-scale discriminator 602 of FIG. 5 may include a first comparator 801, a selector 802, and second and third comparators 803 and 804, as illustrated in FIG. 7.

[0048] The first comparator 801 compares the source data of the current frame (Fn) with the source data of the previous frame (Fn-1) inputted from the frame memory 302. If the source data of the previous frame supplied to each pixel is the same as the source data of the current frame, the first comparator 801 generates a comparison signal (CS1) of a first state (e.g., a high state). If the source data of the previous frame supplied to each pixel is different from the source data of the current frame, the first comparator 801 generates a comparison signal (CS1) of a second state (e.g., a low state).

[0049] For example, if the first comparator 801 supplies the comparison signal (CS1) of the first (high) state to the

selector 802, the selector 802 outputs the source data of the current frame (Fn) to a first output terminal 1 in a floating state. Meanwhile, if the first comparator 801 supplies the comparison signal (CS1) of the second (low) state to the selector 802, the selector 802 outputs the source data of the current frame (Fn) to the second and third comparators 803 and 804 through a second output terminal 2.

[0050] The second comparator 803 compares the source data of the current frame (Fn) supplied from the selector 802 with a first reference signal (Ref1) corresponding to a preset uppermost gray scale and generates a first discrimination signal (SS1). At this time, if the source data of the current frame (Fn) is the same as the first reference signal (Ref1), the second comparator 803 generates a first discrimination signal (SS1) of a first state (e.g., a high state). If the source data of the current frame (Fn) is different from the first reference signal (Ref1), the second comparator 803 generates a first discrimination signal (SS1) of a second state (e.g., a low state).

[0051] The third comparator 804 compares the source data of the current frame (Fn) supplied from the selector 802 with a second reference signal (Ref2) corresponding to a preset lowermost gray scale and generates a second discrimination signal (SS2). At this time, if the source data of the current frame (Fn) is the same as the second reference signal (Ref2), the third comparator 804 generates a second discrimination signal (SS2) of a first state (e.g., a high state). If the source data of the current frame (Fn) is different from the second reference signal (Ref2), the third comparator 804 generates a second discrimination signal (SS2) of a second state (e.g., a low state).

[0052] If the source data supplied to the pixel of the current frame (Fn) is identical in gray scale to the source data of the previous frame (Fn), or the source data of the current frame (Fn) is not the uppermost gray scale, the gray-scale discriminator 602 generates the first discrimination signal (SS1) of the second state. Also, if the source data supplied to the pixel of the current frame (Fn) is identical in gray scale to the source data of the previous frame (Fn-1), or the source data of the current frame (Fn) is not the lowermost gray scale, the gray-scale discriminator 602 generates the second discrimination signal (SS2) of the second state.

[0053] Meanwhile, if the source data supplied to the pixel of the current frame (Fn) is changed to the uppermost gray scale from the other gray scales, the gray-scale discriminator 602 generates the first discrimination signal (SS1) of the first state. Also, if the source data supplied to the pixel of the current frame (Fn) is changed to the lowermost gray scale from the other gray scales, the gray-scale discriminator 602 generates the second discrimination signal (SS2) of the first state.

[0054] Accordingly, only when the source data supplied to each pixel of the current frame (Fn) is first changed to the lowermost or uppermost gray scale, the gray-scale discriminator 602 generates the first or second discrimination signal (SS1, SS2) of the first state.

[0055] In FIG. 4, the gate driver 114 may include a shift register that sequentially generates a scan pulse, for example, gate high pulse according to the gate control signal (GCS) supplied from the timing controller 151; and a level shifter that shifts the voltage of scan pulse to be suitable for the level of driving the liquid crystal cell (Clc). Thus, the thin film transistor is turned on in response to the scan pulse.

As the thin film transistor is turned on, the video signal of the data line **115** is supplied to the pixel electrode of the liquid crystal cell (Clc).

