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Liu et al.(10) **Pub. No.: US 2007/0290970 A1**(43) **Pub. Date: Dec. 20, 2007**(54) **METHOD FOR DRIVING A LIQUID
CRYSTAL DISPLAY****Publication Classification**

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- (57) **ABSTRACT**

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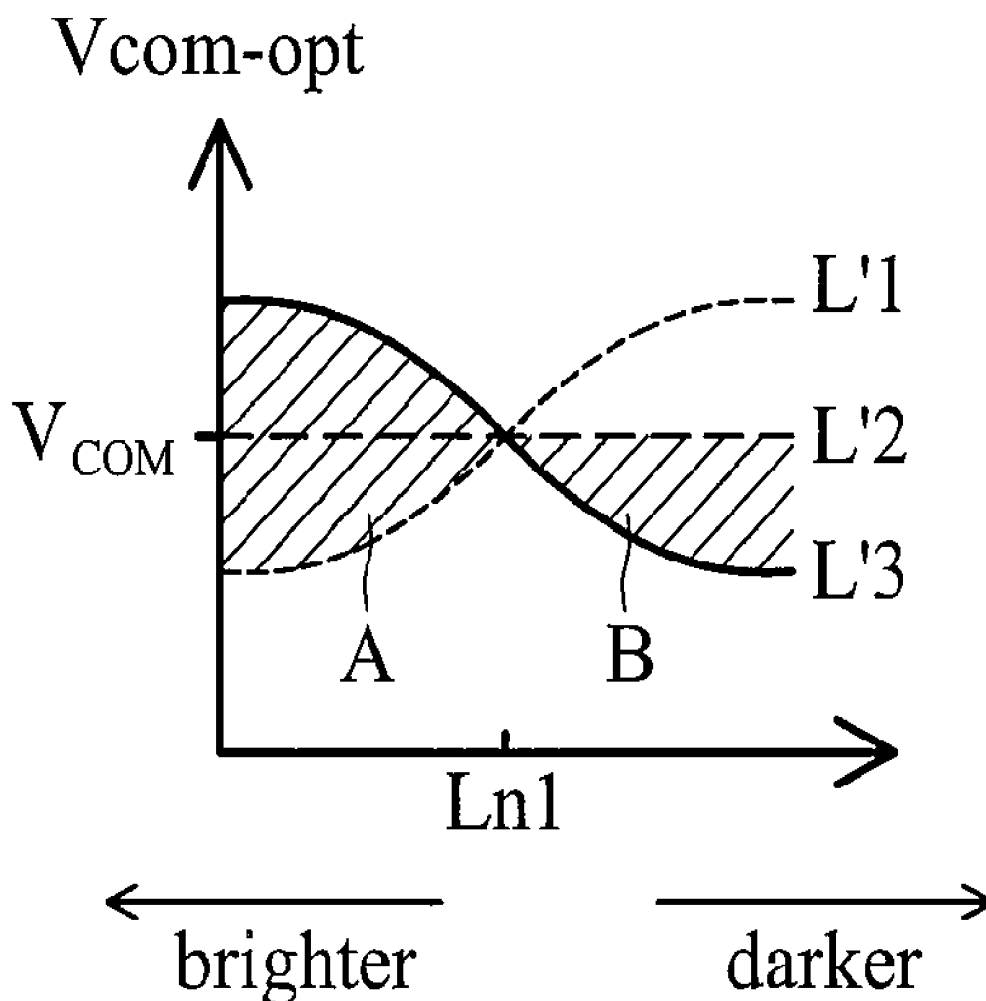
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A method for driving a normal black type liquid crystal display (LCD) includes driving the LCD by applying uncompensated source signals corresponding to gray levels; recording first optimized common signal voltages (Vcom-opt1) of common signals corresponding with the gray levels; adjusting the source signal to drive the LCD so second optimized common signal voltages (Vcom-opt2) of common signals corresponding with the gray levels conform to the following conditions: (1) when the gray level is lower than a predetermined gray level, the Vcom-opt2 exceeds a predetermined voltage of the common signal and the absolute difference between the Vcom-opt2 and the predetermined voltage is less than or equal to that between the Vcom-opt1 and the predetermined voltage; and (2) when the gray level exceeds the predetermined gray level, the absolute difference between the Vcom-opt2 and the predetermined voltage is less than or equal to that between the Vcom-opt1 and the predetermined voltage.



