US 20180374428A1

(19) United States

(12) Patent Application Publication

CHEN

(10) Pub. No.: US 2018/0374428 A1

(43) Pub. Date: Dec. 27, 2018

(54) **LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR DRIVING THE SAME**

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(21) Appl. No.: **15/743,954**

(22) PCT Filed: **May 22, 2017**

(86) PCT No.: **PCT/CN2017/085349**

§ 371 (c)(1),
(2) Date: **Jan. 11, 2018**

(30) **Foreign Application Priority Data**

Dec. 27, 2016 (CN) 201611228633.3

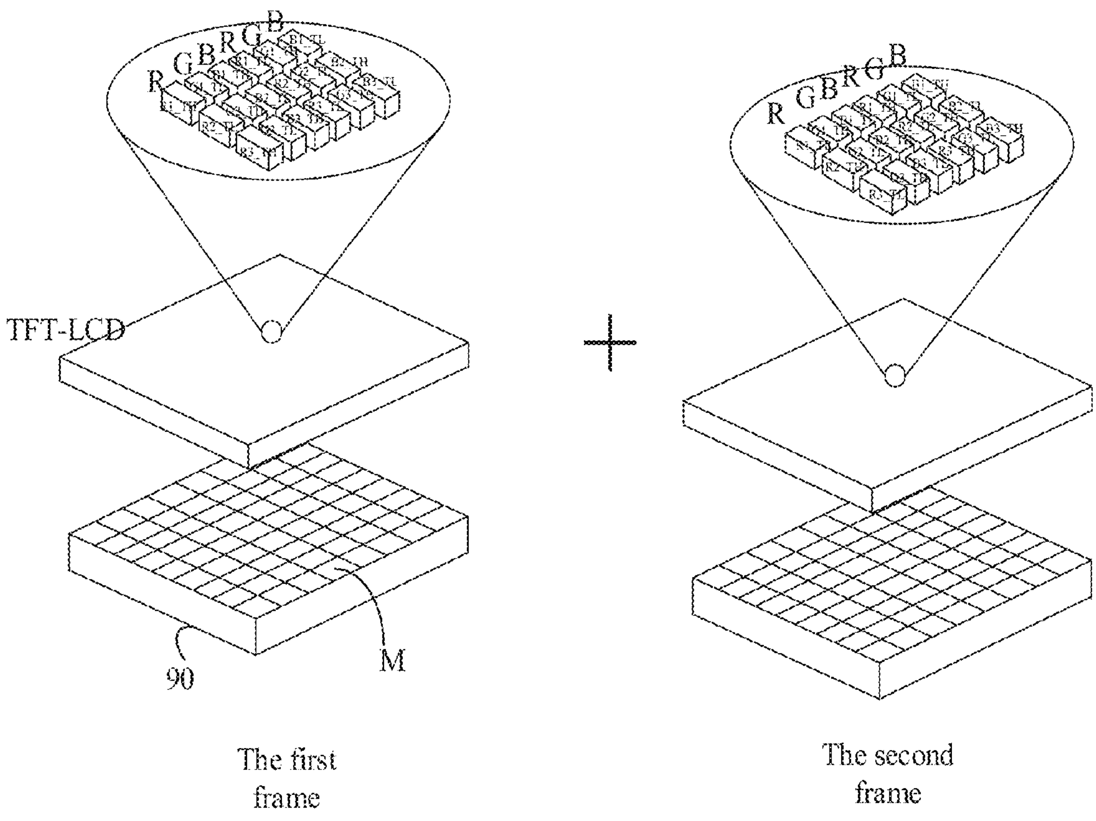
Publication Classification

(51) **Int. Cl.**
G09G 3/34 (2006.01)
G09G 3/36 (2006.01)

(52) **U.S. Cl.**
CPC ***G09G 3/342*** (2013.01); ***G09G 3/3607*** (2013.01); ***G09G 3/3413*** (2013.01); *G09G 2320/0626* (2013.01); *G09G 2320/029* (2013.01); *G09G 2360/16* (2013.01); *G09G 2320/0242* (2013.01)

(57) **ABSTRACT**

A method for driving an LCD device includes displaying each picture with two frame images sequentially; driving voltages for two adjacent sub-pixels in each of the frame images are different, and driving voltages for each sub-pixel in the first frame image and the second frame image are different; determining backlight brightness regulation signals for each of the backlight subareas; the backlight brightness regulation signals are grouped signals, the number of the groups is identical to the number of types of the color sub-pixels; calculating an average color chroma of a current picture region corresponding to each of the backlight subareas; determining whether the average color chroma of each of the backlight subareas is within a preset range; if yes, performing a brightness regulation to a backlight source of the backlight subarea in each of the frame images of a next picture according to the backlight brightness regulation signal of the backlight subarea.