[0056] The data driver **114** generates the first modulation voltage that is higher than the maximum gamma voltage or the second modulation voltage that is lower than the minimum gamma voltage based on the discrimination signal (SS) outputted from the timing controller **151**. Also, the data driver **114** converts the modulated data (MRGB) into the video signal using the plurality of gamma voltages including the first or second modulation voltage according to the data control signal (DCS) outputted from the timing controller **151** and supplies the generated video signal to the data lines (DL1 to DLm).

[0057] For this, as illustrated in FIG. 8, the data driver **114** may include a shift register **121**, a latch **122**, a modulator **501**, a gamma voltage generator **502**, a digital-analog converter **123**, and an output unit **124**.

[0058] The shift register **121** sequentially generates a sampling signal using source shift clock (SSC) and source start pulse (SSP) in the data control signal (DCS) provided from the timing controller **151** and supplies the generated sampling signal to the latch **122**.

[0059] The latch **122** sequentially samples the modulated data (MRGB) for one horizontal line supplied from the timing controller **151** according to the sampling signal outputted from the shift register **121**. Also, the latch **122** supplies the modulated data (MRGB) for one horizontal line, which is sampled according to source output enable (SOE) in the data control signal (DCS) provided from the timing controller **151**, to the digital-analog converter **123**.

[0060] As illustrated in FIG. 9, the modulator **501** may include a first transistor (M1) that outputs a first compensation voltage (MV1) which is switched based on the first discrimination signal (SS1) of the timing controller **151** and a second transistor (M2) that outputs a second compensation voltage (MV2) which is switched based on the second discrimination signal (SS2) of the timing controller **151**.

[0061] The first transistor (M1) may be connected to a first discrimination signal input line, to which the first discrimination signal (SS1) is supplied, in a diode connection. Thus, if the first discrimination signal (SS1) is in the high state, the first transistor (M1) outputs the first compensation voltage (MV1) corresponding to the voltage level of the high state to the gamma voltage generator **502** through a first resistor (RV1). Other configurations, including a configuration without first resistor RV1 are also possible.

[0062] The second transistor (M2) may be connected to a second discrimination signal input line, to which the second discrimination signal (SS2) is supplied, in a diode connection. Thus, if the second discrimination signal (SS2) is in the high state, the second transistor (M2) outputs the second compensation voltage (MV2) corresponding to the voltage level of the high state to the gamma voltage generator **502** through a second resistor (RV2). Other configurations, including a configuration without second resistor RV2 are also possible.

[0063] The gamma voltage generator **502** generates a plurality of gamma voltages in each of voltage-dividing nodes among a plurality of voltage-dividing resistors (R1 to Rn) connected in series between a first driving voltage (VDD1) and a second driving voltage (VDD2).

[0064] Among the voltage-dividing nodes, the uppermost voltage-dividing node may be connected with the first

transistor (M1) of the modulator **501** through the first resistor (RV1). If the first discrimination signal (SS1) is in the low state, the uppermost voltage-dividing node outputs the maximum gamma voltage (V255) corresponding to the uppermost gray scale of the modulated data (MRGB) using the first and second voltage-dividing resistors (R1, R2) and the first driving voltage (Vdd1). Meanwhile, if the first discrimination signal (SS1) is in the high state, the uppermost voltage-driving node outputs a first modulation voltage (V255'), which is higher than the maximum gamma voltage (V255) corresponding to the uppermost gray scale, using the first compensation voltage (MV1), the first resistor (RV1), the first and second voltage-dividing resistors (R1, R2), and the first driving voltage (VDD1) corresponding to the first discrimination signal (SS1) of the high state.

[0065] The lowermost voltage-dividing node may be connected with the second transistor (M2) of the modulator **501** through the second resistor (RV2). If the second discrimination signal (SS2) is in the low state, the lowermost voltage-dividing node outputs the minimum gamma voltage (V0) corresponding to the lowermost gray scale of the modulated data (MRGB) using n and n-1 voltage-dividing resistors (Rn, Rn-1) and second driving voltage (VDD2). Meanwhile, if the second discrimination signal (SS2) is in the high state, the lowermost voltage-dividing node outputs a second modulation voltage (V0'), which is lower than the minimum gamma voltage (V0) corresponding to the lowermost gray scale of modulated data (MRGB) using the second compensation voltage (MV2), the second resistor (RV2), n and n-1 voltage-dividing resistors (Rn, Rn-1), and the second driving voltage (VDD2) corresponding to the second discrimination signal (SS2) of the high state.