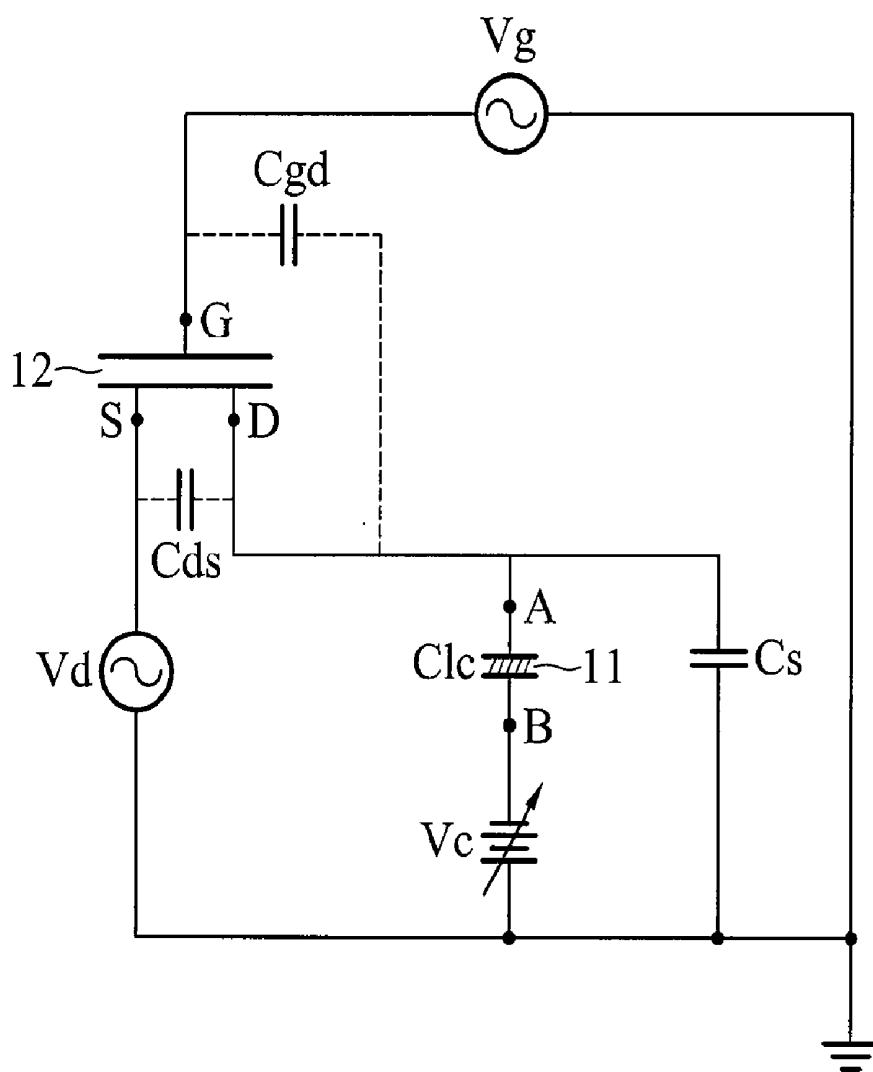


FIG. 1

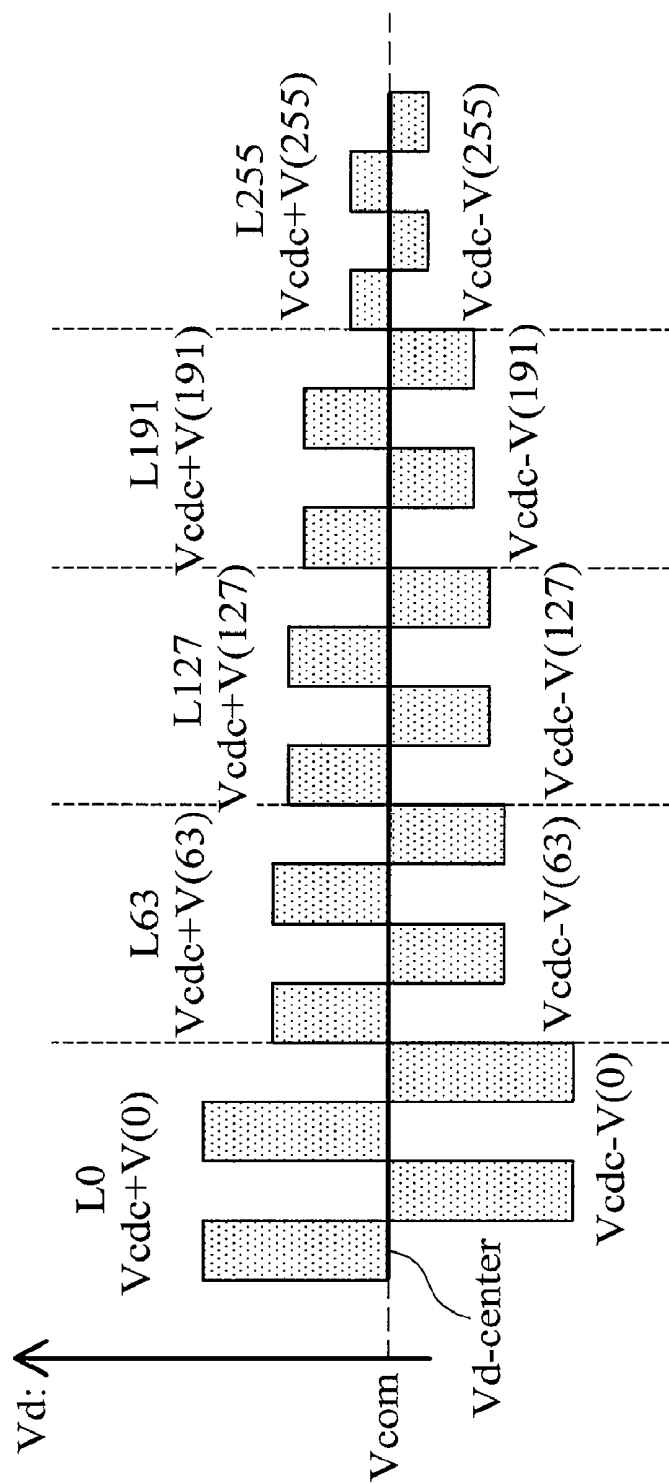


FIG. 2A

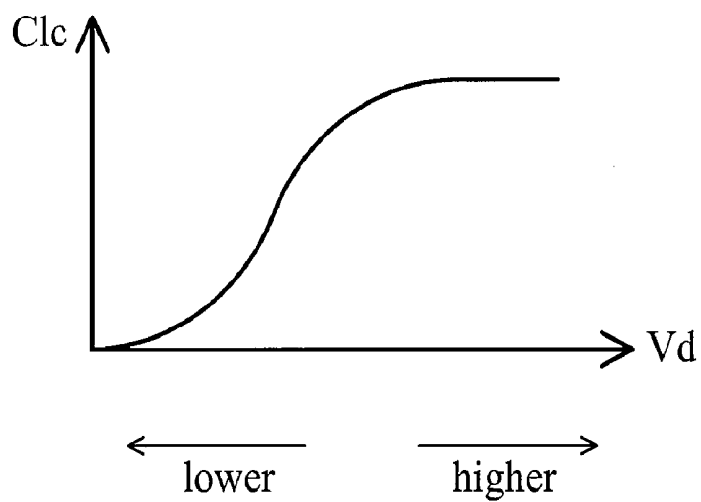


FIG. 2B

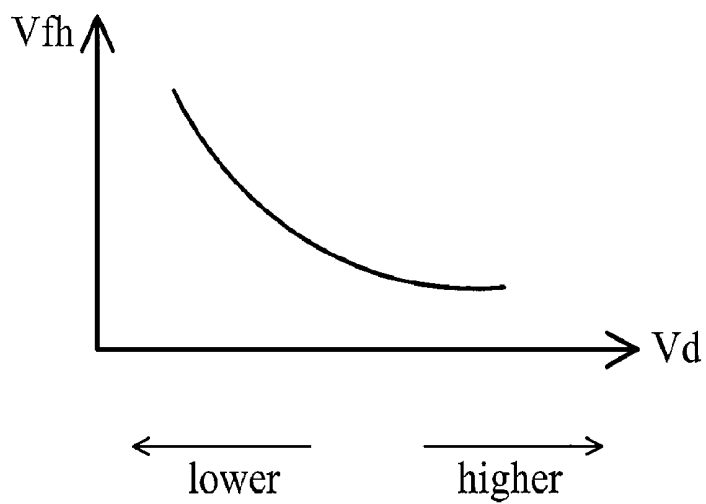


FIG. 2C

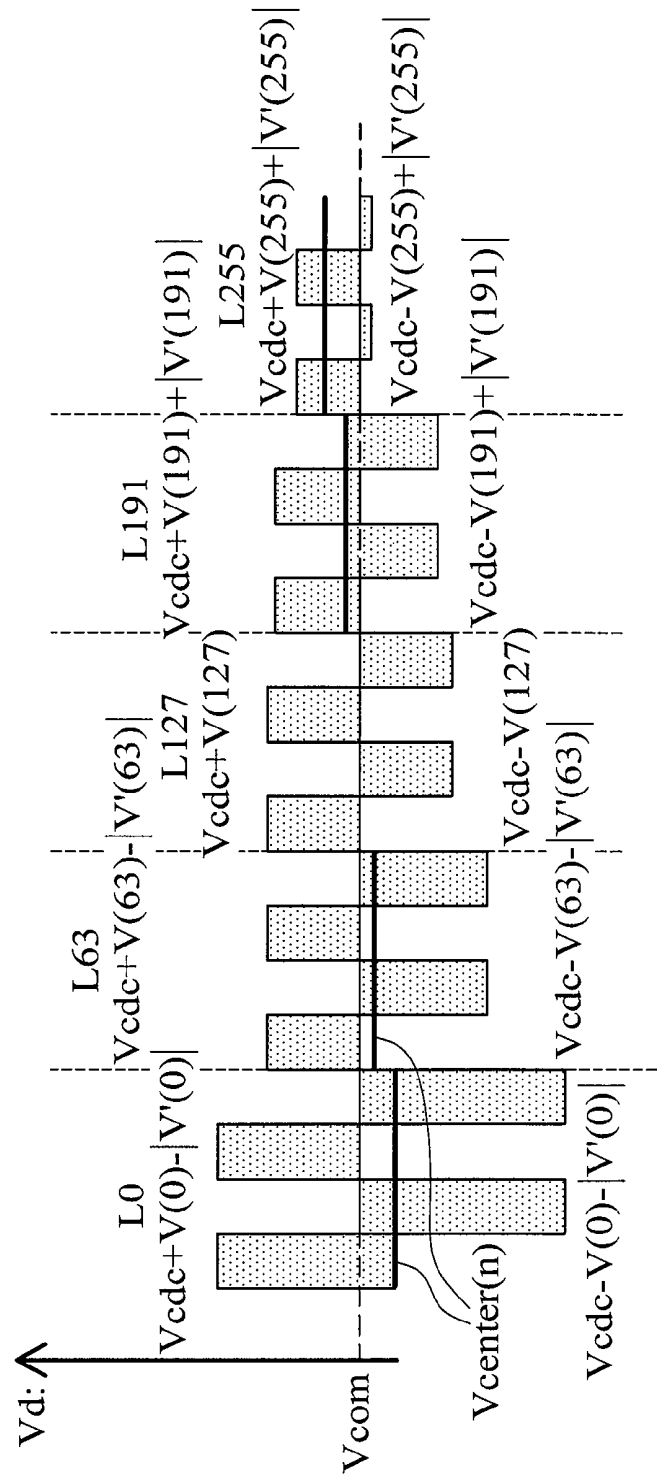


FIG. 2D

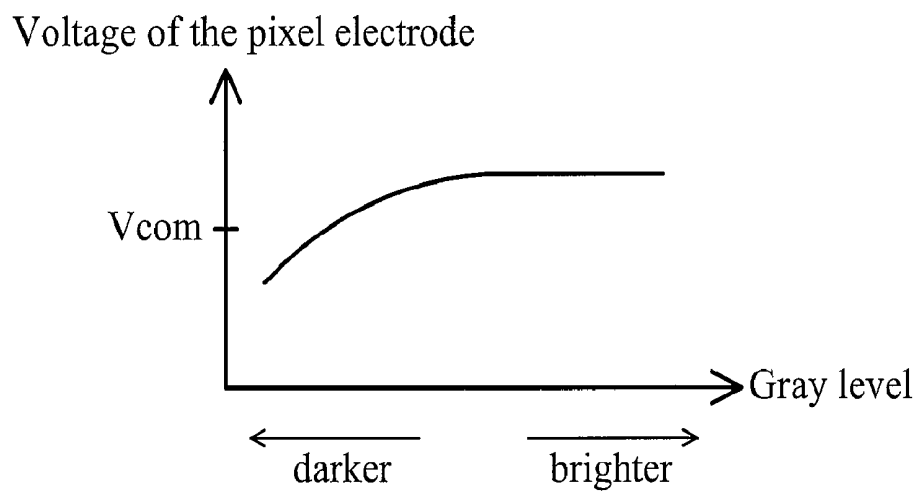


FIG. 3A

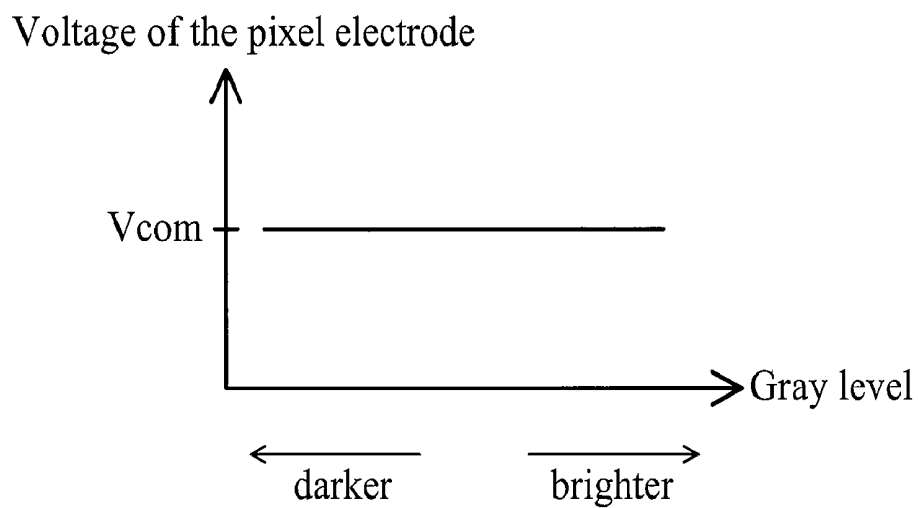


FIG. 3B

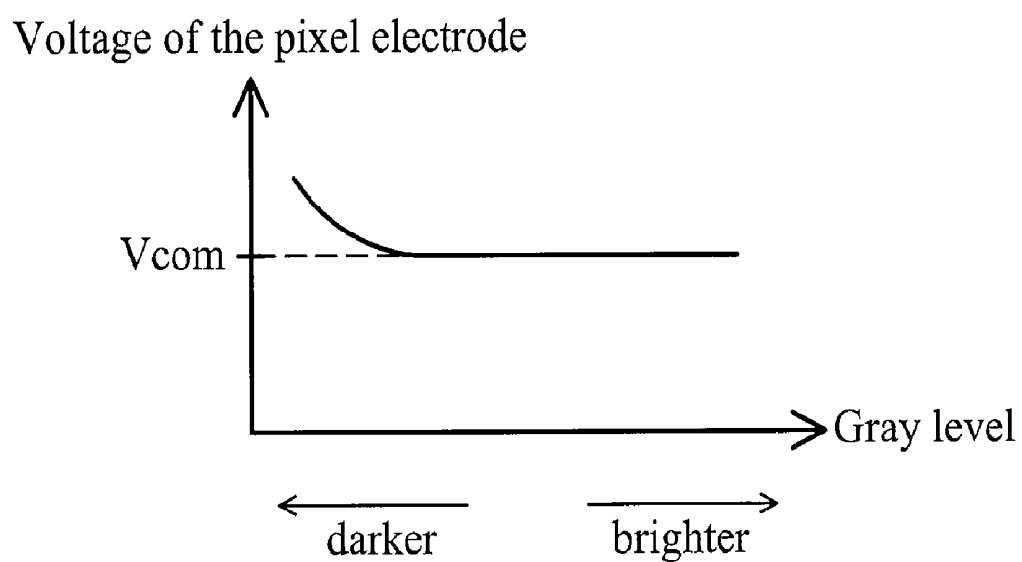


FIG. 3C

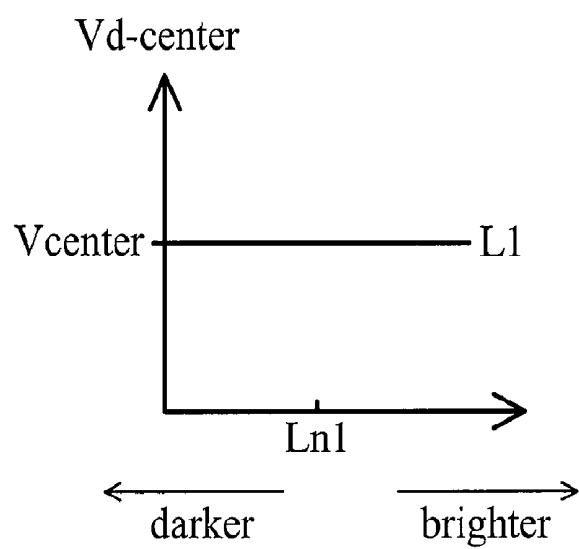


FIG. 4A

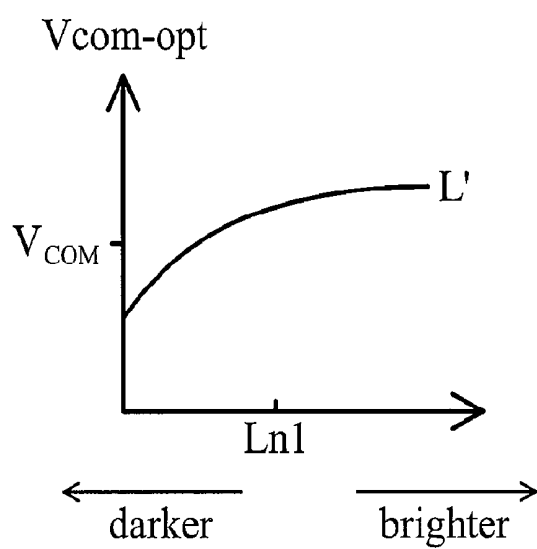


FIG. 4B

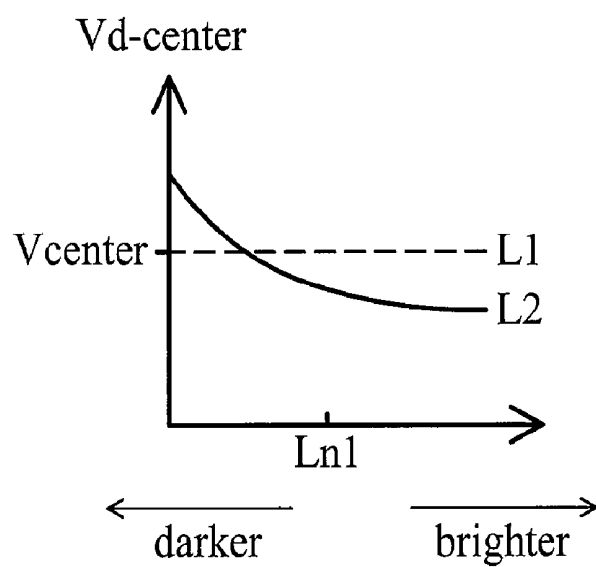


FIG. 4C

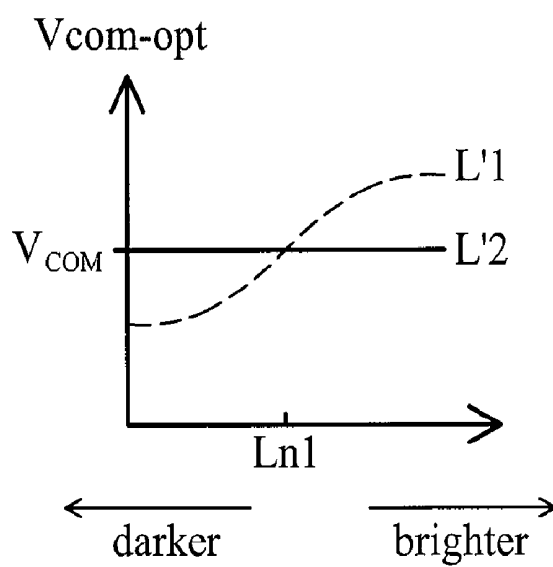


FIG. 4D

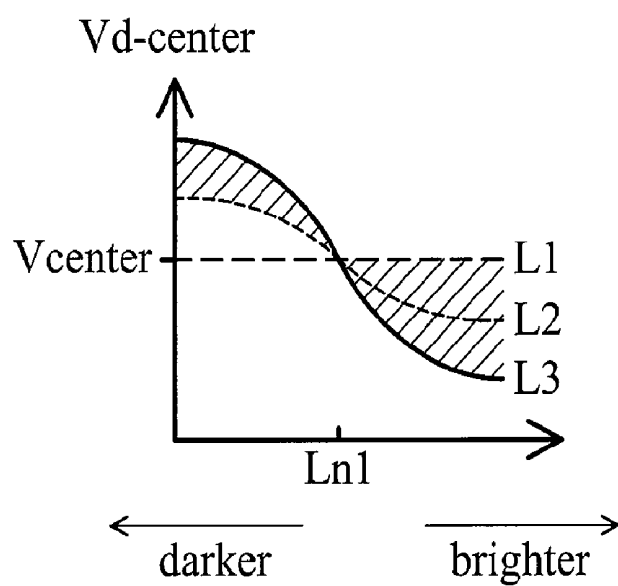


FIG. 4E

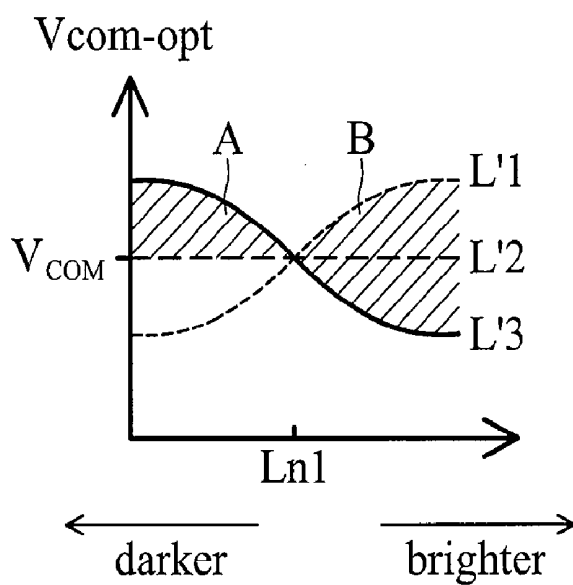


FIG. 4F

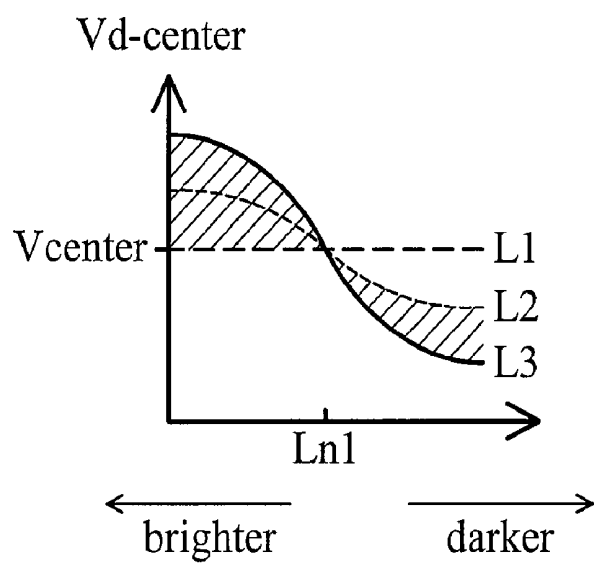


FIG. 4G

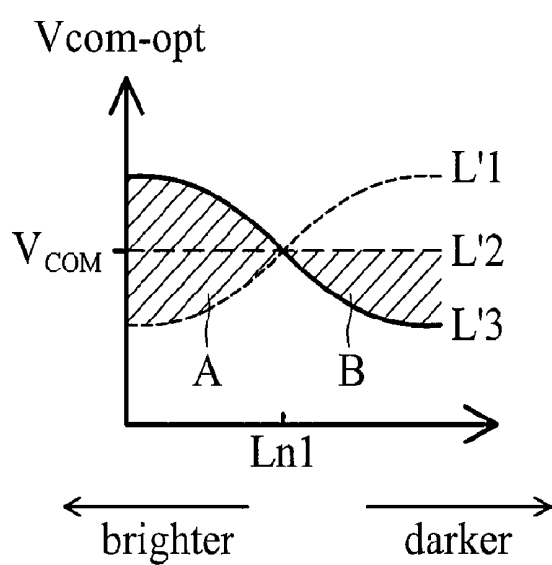


FIG. 4H

METHOD FOR DRIVING A LIQUID CRYSTAL DISPLAY

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates to a liquid crystal display, and more particularly, to a method for eliminating image sticking in an LCD.

[0003] 2. Description of the Related Art

[0004] FIG. 1 is a schematic diagram of a pixel and a driving circuit of a panel. The panel comprises a liquid crystal layer 11 disposed between a pixel electrode A (not shown) formed on a first substrate and a counter electrode (not shown) formed on a second substrate. A thin film transistor (TFT) 12 is disposed on the first substrate. A gate G of TFT 12 is electrically coupled to a gate line of the first substrate and a source S of TFT 12 is electrically coupled to a source line of the first substrate. Pixel electrode A is coupled to a drain D of TFT 12. Counter electrode B is coupled to a common signal source providing a common signal V_C .