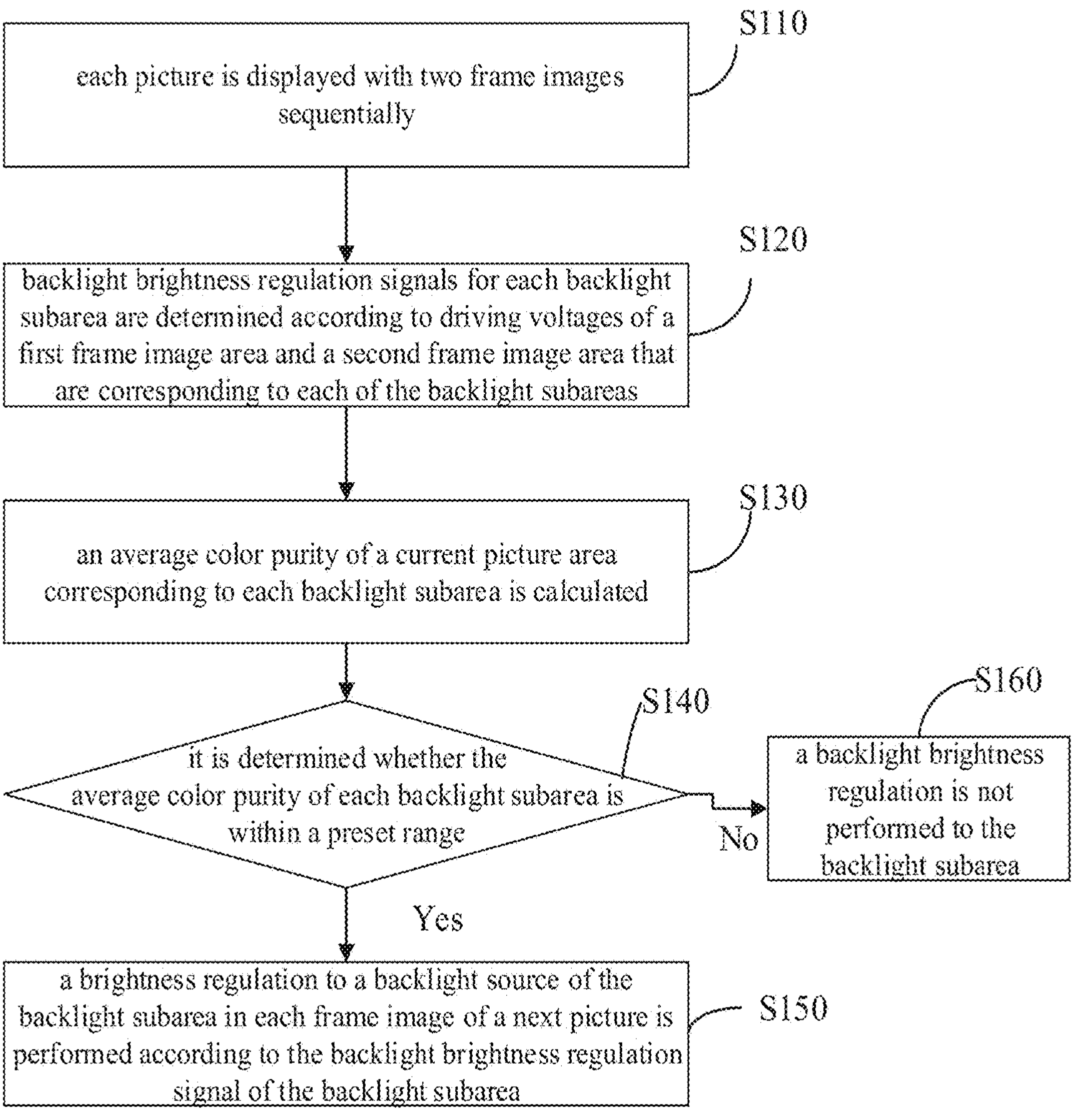

S110
each picture is displayed with two frame images sequentially
S120
backlight brightness regulation signals for each backlight subarea are determined according to driving voltages of a first frame image area and a second frame image area that are corresponding to each of the backlight subareas
S130
an average color purity of a current picture area corresponding to each backlight subarea is calculated
S140
it is determined whether the average color purity of each backlight subarea is within a preset range
No
S160
a backlight brightness regulation is not performed to the backlight subarea
Yes
a brightness regulation to a backlight source of the backlight subarea in each frame image of a next picture is performed according to the backlight brightness regulation signal of the backlight subarea
S150