[0066] Except the lowermost and uppermost voltage-dividing nodes, each voltage-dividing node outputs the gamma voltage between the minimum and maximum gamma voltages according to the voltage division by the voltage-dividing resistor adjacent to each voltage-dividing node.

[0067] The gamma voltage generator **502** supplies the plurality of gamma voltages (V0 or V0', V1 to V254, V255 or V255') including the first modulation voltage (V255'), which is higher than the maximum gamma voltage (V255), or the second modulation voltage (V0'), which is lower than the minimum gamma voltage (V0), to the digital-analog converter **123**, according to the first or second compensation voltage (MV1, MV2) supplied from the modulator **501** by the discrimination signals (SS1, SS2).

[0068] In FIG. 8, the digital-analog converter **123** converts the latched and modulated data (MRGB) supplied from the latch **122** into the video signal by using the plurality of gamma voltages (V0 or V0', V1 to V254, V255 or V255') supplied from the gamma voltage generator **502**.

[0069] The output unit **124** outputs the video signal for one horizontal line supplied from the digital-analog converter **123** to the data lines.

[0070] Only if the first or second discrimination signal (SS1, SS2) of the high stage is supplied to the data driver **113** from the timing controller **151**, the data driver **113** converts the modulated data (MRGB) into the video signal by using the plurality of gamma voltages including the first and second modulation voltages (V255', V0'), and supplies the video signal to the data lines. If not, the data driver **113** converts the modulated data (MRGB) into the video signal using the plurality of gamma voltages including the upper-

most (V255) and lowermost (V0) gamma voltages and supplies the video signal to the data lines.

[0071] In the apparatus and method for driving the LCD device according to the present invention, if the source data supplied to the pixel of the current frame (Fn) is changed to the uppermost gray scale from the other gray scales, as illustrated in FIG. 10A, the first modulation voltage (V255'), which is higher than the maximum gamma voltage (V255), is supplied to the liquid crystal cell (Clc) so that it is possible to increase the response speed of liquid crystal for the uppermost gray scale.

[0072] In the apparatus and method for driving the LCD device according to the present invention, if the source data supplied to the pixel of the current frame (Fn) is changed to the lowermost gray scale from the other gray scales, as illustrated in FIG. 10B, the second modulation voltage (V0'), which is lower than the minimum gamma voltage (V0), is supplied to the liquid crystal cell (Clc) so that it is possible to increase the response speed of liquid crystal for the lowermost gray scale.

[0073] As mentioned above, the apparatus and method for driving the LCD device according to the present invention has the following advantages.

[0074] In the apparatus and method for driving the LCD device according to the present invention, it is checked whether the data for each pixel of the current frame is the same as the data for each pixel of the previous frame or not. Based on the checking result, if the data for each pixel is changed to the uppermost or lowermost gray scale, the first modulation voltage, which is higher than the maximum gamma voltage, or the second modulation voltage, which is lower than the minimum gamma voltage, is supplied to the liquid crystal cell, whereby it is possible to obtain the rapid response speed of liquid crystal for the lowermost or uppermost gray scale, thereby enhancing the picture quality.

[0075] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. An apparatus for driving an LCD device, comprising:
 - a liquid crystal panel including liquid crystal cells formed in areas defined by gate and data lines;
 - a gate driver to supply a scan pulse to the gate lines;
 - a timing controller to modulate source data supplied from an external source to generate modulated data and to generate discrimination signals by comparing source data of a current frame with uppermost and lowermost gray levels of source data if source data of a current frame is the different from source data of a previous frame; and
 - a data driver to convert the modulated data into a video signal using a plurality of gamma voltages including a first modulation voltage that is higher than a maximum gamma voltage or a second modulation voltage that is lower than a minimum gamma voltage and to supply the video signal to the data lines.
2. The apparatus of claim 1, wherein the timing controller comprises:
 - an over-driving circuit for generating the modulated data; and

a gray-scale discriminator for generating the discrimination signals.