[0005] The source line is coupled to a source signal source providing various source signals V_d for adjusting the voltage level of pixel electrode A and changing a first voltage difference between pixel electrode A and counter electrode B. Thus, the arrangement of molecules in liquid crystal layer 11 is adjusted for controlling the gray levels of liquid crystal layer 11. If the panel is a normal black type, the brightness of a pixel is brighter as the first voltage difference is higher. On the other hand, if the panel is a normal white type, the pixel is less bright as the first voltage difference is higher.

[0006] FIG. 2A shows a conventional waveform of a signal to be applied to the panel shown in FIG. 1. In the conventional method, the source signal source provides various source signals V_d according to various gray levels. A symbol V_d -center represents middle-voltages of the source signals V_d . In this embodiment, the panel is a normal white type. Common signal V_C comprises a fixed middle-voltage V_{COM} . In various gray levels L_n ($0 \leq n \leq 255$), the source signal source provides voltage levels $V_{dc}+V(n)$ and $V_{dc}-V(n)$ such that the first voltage difference between pixel electrode A and counter electrode B is $V(n)$, where n is a gray level, $V(n)$ is an amplitude of an analog voltage for generating the gray level of the panel, and voltage level V_{dc} is a constant value. In an ideal state the voltage difference V_{ds} between the source S and the drain D is equal to