FIG. 1

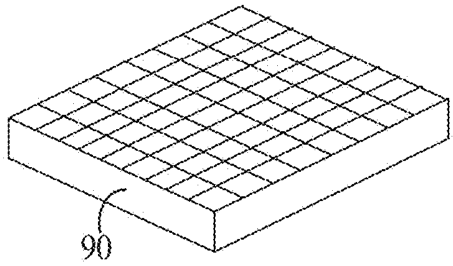


FIG. 2

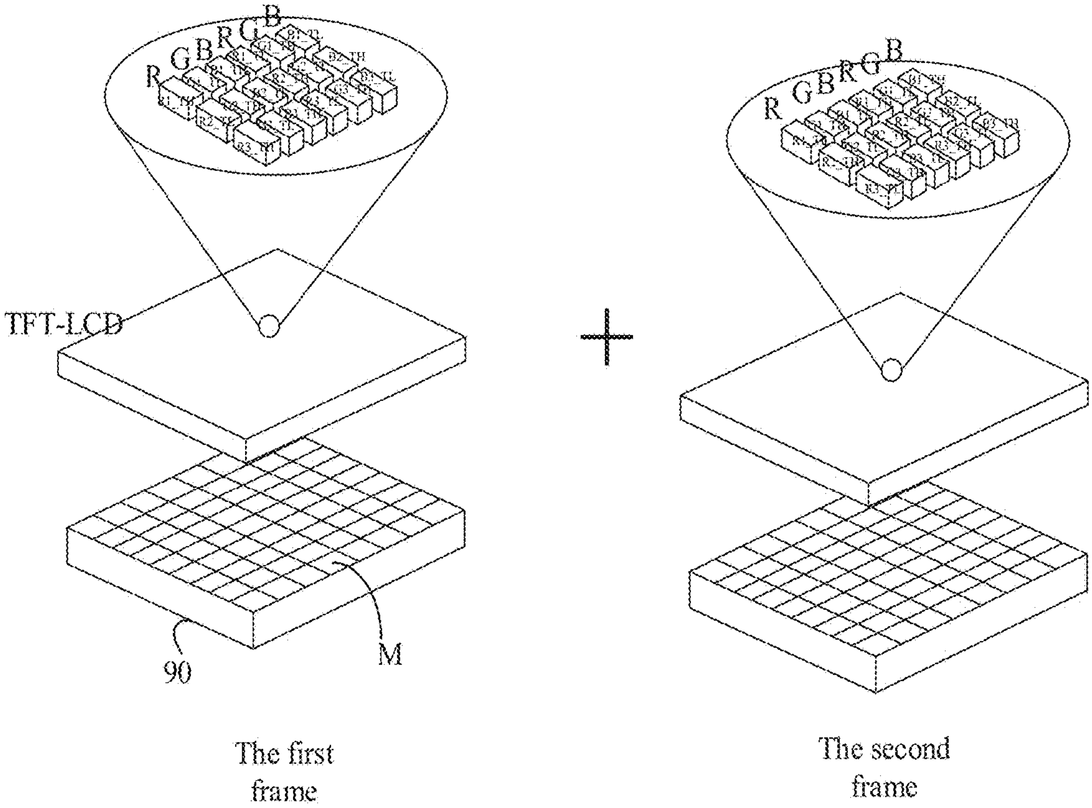


FIG. 3

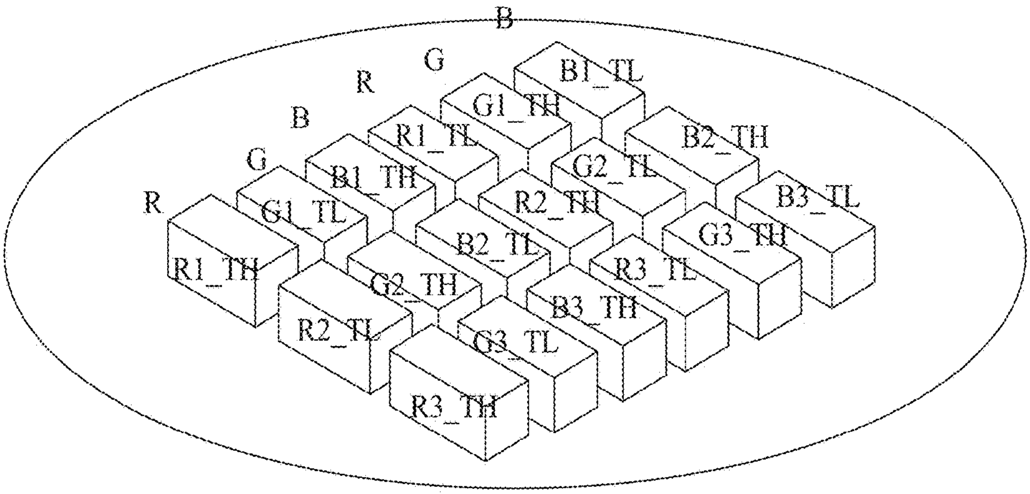

B
G
R
B
G
R
B1_TL
G1_TH
R1_TL
B1_TH
G1_TL
R1_TH
B2_TH
G2_TL
R2_TH
B2_TL
G2_TH
R2_TL
B3_TL
G3_TH
R3_TL
B3_TH
G3_TL
R3_TH

FIG. 4

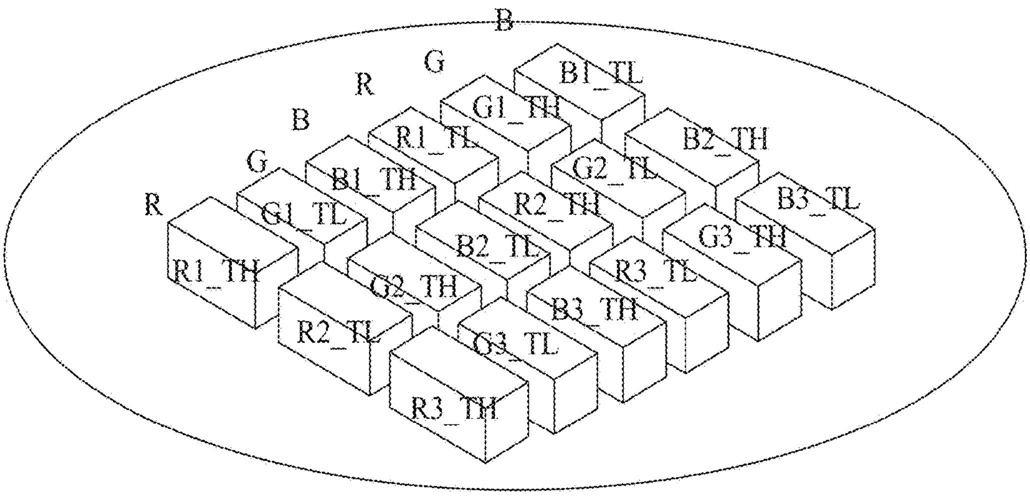

B
G
R
B
G
R
B1_TL
G1_TH
R1_TL
B1_TH
G1_TL
R1_TH
B2_TH
G2_TL
R2_TH
B2_TL
G2_TH
R2_TL
B3_TL
G3_TH
R3_TL
B3_TH
G3_TL
R3_TH

Fig.5

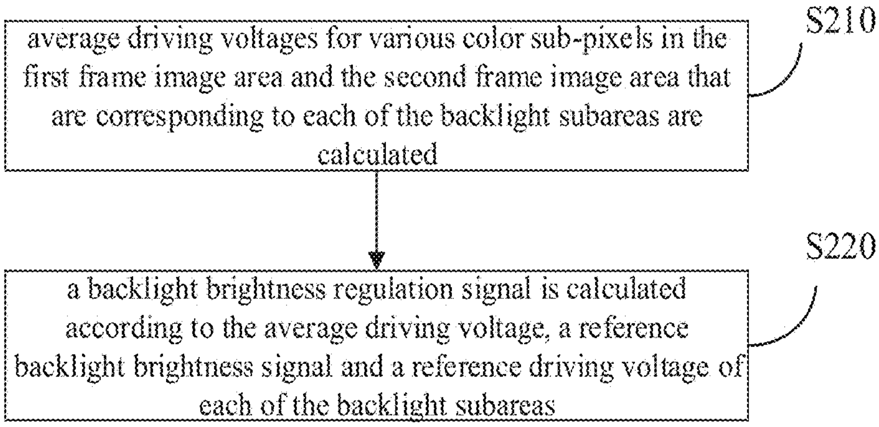

average driving voltages for various color sub-pixels in the first frame image area and the second frame image area that are corresponding to each of the backlight subareas are calculated
S210
a backlight brightness regulation signal is calculated according to the average driving voltage, a reference backlight brightness signal and a reference driving voltage of each of the backlight subareas
S220