3. The apparatus of claim 2, wherein the over-driving circuit comprises:

- a frame memory to store source data; and
- a look-up table to generate the modulated data by comparing the source data of the current frame with the source data of the previous frame outputted from the frame memory.

4. The apparatus of claim 3, wherein the gray-scale discriminator comprises:

- a first comparator to generate a comparison signal by comparing the source data of the current frame with the source data of the previous frame outputted from the frame memory;
- a selector to selectively output the source data of the current frame according to the comparison signal;
- a second comparator to generate a first discrimination signal by comparing the source data of the current frame supplied from the selector with a first reference signal corresponding to a preset uppermost gray scale; and
- a third comparator to generate a second discrimination signal by comparing the source data of the current frame supplied from the selector with a second reference signal corresponding to a preset lowermost gray scale.

5. The apparatus of claim 4, wherein the data driver comprises:

- a shift register to sequentially generate a sampling signal;
- a latch to sequentially sample the modulated data according to the sampling signal;
- a modulator to generate first and second compensation voltages according to the first and second discrimination signals;
- a gamma voltage generator to generate a plurality of gamma voltages including the first modulation voltage that is higher than the maximum gamma voltage, or the second modulation voltage that is lower than the minimum gamma voltage, according to the first or second compensation voltage; and
- a digital-analog converter to convert the modulated data into the video data using the plurality of gamma voltages supplied from the gamma voltage generator.

6. The apparatus of claim 5, wherein the plurality of gamma voltages are at respective ones of voltage-dividing nodes among a plurality of voltage-dividing resistors connected in series between a first driving voltage and a second driving voltage.

7. The apparatus of claim 6, wherein the modulator comprises:

- a first transistor that outputs a first compensation voltage according to the first discrimination signal if the source data of the current frame is changed to the uppermost gray scale from the other gray scales;
- a first resistor connected between the first transistor and the uppermost voltage-dividing node among the voltage-dividing nodes of the gamma voltage generator;
- a second transistor that outputs a second compensation voltage according to the second discrimination signal if the source data of the current frame is changed to the lowermost gray scale from the other gray scales; and

a second resistor connected between the second transistor and the lowermost voltage-dividing node among the voltage dividing nodes of the gamma voltage generator.

8. The apparatus of claim 7, wherein the first compensation voltage corresponds to the voltage level of the first discrimination signal, and the second compensation voltage corresponds to the voltage level of the second discrimination signal.

9. The apparatus of claim 8, wherein the uppermost voltage-dividing node outputs the maximum gamma voltage or the first modulation voltage according to the first discrimination signal, and the lowermost voltage-dividing node outputs the minimum gamma voltage or the second modulation voltage according to the second discrimination signal.

10. A method for driving an LCD device having a liquid crystal panel including a plurality of liquid crystal cells formed in areas defined by gate and data lines comprising: modulating source data supplied from an external source to modulated data;

generating a discrimination signal by comparing source data of a current frame with uppermost and lowermost gray scales of source data if source data of a current frame is different from source data of a previous frame;

supplying a scan pulse to the gate lines;

converting the modulated data to a video signal by using a plurality of gamma voltages including a first modulation voltage that is higher than a maximum gamma voltage or a second modulation voltage that is lower than a minimum gamma voltage, according to the discrimination signal; and

supplying the converted video signal to the data lines in synchronization with the scan pulse.

11. The method of claim 10, wherein generating the modulated data comprises:

storing the source data in a frame memory; and

generating the modulated data by comparing the source data of the current frame with the source data of the previous frame outputted from the frame memory in a look-up table.