zero and capacitances of all capacitors are infinite. Besides, the middle-voltage V_{COM} is equal to voltage level V_{dc} (V_d -center), and a voltage received by pixel electrode A is equal to source signal V_d . In practice, due to effects upon voltage difference V_{ds} between the source S and the drain D and stray capacitors, the source signal V_d is compensated such that the voltage received by pixel electrode A is equal to the source signal V_d shown in FIG. 2A.

[0007] The voltage received by pixel electrode A is a shift result of the source signal V_d , generated by the voltage difference V_{ds} , a stray capacitor C_{gd} and the gate voltage V_g (FIG. 1), and a feed-through voltage V_{fh} . The feed-through voltage V_{fh} is expressed by the following equation (1):

$$V_{fh} = \frac{C_{gd}}{C_{lc} + C_s + C_{gd}}(V_{gh} - V_{gl}) \quad \text{Equation (1)}$$

[0008] where V_{gh} is a high level of the gate voltage V_g , and V_{gl} is a low level of the gate voltage V_g . The difference between V_{gh} and V_{gl} is constant.

[0009] Because the voltage received by pixel electrode A changes according to the source signal V_d changed by the source signal source, the capacitance of a capacitor C_{lc} also changes according to the voltage (analog voltage) received by pixel electrode A. FIG. 2B shows a relationship between the source signal V_d (the analog voltage of pixel electrode A) and the capacitance of a capacitor C_{lc} . When the level of the source signal V_d increases, the capacitance of the capacitor C_{lc} does, as well. Thus, the capacitance of the capacitor C_{lc} depends on the level