FIG.6

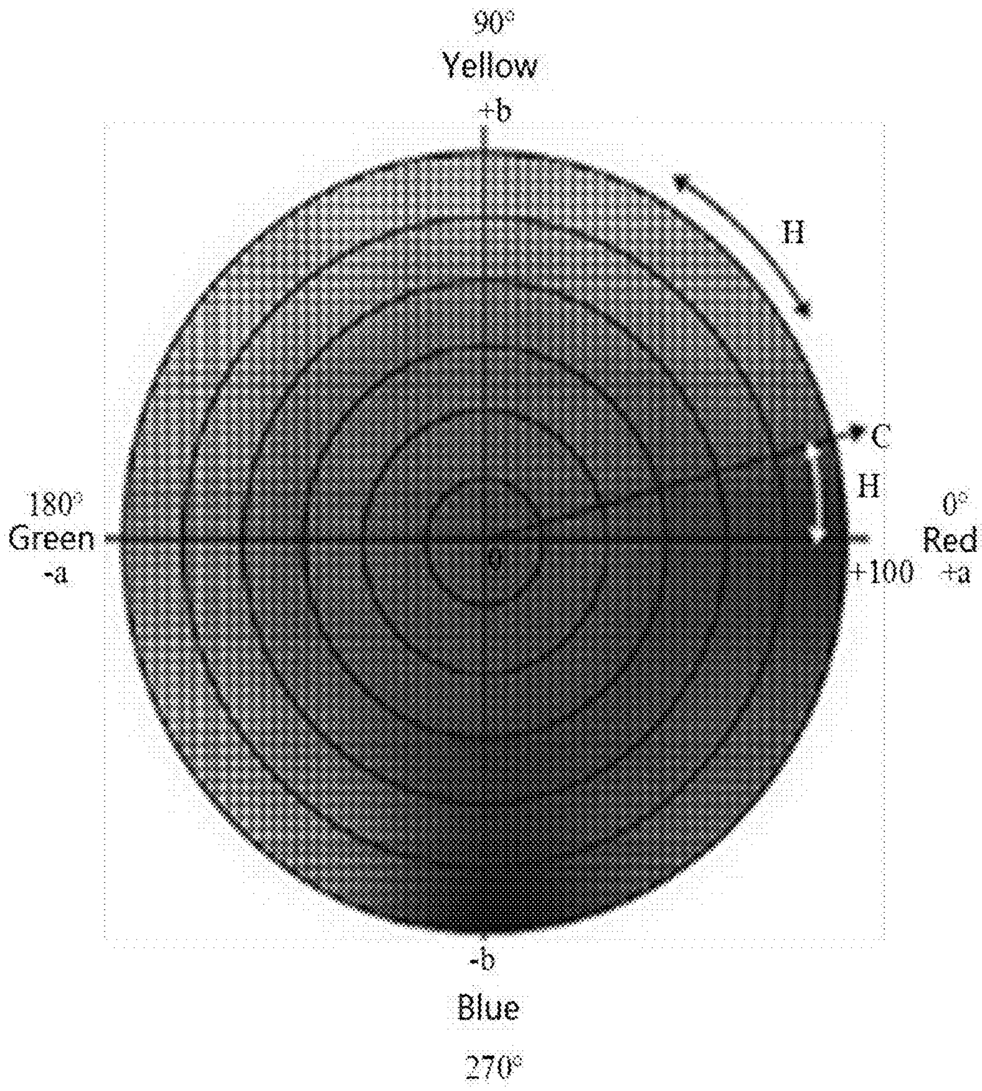

90°
Yellow
+b
H
C
H
180°
Green
-a
0
0°
Red
+100
+a
-b
Blue
270°

FIG. 7

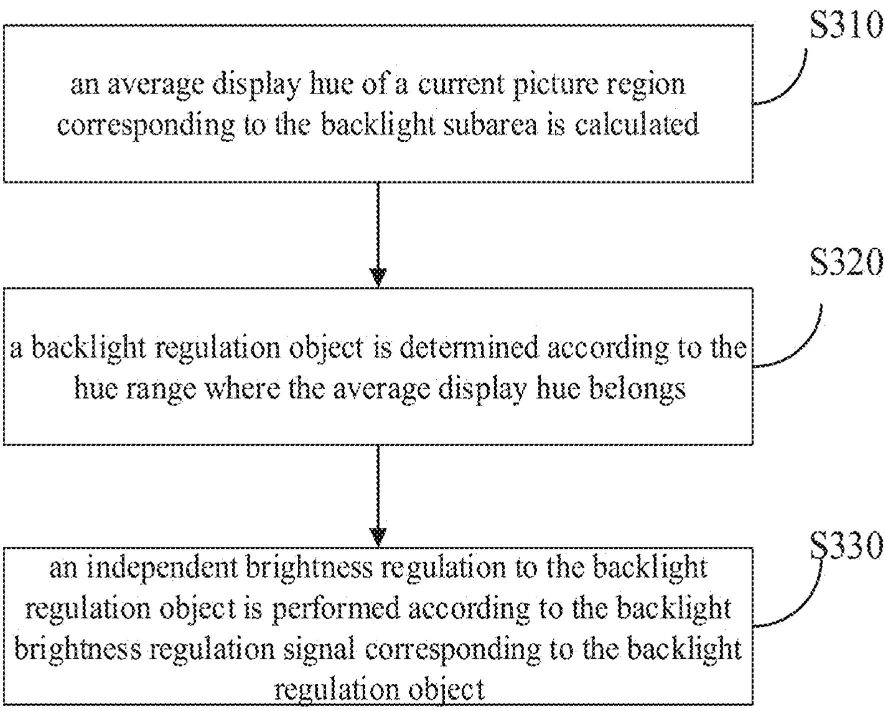

S310
an average display hue of a current picture region corresponding to the backlight subarea is calculated
S320
a backlight regulation object is determined according to the hue range where the average display hue belongs
S330
an independent brightness regulation to the backlight regulation object is performed according to the backlight brightness regulation signal corresponding to the backlight regulation object

FIG. 8

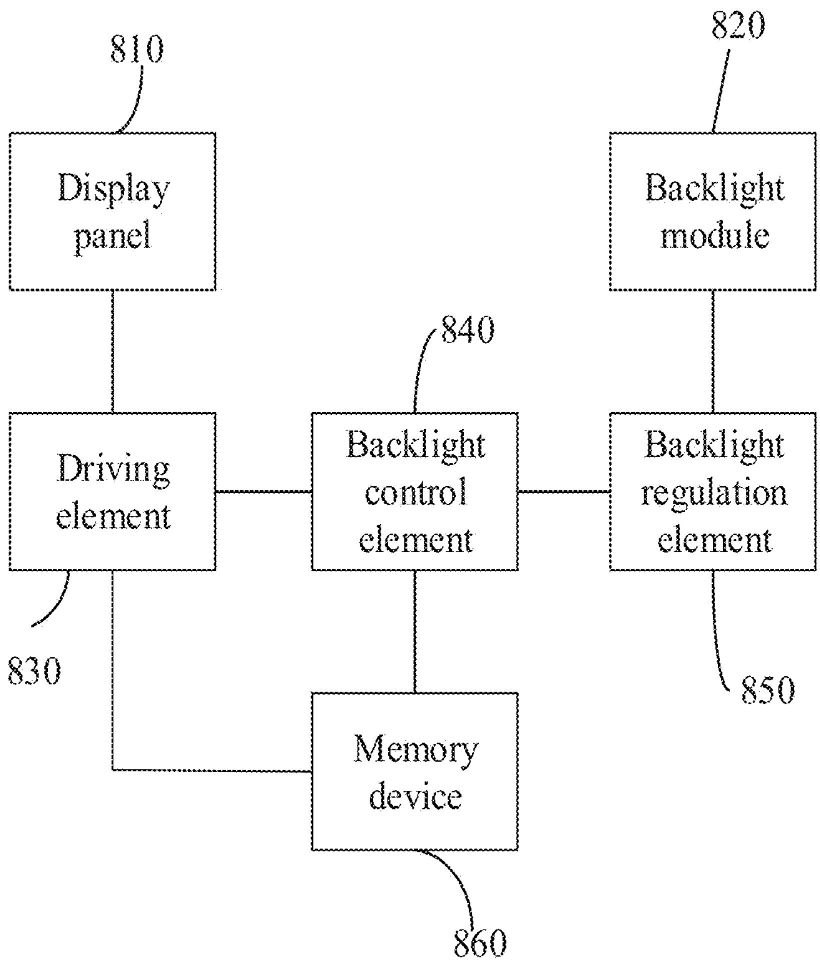

810
820
Display panel
Backlight module
840
Driving element
Backlight control element
Backlight regulation element
830
850
Memory device
860