12. The method of claim 11, wherein generating the discrimination signal comprises:

generating a comparison signal by comparing the source data of the current frame with the source data of the previous frame outputted from the frame memory;

selectively outputting the source data of the current frame according to the comparison signal;

comparing the source data of the current frame selected with a preset uppermost gray scale and generating a first discrimination signal if the source data of the current frame is different from the preset uppermost gray scale; and

comparing the source data of the current frame selected with a preset lowermost gray scale and generating a second discrimination signal if the source data of the current frame is different from the preset lowermost gray scale.

13. The method of claim 12, wherein converting the modulated data into the video signal comprises:

sequentially generating a sampling signal;

sequentially latching the modulated data according to the sampling signal;

generating first and second compensation voltages according to the first and second discrimination signals; generating the plurality of gamma voltages including the first modulation voltage that is higher than the maximum gamma voltage or the second modulation voltage that is lower than the minimum gamma voltage according to the first or second compensation voltage; and converting the modulated data into the video signal by using the plurality of gamma voltages.

14. The method of claim 13, wherein generating the plurality of gamma voltages comprises:

generating the plurality of gamma voltages including the first modulation voltage by using the first compensation voltage if the source data of the current frame is changed to the uppermost gray scale from the other gray scales;

generating the plurality of gamma voltages including the second modulation voltage by using the second compensation voltage if the source data of the current frame is changed to the lowermost gray scale from the other gray scales; and

generating the plurality of gamma voltages including the lowermost and maximum gamma voltages if the source data of the current frame is not the lowermost or/and uppermost gray scales.

15. A method of generating a gamma voltage in a liquid crystal display device, comprising:

comparing a source data of a current frame with source data of a previous frame;

generating a first comparison signal if the source data of the current frame is different from source data of the previous frame and generating a second comparison signal if the source data of the current frame is the same as the source data of the previous frame;

outputting the source data of the current frame in response to the first comparison signal;

comparing source data of the current frame with the a first reference value and a second reference value;

outputting a first discrimination signal if the source data of the current frame is the same as the first reference value and outputting a second discrimination signal if the source data of the current frame is the same as a second reference value; and

generating a first gamma voltage value in response to the first discrimination signal and generating a second gamma voltage value in response to the second discrimination signal.

16. The method of claim 15, wherein the first gamma voltage value is greater than a gamma voltage value corresponding to maximum gray level of the source data.

17. The method of claim 15, wherein the second gamma voltage value is less than a gamma voltage value corresponding to a maximum gray level of the source data.

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专利名称(译)	用于驱动液晶显示装置的装置和方法		
公开(公告)号	US20070146273A1	公开(公告)日	2007-06-28
申请号	US11/594167	申请日	2006-11-08
[标]申请(专利权)人(译)	游松RYOL		
申请(专利权)人(译)	YOU, 宋RYOL		
当前申请(专利权)人(译)	LG DISPLAY CO., LTD.		
[标]发明人	YOU SONG RYOL		
发明人	YOU, SONG RYOL		
IPC分类号	G09G3/36		
CPC分类号	G09G3/3648 G09G2320/0252 G09G2320/0261 G09G2320/0285 G09G2340/16		
优先权	1020050131259 2005-12-28 KR		
其他公开文献	US9837031		
外部链接	Espacenet USPTO		

摘要(译)

公开了一种用于驱动LCD装置的装置和方法，以获得快速响应速度和提高图像质量，其中该装置包括液晶面板，该液晶面板包括形成在由栅极线和数据线限定的区域中的液晶单元；栅极驱动器，向栅极线提供扫描脉冲；定时控制器，调制从外部提供的源数据到调制数据，以获得液晶单元的快速响应速度，并根据源数据通过比较当前帧的源数据与源数据的最高和最低灰度来生成鉴别信号当前帧的结构与前一帧的源数据是否相同；数据驱动器通过使用包括高于最大伽马电压的第一调制电压或低于最小伽马电压的第二调制电压的多个伽马电压将调制数据转换为视频信号，并提供视频信号到数据线。