of the analog voltage of pixel electrode A. When the level of the source signal V_d is higher, the analog voltage of pixel electrode A is also higher. Thus, the analog voltage of pixel electrode A depends on the level of the source signal V_d .

[0010] FIG. 2C shows a relationship between the source signal V_d and the feed-through voltage V_{fh} . When the level of the source signal V_d is higher, the level of the feed-through voltage V_{fh} is lower.

[0011] FIG. 2D is a schematic diagram of another conventional method for driving the panel shown in FIG. 1. The conventional method adjusts source signal V_d corresponding to different gray levels such that the middle-voltage thereof is not constant. In this example, the panel shown in FIG. 1 is a normal white type and the common signal V_C comprises a constant middle-voltage V_{COM} . When the liquid crystal layer 11 displays various gray levels, pixel electrode A requires various voltage levels. Thus, the feed-through voltages V_{fh} are different. In order that pixel electrode A receives the analog voltage $\pm V(n)$ shown in FIG. 2A, when the liquid crystal layer 11 displays the gray level L_n , the source signal V_d provides voltage levels $V_{center(n)}+V(n)$ and $V_{center(n)}-V(n)$ to pixel electrode A such that the first voltage difference between pixel electrode A and the counter electrode B is $V(n)$, where $V_{center(n)}-V_{fh(n)}=V_{COM}$. Thus, $V_{center(n)}=V_{COM}+V_{fh(n)}$. $V_{fh(n)}$ represents a voltage difference between $V_{center(n)}$ and V_{COM} , where $V_{center(n)}$ is obtained according to the voltage difference V_{ds} .