FIG. 9

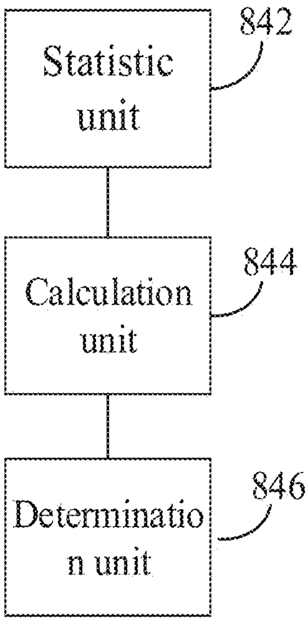

Statistic unit
842
Calculation unit
844
Determinatio n unit
846

FIG. 10

LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR DRIVING THE SAME

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Chinese Patent Application No. 201611228633.3, entitled "LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR DRIVING THE SAME" filed on Dec. 27, 2016, the contents of which is expressly incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

[0002] The present disclosure relates to a liquid crystal display (LCD) technology field, and particularly relates to an LCD device and a method for driving the same.

BACKGROUND OF THE INVENTION

[0003] Most conventional large size LCDs adopt negative Vertical Alignment (VA) liquid crystal display or In-plane Switching (IPS) liquid crystal display technology. As to the driving of a VA LCD, in a large viewing angle, the brightness is rapidly saturated with the driving voltage, such that the viewing angle color shift is serious and the quality of the image is affected.

SUMMARY OF THE INVENTION

[0004] According to various embodiments of the present disclosure, an LCD device and a method for driving the same are provided, which can address the deficiency of viewing angle color cast.

[0005] A method for driving an LCD device includes:

[0006] displaying each picture with two frame images sequentially; the two frame images include a first frame image and a second frame image; driving voltages for two adjacent sub-pixels in each of the frame images are different;

[0007] determining backlight brightness regulation signals for each backlight subarea according to driving voltages of a first frame image area and a second frame image area, the first frame image area and the second frame image are corresponding to each of the backlight subareas; the backlight brightness regulation signals are grouped signals, the number of the groups is identical to the number of types of the color sub-pixels;

[0008] calculating an average color chroma of a current picture region corresponding to each of the backlight subareas;

[0009] determining whether the average color chroma of each of the backlight subareas is within a preset range;

[0010] if the average color chroma of each of the backlight subareas is within a preset range, performing a brightness regulation to a backlight source of the backlight subarea in each of the frame images of a next picture according to the backlight brightness regulation signal of the backlight subarea.

[0011] In an embodiment, the driving voltages for each sub-pixel in the first frame image and the second frame image are found and acquired utilizing a Look-up table (LUT) according to an input signal of each picture.

[0012] In an embodiment, further included is a step of pre-storing the LUT.

[0013] In an embodiment, the step of determining backlight brightness regulation signals for each of the backlight subareas according to driving voltages of a first frame image area and a second frame image area, with the first frame image area and the second frame image corresponding to each of the backlight subareas, includes: calculating average driving voltages for various color sub-pixels in the first frame image area and the second frame image area, with the first frame image area and the second frame image corresponding to each of the backlight subareas; and calculating a backlight brightness regulation signal according to the average driving voltage, a reference backlight brightness signal and a reference driving voltage.

[0014] In an embodiment, in the step of calculating a backlight brightness regulation signal according to the average driving voltage, a reference backlight brightness signal and a reference driving voltage, the formulas to calculate the backlight brightness regulation signal of each color sub-pixel in each of the backlight subareas are:

$$A_{M\_P1}*P_{M\_ave1}A_{M\_P2}*P_{M\_ave2};$$

$$2*A_{M\_P}*P_{M\_ave}=A_{M\_P1}*P_{M\_ave1}+A_{M\_P2}*P_{M\_ave2},$$

[0015] P is a target color sub-pixel; M is a serial number of the backlight subarea, A_{M_P1} is the backlight brightness regulation signal to perform the backlight brightness regulation to the backlight source of a P sub-pixel in a backlight subarea M corresponding to the first frame image of the next picture; A_{M_P2} is the backlight brightness regulation signal to perform a backlight brightness regulation to the backlight source of the P sub-pixel in the backlight subarea M corresponding to the second frame image of the next picture; P_{M_P1} is an average value of the driving voltage of the P sub-pixel in the backlight subarea M corresponding to the first frame image of the current picture; P_{M_ave2} is an average value of the driving voltage of the P sub-pixel in the backlight subarea M corresponding to the second frame image of the current picture; A_{M_P} is the reference backlight brightness signal of the P sub-pixel in the backlight subarea M corresponding to the image of the current picture; P_{M_ave} is the average value of the reference driving voltage of the P sub-pixel in the frame image area corresponding to the backlight subarea M on the image of the current picture.

[0016] In an embodiment, in the step of determining whether the average color chroma of each of the backlight subareas is within a preset range, if the average color chroma is not within the preset range, a brightness regulation will not be performed to the backlight source of the backlight subarea.

[0017] In an embodiment, the step of performing a brightness regulation to a backlight source of the backlight subarea in each of the frame images of a next picture according to the backlight brightness regulation signal of the backlight subarea includes: calculating an average display hue of a current picture region corresponding to the backlight subarea; determining a backlight regulation object according to the hue range where the average display hue belongs; the backlight regulation object includes a backlight source of at least one of a red sub-pixel, a green sub-pixel and a blue sub-pixel; and performing an independent brightness regulation to the backlight regulation object according to the backlight brightness regulation signal corresponding to the backlight regulation object.

[0018] In an embodiment, in the step of determining a backlight regulation object according to the hue range where the average display hue belongs, when the average display hue is 0°<H≤45° or 315°<H≤360°, the object of the backlight regulation is the backlight source corresponding to the

red sub-pixel; when the average display hue is $45° < H \leq 135°$, the object of the backlight regulation are the backlight sources respectively corresponding to the red sub-pixel and the green sub-pixel; when the average display hue is $135° < H \leq 205°$, the object of the backlight regulation is the backlight source corresponding to the green sub-pixel; when the average display hue is $205° < H \leq 245°$, the object of the backlight regulation are the backlight sources respectively corresponding to the green sub-pixel and the blue sub-pixel; when the average display hue is $245° < H \leq 295°$, the object of the backlight regulation is the backlight source corresponding to the blue sub-pixel; and when the average display hue is $295° < H \leq 315°$, the object of the backlight regulation are the backlight sources respectively corresponding to the blue sub-pixel and the red sub-pixel; H is the average display hue.