[0012] FIG. 3A shows a relationship between the gray level and the voltage received by pixel electrode A where source signal V_d shown in FIG. 2A is applied in the circuit shown in FIG. 1. FIG. 3B shows a relationship between the gray level and the voltage received by pixel electrode A where source signal V_d shown in FIG. 2D is applied in the circuit shown in FIG. 1. The middle-voltage received by pixel electrode A is equivalent to V_{COM} and causes the analog voltage corresponding to gray level and the common signal V_C received by counter electrode B to operate normally. Since source signal V_d is provided from the first substrate, when source signal V_d is compensated, a voltage difference is generated between the DC component of the compensated source signal V_d and that of a fixed voltage received by the counter electrode B of the second substrate. For a long time, a unidirectional deviation is formed in the liquid crystal layer 11 such that an electrical field is gener-

ated. It is difficult to remove such electrical field, and thus an image sticking issue arises in the panel resulting in image distortion.

[0013] U.S. Pat. No. 6,570,549 (the '549 patent) discloses a method of driving an LCD to address the image sticking issue. FIG. 3C shows a relationship between the gray level and the voltage received by pixel electrode A where source signal V_d disclosed in the '549 patent is applied in the circuit shown in FIG. 1. When the brightness of the panel is darker (the voltage level of the source signal V_d is lower), the method of the '549 patent causes the middle-voltage received by pixel electrode A to exceed V_{COM} such that the unidirectional deviation in the liquid crystal layer is removed for ameliorating the image sticking issue.

[0014] The '549 patent, however, does not specify that a middle-voltage received by pixel electrode A in a specific gray range is necessary to compensate and does not define a compensation range.

BRIEF SUMMARY OF THE INVENTION

[0015] A method for driving a normal black or white liquid crystal display (LCD) is provided. The LCD comprises a liquid crystal layer, a thin film transistor (TFT), a pixel electrode, and a counter electrode. The TFT comprises a source receiving a source signal and a drain coupled to the pixel electrode. The counter electrode receives a common signal. When a voltage level of the source signal is higher, the brightness of the LCD is brighter. The LCD is applied with a preset common voltage.

[0016] An exemplary embodiment of a method according to the present invention drives a normal black liquid crystal display. The LCD is driven by applying uncompensated source signals corresponding to gray levels. First optimized voltages of common signals corresponding to the gray levels are recorded. The source signal is adjusted to drive the LCD such that second optimized common signal voltages of common signals corresponding to the gray levels conform to the following conditions: (1) when the gray level is lower than a predetermined gray level, the second optimized common signal voltage is higher than a predetermined voltage of the common signal and the absolute difference between the second optimized common signal voltage and the predetermined voltage is less than or equal to that between the first optimized common signal voltage and the predetermined voltage and (2) when the gray level is not lower than the predetermined gray level, the absolute difference between the second optimized common signal voltage and the predetermined voltage is less than or equal to that between the first optimized common signal voltage and the predetermined voltage. Preferably, when the LCD typically displays dynamic images and an interlacing method is utilized for providing various gray levels, if the gray level is not lower than the predetermined gray level, the second optimized common signal voltage is interlaced to higher and lower than the predetermined voltage of the common signal in any eight neighboring gray levels. In other words, the second optimized common signal voltages of common signals corresponding to the gray levels are described in the following. In a first group comprising eight gray levels, the second optimized common signal voltage is higher (or lower) than the predetermined voltage of the common signal and in a second group neighboring the first group and comprising eight gray levels, the second optimized common

signal voltage is lower (or higher) than the predetermined voltage of the common signal for reducing the image sticking in dynamic images.

[0017] Another exemplary embodiment of a method according to the present invention drives the normal white type liquid crystal display, in which brightness of the LCD is reduced when the voltage of a source signal is increased. The LCD is driven by applying uncompensated source signals corresponding to gray levels. First optimized common signal voltages ($V_{com-opt1}$) of common signals corresponding to the gray levels are recorded. The source signal is adjusted to drive the LCD such that second optimized common signal voltages ($V_{com-opt2}$) of common signals corresponding to the gray levels conform to the following conditions: (1) when the gray level is lower than a predetermined gray level, the second optimized common signal voltage is lower than a predetermined voltage of the common signal and the absolute difference between the second optimized common signal voltage and the predetermined voltage is less than or equal to that between the first optimized common signal voltage and the predetermined voltage, and (2) when the gray level is not lower than the predetermined gray level, the absolute difference between the second optimized common signal voltage and the predetermined voltage is less than or equal to that between the first optimized common signal voltage and the predetermined voltage. Preferably, when the LCD typically displays dynamic images and an interlacing method is utilized for providing various gray levels, if the gray level is not lower than the predetermined gray level, the second optimized common signal voltage is interlaced to higher or lower than the predetermined voltage of the common signal in any eight neighboring gray levels. The second optimized common signal voltages of common signals corresponding to the gray levels are described in the following. In a first group comprising eight gray levels, the second optimized common signal voltage is higher (or lower) than the predetermined voltage of the common signal and in a second group neighboring the first group and comprising eight gray levels, the second optimized common signal voltage is lower (or higher) than the predetermined voltage of the common signal for reducing image sticking in dynamic images.

[0018] A detailed description is given in the following embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The invention can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawings, wherein:

[0020] FIG. 1 is a schematic diagram of a pixel and a driving circuit of a panel;

[0021] FIG. 2A shows a conventional waveform of a signal to be applied to the panel shown in FIG. 1;

[0022] FIG. 2B shows a relationship between the source signal V_d (the analog voltage of pixel electrode A) and the capacitance of a capacitor C_{lc} ;

[0023] FIG. 2C shows a relationship between the source signal V_d and the feed-through voltage V_{fh} ;

[0024] FIG. 2D is a schematic diagram of another conventional method for driving the panel shown in FIG. 1;

[0025] FIG. 3A shows a relationship between the gray level and the voltage received by pixel electrode A when source signal V_d shown in FIG. 2A is applied in the circuit shown in FIG. 1;

[0026] FIG. 3B shows a relationship between the gray level and the voltage received by pixel electrode A when source signal V_d shown in FIG. 2D is applied in the circuit shown in FIG. 1;

[0027] FIG. 3C shows a relationship between the gray level and the voltage received by pixel electrode A where source signal V_d disclosed in the '549 patent is applied in the circuit shown in FIG. 1;

[0028] FIG. 4A shows a relationship curve L1 between the middle-voltage V_{d_center} of the source signal V_d and the gray levels (various source signals) when the source signal V_d is uncompensated;

[0029] FIG. 4B shows a relationship curve L'1 circuit between an optimized common signal voltage $V_{com-opt}$ and gray levels (various source signals) when the LCD shown in FIG. 1 is driven by the uncompensated source signal V_d ;

[0030] FIG. 4C shows a relationship curve L2 between the middle-voltage V_{d_center} of the source signal V_d and the gray levels (various source signals) when the source signal V_d is compensated;

[0031] FIG. 4D shows a relationship curve L'2 between an optimized common signal voltage $V_{com-opt}$ and gray levels (various source signals) when the LCD shown in FIG. 1 is driven by the compensated source signal V_d ; and

[0032] FIGS. 4E to 4H are schematic diagrams of an exemplary embodiment of the method for driving an LCD, according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0033] The following description is of the best-contemplated mode of carrying out the invention. This description is made for the purpose of illustrating the general principles of the invention and should not be taken in a limiting sense. The scope of the invention is determined by reference to the appended claims.