[0019] An LCD device includes: a display panel; a backlight module configured to provide backlight to the display panel; the backlight module is divided into a plurality of backlight subareas; a driving element connected to the display panel and configured to display each picture with two frame images sequentially; the two frame images include a first frame image and a second frame image; driving voltages for two adjacent sub-pixels in each of the frame images are different, and driving voltages for each sub-pixel in the first frame image and the second frame image are different; a backlight control element connected to the driving element, including one or more processors; and memory storing instructions, which, when executed by the one or more processors cause the one or more processors to perform operations including: determining backlight brightness regulation signals for each of the backlight subareas according to driving voltages of a first frame image area and a second frame image area, the first frame image area and the second frame image are corresponding to each of the backlight subareas; the backlight brightness regulation signals are grouped signals, and the number of the groups is identical to the number of types of the color sub-pixels; and calculating an average color chroma of a current picture region corresponding to each of the backlight subareas, and determining whether the average color chroma of each of the backlight subareas is within a preset range; and a backlight regulation element connected to the backlight control element and the backlight module respectively; the backlight regulation element is configured to perform a brightness regulation to a backlight source of the backlight subarea in each of the frame images of a next picture according to the backlight brightness regulation signal of the backlight subarea when the average color chroma of the backlight subarea is determined by the backlight control element to be in the preset range.

[0020] In an embodiment, further included is a storage element configured to store an LUT; the LUT is a correspondence table on input signals and the driving voltages for each sub-pixel in the first frame image and the second frame image, the first frame image area and the second frame image are corresponding to the input signals; the driving element acquires the driving voltages for each sub-pixel of the first frame image and the second frame image by looking up in the LUT.

[0021] In an embodiment, the one or more processors further execute the instructions to provide steps in following units: a statistic unit configured to calculate average driving voltages for various color sub-pixels in the first frame image area and the second frame image area, the first frame image area and the second frame image are corresponding to each of the backlight subareas; and a calculation unit configured to calculate a backlight brightness regulation signal according to the average driving voltage, a reference backlight brightness signal and a reference driving voltage of each of the backlight subareas.

[0022] In an embodiment, the formulas to calculate the backlight brightness regulation signal of each color sub-pixel in each of the backlight subareas are:

$$A_{M\_P1}*P_{M\_ave1}A_{M\_P2}*P_{M\_ave2};$$

$$2*A_{M\_P}*P_{M\_ave}=A_{M\_P1}*P_{M\_ave1}+A_{M\_P2}*P_{M\_ave2},$$

[0023] P is a target color sub-pixel; M is a serial number of the backlight area; A_{M_P1} is a backlight brightness regulation signal to perform a backlight brightness regulation to a backlight source of a P sub-pixel in a backlight area M corresponding to the first frame image of the next picture; A_{M_P2} is a backlight brightness regulation signal to perform a backlight brightness regulation to a backlight source of the P sub-pixel in the backlight area M corresponding to the second frame image of the next picture; P_{M_ave1} is an average value of a driving voltage of the P sub-pixel in the backlight area M corresponding to the first frame image of the current picture; P_{M_ave2} is an average value of the driving voltage of the P sub-pixel in the backlight area M corresponding to the second frame image of the current picture; A_{M_P} is a reference backlight brightness signal of the P sub-pixel in the backlight area M corresponding to the image of the current picture; P_{M_ave} is an average value of a reference driving voltage of the P sub-pixel in the frame image area corresponding to the backlight area M on the image of the current picture.

[0024] In an embodiment, the one or more processors further execute the instructions to provide a step of controlling the backlight regulation element not to perform a backlight regulation to the backlight source in the backlight subarea when the average color chroma of the backlight subarea is determined by the one or more processors to be out of the preset range.

[0025] In an embodiment, the one or more processors further execute the instructions to provide a step of calculating the average display hue of the current picture region corresponding to the backlight and determining the backlight regulation object according to the range where the average display hue belongs when the average color chroma is determined by the at least processor to be within the preset range; the backlight regulation object includes a backlight source of at least one of a red sub-pixel, a green sub-pixel and a blue sub-pixel; the backlight regulation element is further configured to perform an independent brightness regulation to the backlight regulation object according to the backlight regulation signal corresponding to the backlight regulation object.

[0026] In an embodiment, the one or more processors further execute the instructions to provide steps of: determining the object of the backlight regulation to be the backlight source corresponding to the red sub-pixel when the average display hue is $0° < H \leq 45°$ or $315° < H \leq 360'$; determining the object of the backlight regulation to be the backlight sources respectively corresponding to the red sub-pixel and the green sub-pixel when the average display hue is $45° < H \leq 135°$; determining the object of the backlight regulation to be the backlight source corresponding to the green sub-pixel when the average display hue is

135°<H≤205°; determining the object of the backlight regulation to be the backlight sources respectively corresponding to the green sub-pixel and the blue sub-pixel when the average display hue is 205°<H≤245°; determining the object of the backlight regulation to be the backlight source corresponding to the blue sub-pixel when the average display hue is 245°<H≤295°; and determining the object of the backlight regulation to be the backlight sources respectively corresponding to the blue sub-pixel and the red sub-pixel when the average display hue is 295°<H≤315°; and H is the average display hue.

[0027] In an embodiment, the backlight source is a white backlight source, an RGB backlight source, an RGBW backlight source or an RGBY backlight source.