[0034] The invention provides a method for driving an LCD according to the layouts of a driving circuit, materials of a liquid crystal layer, changes of the leading axle of the liquid crystal and characteristics of positive or negative ions. The method for driving an LCD, according to the present invention, can be implemented for reducing image sticking. Taking the LCD shown in FIG. 1 and FIGS. 4A to 4F as an example, the operating principle of the method for driving an LCD is described in the following

[0035] FIG. 4A shows a relationship curve L1 between the middle-voltage V_{d_center} of the source signal V_d and the gray levels (various source signals) when the source signal V_d is uncompensated (e.g., the middle-voltage of the source signal V_d is kept constant). FIG. 4B shows a relationship curve L'1 circuit between an optimized common signal voltage $V_{com-opt}$ and gray levels (various source signals) when the LCD shown in FIG. 1 is driven by the uncompensated source signal V_d (e.g., the middle-voltage of the source signal V_d is kept constant). As shown in FIG. 4A, the middle-voltage V_{d_center} is held and equal to voltage V_{center} when the brightness of the pixel or gray level of the liquid crystal layer 11 exceeds a preset value Ln_1 . As shown in FIG. 4B, when the brightness of the pixel or gray level of the liquid crystal layer 11 is increased, the optimized com-

mon signal voltage $V_{com-opt}$ is also increased. The optimized common signal voltage $V_{com-opt}$ is not equal to a predetermined voltage V_{COM} set for the LCD.

[0036] FIG. 4C shows a relationship curve L2 between the middle-voltage V_{d_center} of the source signal V_d and the gray levels (various source signals) when the source signal V_d is compensated (e.g., the middle-voltage of the source signal V_d is not constant). FIG. 4D shows a relationship curve L'2 between an optimized common signal voltage $V_{com-opt}$ and gray levels (of various signals) when the LCD shown in FIG. 1 is driven by the compensated source signal V_d . For example, the source signal V_d is compensated utilizing the conventional method shown in FIG. 2D. The curve L'2 shows a relationship between the predetermined voltage V_{COM} set for the LCD and various gray levels.

[0037] FIGS. 4E and 4F are schematic diagrams of an exemplary embodiment of the method for driving an LCD. The curve L'3 shown in FIG. 4F is generated according to the curves L'1 and L'2 shown in FIG. 4D. The curve L'3 is a mirror curve of the curve L'1 with respect to the curve L'2. In any one gray level, the voltage difference between curves L'3 and L'2 is equal to that between curves L'1 and L'2. When the brightness or the gray level exceeds the preset value Ln_1 , the voltage of the curve L'1 exceeds the predetermined voltage V_{COM} of the curve L'2 and the voltage of the curve L'3 is less than that of the curve L'2.

[0038] According to the present invention, the voltages of the source signals V_d are adjusted such that the middle-voltages V_{d_center} of the source signals V_d corresponding to gray levels are within the shadow of FIG. 4E. Thus, the optimized common signal voltages $V_{com-opt}$ are located within the shadow of FIG. 4F. When the brightness or the gray level is lower than the preset value Ln_1 , the optimized common signal voltage $V_{com-opt}$ is between the voltages of curves L'2 and L'3 (as represented by shadow A in FIG. 4F). When the brightness or the gray level is higher than the preset value Ln_1 , the optimized common signal voltage $V_{com-opt}$ is between the voltages of curves L'3 and L'1 (as represented by shadow B in FIG. 4F). When the brightness or the gray level is lower than the preset value Ln_1 , the optimized common signal voltage $V_{com-opt}$ is set to be higher than the predetermined voltage V_{COM} of the curve L'2 and the absolute voltage difference between the optimized common signal voltage $V_{com-opt}$ and the predetermined voltage V_{COM} of the curve L'2 is less than or equal to that between the curves L'2 and L'1. When the brightness or the gray level is not lower than the preset value Ln_1 , the absolute voltage difference between the optimized common signal voltage $V_{com-opt}$ and the predetermined voltage V_{COM} of the curve L'2 is set to be lower than or equal to that between the curves L'2 and L'1.

[0039] According to one embodiment of the present invention, when the brightness or the gray level is not lower than the preset value Ln_1 (e.g., the gray level of the preset value Ln_1 is 128; the gray level is higher as the brightness is brighter), an interlacing method is utilized such that the optimized common signal voltage $V_{com-opt}$ is higher or lower than the predetermined voltage V_{COM} of the common signal in any eight neighboring gray levels. Taking 256 gray levels as an example, a first group comprises eight gray levels, such as 136 to 143, and a second group comprises eight gray levels, such as 144 to 151. In the first group, the optimized common signal voltage $V_{com-opt}$ can be set to be higher (or lower) than the predetermined voltage V_{COM} of

the common signal. In the second group neighboring the first group, the optimized common signal voltage $V_{com-opt}$ can be set to be lower (or higher) than the predetermined voltage of the common signal. When dynamic images are displayed for a long time, an inter-electric field occurring due to the image sticking issue is removed so as to reduce image sticking itself.

[0040] When the method for driving the LCD is applied in an uncompensated LCD suffering from the image sticking or poor liquid crystal material, the image sticking can be significantly improved. The image sticking includes a surface type sticking and a line shape sticking. The present invention reduces the line shape sticking and improves surface type sticking. Generally, when image sticking is generated, the image sticking exists in the LCD and can not be removed. If the method of the invention is utilized for a long time, the surface type sticking in some LCDs can be improved or completely eliminated.

[0041] In the previous embodiment, the LCD is a normal black type. In the following embodiment, the LCD is a normal white type described with reference to FIGS. 4G and 4H.

[0042] In FIGS. 4A to 4F, the x-axis is horizontal with gray levels increasing from left to right. In FIGS. 4G and 4H, the x-axis is horizontal with gray levels reducing from left to right. The curve L'3 shown in FIG. 4H is generated according to the curves L'1 and L'2. The $V_{com-opt}$ curve L'3 is a mirror curve of the curve L'1 with respect to the curve L'2. Thus, the voltage difference between curves L'3 and L'2 is equal to that between curves L'1 and L'2 in a gray level. When the gray level exceeds the preset value Ln_1 (the brightness of the gray level is brighter than that of the preset value Ln_1), the voltage of the curve L'1 is less than the predetermined voltage V_{COM} of the curve L'2 and the voltage of the curve L'3 exceeds that of the curve L'2.