[0028] An LCD device includes: a display panel; a backlight module configured to provide backlight to the display panel; the backlight module is divided into a plurality of backlight subareas; a driving element connected to the display panel and configured to display each picture with two frame images sequentially; the two frame images include a first frame image and a second frame image; driving voltages for two adjacent sub-pixels in each of the frame images are different, and driving voltages for each sub-pixel in the first frame image and the second frame image are different; a backlight control element connected to the driving element, including one or more processors; and memory storing instructions, which, when executed by the one or more processors cause the one or more processors to perform operations including: determining backlight brightness regulation signals for each of the backlight subareas according to driving voltages of a first frame image area and a second frame image area that are corresponding to each of the backlight subareas; the backlight brightness regulation signals are grouped signals, and the number of the groups is identical to the number of types of the color sub-pixels; and calculating an average color chroma of a current picture region corresponding to each of the backlight subareas, and determining whether the average color chroma of each of the backlight subareas is within a preset range; and a backlight regulation element connected to the backlight control element and the backlight module respectively; the backlight regulation element is configured to perform a brightness regulation to a backlight source of the backlight subarea in each of the frame images of a next picture according to the backlight brightness regulation signal of the backlight subarea when the average color chroma of the backlight subarea is determined by the backlight control element to be in the preset range; the one or more processors further execute the instructions to perform operations in following units: a statistic unit configured to calculate average driving voltages for various color sub-pixels in the first frame image area and the second frame image area that are corresponding to each of the backlight subareas; and a calculation unit configured to calculate a backlight brightness regulation signal according to the average driving voltage, a reference backlight brightness signal and a reference driving voltage of each of the backlight subareas, the calculation formulas are as follows:

$$A_{M\_P1}*P_{M\_ave1}A_{M\_P2}*P_{M\_ave2};$$

$$2*A_{M\_P}*P_{M\_ave}=A_{M\_P1}*P_{M\_ave1}+A_{M\_P2}*P_{M\_ave2},$$

[0029] P is a target color sub-pixel; M is a serial number of the backlight subarea, A_{M_P1} is a backlight brightness regulation signal to perform a backlight brightness regulation to a backlight source of a P sub-pixel in a backlight subarea M corresponding to the first frame image of the next picture; A_{M_P2} is a backlight brightness regulation signal to perform a backlight brightness regulation to a backlight source of the P sub-pixel in the backlight subarea M corresponding to the second frame image of the next picture; P_{M_ave1} is an average value of a driving voltage of the P sub-pixel in the backlight subarea M corresponding to the first frame image of the current picture; P_{M_ave2} is an average value of the driving voltage of the P sub-pixel in the backlight subarea M corresponding to the second frame image of the current picture; A_{M_P} is a reference backlight brightness signal of the P sub-pixel in the backlight subarea M corresponding to the image of the current picture; P_{M_ave} is an average value of a reference driving voltage of the P sub-pixel in the frame image area corresponding to the backlight subarea M on the image of the current picture.

[0030] In an embodiment, the one or more processors further execute the instructions to provide a step of calculating the average display hue of the current picture region corresponding to the backlight and determining the backlight regulation object according to the range where the average display hue belongs when the average color chroma is determined by the at least processor to be within the preset range; the backlight regulation object includes a backlight source of at least one of a red sub-pixel, a green sub-pixel and a blue sub-pixel; the backlight regulation element is further configured to perform an independent brightness regulation to the backlight regulation object according to the backlight regulation signal corresponding to the backlight regulation object.

[0031] The above LCD driving method, by displaying each picture with two frame images sequentially, each of the frame images is driven by alternate high and low voltage signals, and the high and low driving voltages of the first frame image and second frame image are reverted, and the backlight brightness regulation signals of the next picture are generated in accordance to each driving voltage. Meanwhile, average color chroma of the present picture region corresponding to each of the backlight subareas is calculated and a backlight regulation is merely performed to the backlight source in the backlight subarea corresponding to each of the frame images of the next picture when the average color chroma is determined to be within the preset range, such that the uncomfortable blink notable to the eyes and due to high and low driving voltage switch difference can be reduced, and the blink visible to the eyes and possibly caused by the frequent enabling of backlight source regulation can be avoided, thereby effectively ameliorating the color shift defect of the LCD in large view refraction mismatch.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] The above objects, features and advantages of the present disclosure will become more apparent by describing in detail embodiments thereof with reference to the accompanying drawings. The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the present disclosure. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the views.

[0033] FIG. **1** is a flowchart of a method for driving an LCD device according to an embodiment;

[0034] FIG. **2** is a schematic view of partitioning a backlight area of the LCD device in FIG. **1**;

[0035] FIG. **3** is a schematic view of driving a display area of the LCD device in FIG. **1**;

[0036] FIGS. **4** and **5** are enlarged views of FIG. **3**;

[0037] FIG. **6** is a specific flowchart of the step S**120** in FIG. **1**;

[0038] FIG. **7** is a schematic view of a CIE LCH color space system employed in Step **S150**;

[0039] FIG. **8** is a specific flowchart of the step S**120** in FIG. **1**;

[0040] FIG. **9** is a block diagram of a structure of an LCD device according to an embodiment; and

[0041] FIG. **10** is a block diagram of a structure of a backlight control element according to an embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0042] The present disclosure will be described in the following with reference to the accompanying drawings and the embodiments in order to make the above objects, features and advantages of the present disclosure become more apparent, the specific embodiments will be described in detail in combination with the accompanying drawings. Numerous specific details are described hereinafter in order to facilitate a thorough understanding of the present disclosure. The various embodiments of the disclosure may, however, be embodied in many different forms and should not be construed as limited to the specific embodiments set forth hereinafter, and people skilled in the art can make similar modifications without departing from the spirit of the present disclosure.

[0043] FIG. **1** is a flowchart of a method for driving an LCD device according to an embodiment. The LCD device can be a Twisted Nematic (TN), an Optically Compensated Bend (OCB), a Vertical Alignment (VA) or a curved surface device but not limited thereto. The backlight of the CLD may apply direct-lit backlight, the backlight source can be a white light source, an RGB three color light source, an RGBW four color light source or an RGBY four color light source, but not limited thereto. In the present embodiment, the backlight area of the LCD is divided into a plurality of backlight subareas as illustrated in FIG. **2**. In FIG. **2**, **90** represents the backlight module (or backlight module).

[0044] Referring to FIG. **1**, the method includes the following steps:

[0045] Step **S110**, each picture is displayed with two frame images sequentially.