[0043] Similarly, according to another embodiment of the present invention, when the brightness or the gray level is not lower than the preset value Ln_1 (e.g., the gray level of the preset value Ln_1 is 128; the gray level is higher as the brightness is lower), an interlacing method is utilized such that the optimized common signal voltage $V_{com-opt}$ is higher or lower than the predetermined voltage V_{COM} of the common signal, in any eight neighboring gray levels. Taking 256 gray levels as an example, a first group comprises eight gray levels, such as 16 to 23, and a second group comprises eight gray levels, such as 24 to 31. In the first group, the optimized common signal voltage $V_{com-opt}$ can be set to be higher (or lower) than the predetermined voltage V_{COM} of the common signal. In the second group neighboring the first group, the optimized common signal voltage $V_{com-opt}$ can be set to be lower (or higher) than the predetermined voltage of the common signal.

[0044] According to the present invention, the voltages of the source signals V_d are adjusted such that the middle-voltages V_d -center of the source signals V_d corresponding to gray levels are within the shadow of FIG. 4G. Thus, the optimized common signal voltages $V_{com-opt}$ are located within the shadow of FIG. 4H. If the voltages of the source signals V_d are adjusted and the gray level is less than the preset value Ln_1 (the brightness of the gray level is darker than that of the preset value Ln_1), the optimized common signal voltage $V_{com-opt}$ is set. Thus, the optimized common signal voltage $V_{com-opt}$ is between the voltages of curves L'2 and L'3 (shadow B in FIG. 4H). When the gray level is

higher than the preset value Ln_1 (the brightness of the gray level is brighter than that of the preset value Ln_1), the optimized common signal voltage $V_{com-opt}$ is set. Thus, the optimized common signal voltage $V_{com-opt}$ is between the voltages of curves L'3 and L'1 (shadow A in FIG. 4H). In other words, when the brightness is less than the preset value Ln_1 , the optimized common signal voltage $V_{com-opt}$ is set to be less than the predetermined voltage V_{COM} of the curve L'2, and the absolute voltage difference between the optimized common signal voltage $V_{com-opt}$ and the predetermined voltage V_{COM} of the curve L'2 is less than or equal to the absolute voltage difference between the curves L'2 and L'1.

[0045] When the brightness or the gray level is not lower than the preset value Ln_1 , the absolute voltage difference between the optimized common signal voltage $V_{com-opt}$ and the predetermined voltage V_{COM} of the curve L'2 is less than or equal to the absolute voltage difference between the curves L'2 and L'1.

[0046] The method for driving an LCD is easily implemented in a driving circuit of the LCD. Thus, the image sticking issue in the LCD can be improved or eliminated.

[0047] While the invention has been described by way of example and in terms of the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. To the contrary, it is intended to cover various modifications and similar arrangements. Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A method for driving a liquid crystal display (LCD) comprising a liquid crystal layer, a thin film transistor (TFT) comprising a source for receiving a source signal, a pixel electrode coupled to a drain of the TFT, and a counter electrode for receiving a common signal, wherein when a voltage level of the source signal is higher, the brightness of the LCD is brighter, and the LCD comprises a preset common voltage, the method comprising:

driving the LCD by applying uncompensated source signals corresponding to gray levels;

recording first optimized common signal voltages of a plurality of common signals corresponding to the gray levels; and

adjusting the source signal to drive the LCD such that second optimized common signal voltages of the common signals corresponding to the gray levels conform to either of the following conditions:

(1) when the gray level is lower than a predetermined gray level, the second optimized common signal voltage is higher than a predetermined voltage of the common signal, and the absolute difference between the second optimized common signal voltage and the predetermined voltage is less than or equal to that between the first optimized common signal voltage and the predetermined voltage; and

(2) when the gray level is not lower than the predetermined gray level, the absolute difference between the second optimized common signal voltage and the predetermined voltage is less than or equal to that between the first optimized common signal voltage and the predetermined voltage.

2. The method as claimed in claim 1, wherein when the gray level is not lower than the predetermined gray level, the

second optimized common signal voltages of the common signals corresponding to the gray levels conform to the following condition: in a first group comprising eight gray levels, the second optimized common signal voltage is higher than the predetermined voltage of the common signal, and in a second group comprising another eight gray levels and neighboring the first group, the second optimized common signal voltage is lower than the predetermined voltage of the common signal.

3. A method for driving a liquid crystal display (LCD) comprising a liquid crystal layer, a thin film transistor (TFT) comprising a source for receiving a source signal, a pixel electrode coupled to a drain of the TFT, and a counter electrode for receiving a common signal, wherein when a voltage level of the source signal is higher, the brightness of the LCD is darker, and the LCD comprises a preset common voltage, the method comprising:

driving the LCD by applying uncompensated source signals corresponding to gray levels;

recording first optimized common signal voltages of a plurality of common signals corresponding to the gray levels; and

adjusting the source signal to drive the LCD such that second optimized common signal voltages of the common signals corresponding to the gray levels conform to either of the following conditions:

(1) when the gray level is lower than a predetermined gray level, the second optimized common signal voltage is lower than a predetermined voltage of the common signal, and the absolute difference between the second optimized common signal voltage and the predetermined voltage is less than or equal to that between the first optimized common signal voltage and the predetermined voltage; and

(2) when the gray level is not lower than the predetermined gray level, the absolute difference between the second optimized common signal voltage and the predetermined voltage is less than or equal to that between the first optimized common signal voltage and the predetermined voltage.

4. The method as claimed in claim 3, wherein when the gray level is not lower than the predetermined gray level, the second optimized common signal voltages of the common signals corresponding to the gray levels conform to the following condition: in a first group comprising eight gray levels, the second optimized common signal voltage is higher than the predetermined voltage of the common signal, and in a second group comprising another eight gray levels and neighboring the first group, the second optimized common signal voltage is lower than the predetermined voltage of the common signal.

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摘要(译)

一种用于驱动普通黑色型液晶显示器 (LCD) 的方法，包括通过施加对应于灰度级的未补偿源信号来驱动LCD。记录与灰度级对应的公共信号的第一优化公共信号电压 ($V_{com-opt1}$) ;调整源信号以驱动LCD，使得与灰度级对应的公共信号的第二优化公共信号电压 ($V_{com-opt2}$) 符合以下条件：(1) 当灰度级低于预定灰度级时， $V_{com-opt2}$ 超过公共信号的预定电压，并且 $V_{com-opt2}$ 和预定电压之间的绝对差小于或等于 $V_{com-opt1}$ 和预定电压之间的绝对差；(2) 当灰度级超过预定灰度级时， $V_{com-opt2}$ 与预定电压之间的绝对差值小于或等于 $V_{com-opt1}$ 与预定电压之间的绝对差值。