[0046] Each picture (i.e., the conventional one frame picture) is displayed with two frame images sequentially, i.e., a picture is divided into two frame images in timing sequence. Through a division to the picture in timing sequence, a frequency doubling can be effected to the frame frequency, i.e., doubling the original 60 Hz to 120 Hz. The two frame images are respectively a first frame image (frame_N−1) and a second frame image (frame_N−2). Through a mutual compensation between the first frame image and the second frame image, an picture corresponding to the input signal is displayed for a user. In the present embodiment, driving voltages for two adjacent sub-pixels in each of the frame images are different, and driving voltages for each of the sub-pixels in the first frame image and the second frame image are different; i.e., the driving voltage for each sub-pixel of the first frame image is reverted to be the driving voltage for each sub-pixel in the second fame image. The driving voltages for each of the sub-pixels in the first frame image and the second frame image can be found and acquired utilizing a Look-up table (LUT). In particular, in the LCD device, the LUT will be pre-stored in the hardware frame buffer. The LUT is a correspondence table on the picture input signals and the driving voltages for each of the sub-pixels in the first frame image and the second frame image that are corresponding to the input signals. In the case of a driving signal of 8 bit, corresponding to each R/G/B input signal input color gray scale value 0~255, there are 256 pairs of high and low voltage signals $R_{TH}/G_{TH}/B_{TH}$ and 3*256 pairs of high and low voltage signals $R_{TL}/G_{TL}/B_{TL}$ in total. Therefore, according to the gray scale value of each sub-pixel in the input signal, corresponding high driving voltage and corresponding low driving voltage can be found, thereby providing the high driving voltage as the driving voltage for the corresponding sub-pixel in the first frame image and the low driving voltage as the driving voltage for the corresponding sub-pixel in the second frame image, or providing the low driving voltage as the driving voltage for the corresponding sub-pixel in the first frame image and the high driving voltage as the driving voltage for the corresponding sub-pixel in the second frame image, while the two adjacent sub-pixels employ a driving method for being alternately driven by a high and a low driving voltage as shown in FIG. **3**. FIG. **4** is an enlarged view of a part of the first frame in FIG. **3**, and FIG. **5** is an enlarged view of a part of the second frame in FIG. **3**.

[0047] Step **S120**, backlight brightness regulation signals for each backlight subarea are determined according to driving voltages of a first frame image area and a second frame image area that are corresponding to each of the backlight subareas.

[0048] The backlight brightness regulation signal is used for backlight brightness regulation to the backlight brightness of the two frame images of the next picture to reduce the viewing angle color cast. The backlight brightness regulation signals are grouped signals (A_{M_P1} and A_{M_P2}, P is the target color sub-pixel) to respectively regulate the backlight brightness of the backlight subareas corresponding to the first frame image and the second frame image. And the groups of backlight brightness regulation signals and the types of color sub-pixels are identical in number, so as to perform an independent backlight brightness control to various color sub-pixels. For instance, in the present embodiment, color sub-pixels include red sub-pixels (R sub-pixels), green sub-pixels (G sub-pixels) and blue sub-pixels (B sub-pixels), therefore each group of backlight brightness regulation signals includes an R sub-pixel backlight brightness regulation signal group, a G sub-pixel backlight brightness regulation signal group, and a B sub-pixel backlight brightness regulation signal group to perform independent backlight brightness regulation control to various color sub-pixels in each of the backlight subareas.

[0049] In the present embodiment, the process to determine the backlight brightness regulation signal is illustrated in FIG. **6**, which includes step S**210** and step S**220**.

[0050] Step S**210**, average driving voltages for various color sub-pixels in the first frame image area and the second frame image area that are corresponding to each of the backlight subareas are calculated.

[0051] The formula for calculating average driving voltages for various color sub-pixels in the first frame image area corresponding to each of the backlight subareas is as follows:

$$P_{M\_ave1}=(P_{M\_n\_TL},P_{M\_n+1\_TH},P_{M\_n+2\_TL}, \ldots),n=1,2,3 \ldots$$

[0052] Therein, P is the target color subpixel, M is the serial number for the backlight subarea, ave1 is the average driving voltage value of the first frame image, and n is the serial number of P sub-pixel in backlight subarea M.

[0053] In particular, the average driving voltage for various color sub-pixels is calculated as:

$$R_{M\_ave1}=(R_{M\_n\_TL},R_{M\_n+1\_TH},R_{M\_n+2\_TL}, \ldots),n=1,2,3 \ldots$$

$$G_{M\_ave1}=(G_{M\_n\_TH},G_{M\_n+1\_TL},G_{M\_n+2\_TH}, \ldots),n=1,2,3 \ldots$$

$$B_{M\_ave1}=(B_{M\_n\_TL},B_{M\_n+1\_TH},B_{M\_n+2\_TL}, \ldots), n=1,2,3 \ldots$$

[0054] In Step S**220**, a backlight brightness regulation signal is calculated according to the average driving voltage, a reference backlight brightness signal and a reference driving voltage of each of the backlight subareas.

[0055] The reference backlight brightness signal refers to a backlight brightness signal that is required when a high low voltage compensation is not performed (i.e., in conventional driving method). The reference driving voltage refers to the driving voltage for various sub-pixels when the high low voltage compensation is not performed. As backlight sources corresponding to various color sub-pixels in each subarea are controlled independently, the backlight brightness regulation signals of the backlight sources corresponding to various color sub-pixels in each subarea needs to be calculated. The formulas to calculate the backlight brightness regulation signal of each color sub-pixel in each of the backlight subareas M are:

$$A_{M\_P1}*P_{M\_ave1}A_{M\_P2}*P_{M\_ave2};$$

$$2*A_{M\_P}*P_{M\_ave}=A_{M\_P1}*P_{M\_ave1}+A_{M\_P2}*P_{M\_ave2},$$

[0056] Therein, P is the target color sub-pixel; M is the serial number of the backlight subarea. A_{M_P1} is the backlight brightness regulation signal to perform the backlight brightness regulation to the backlight source of the P sub-pixel in the backlight subarea M corresponding to the first frame image of the next picture. A_{M_P2} is the backlight brightness regulation signal to perform the backlight brightness regulation to the backlight source of the P sub-pixel in the backlight subarea M corresponding to the second frame image of the next picture. P_{M_ave1} is the average value of the driving voltage of the P sub-pixel in the backlight subarea M corresponding to the first frame image of the next picture. In the present embodiment, as the driving voltage of sub-pixel is matched with the input signal (i.e., the gray scale of the corresponding color), thereby allowing the average value of the driving voltage to be an evaluating index of the viewing angle brightness of the color sub-pixel. PM_{ave2} is the average value of the driving voltage of the P sub-pixel in the backlight subarea M corresponding to the second frame image of the next picture. A_{M_P} is the reference backlight brightness signal of the P sub-pixel in the backlight subarea M corresponding to the image of the current picture. P_{M_ave} is the average value of the reference driving voltage of the P sub-pixel in the frame image region corresponding to the backlight subarea M on the image of the current picture. In particular, P_{M_ave1}=Ave($P_n+P_{n+1}+P_{n+2}+\ldots$), n=1, 2, 3 . . . .

[0057] In the present embodiment, each pixel in each of the frame images includes an R sub-pixel, a G sub-pixel and a B sub-pixel. Therefore, the backlight brightness regulation signals of backlight source for various color sub-pixel in each of the backlight subareas need to be calculated correspondingly, in particular:

[0058] The formulas to calculate the backlight brightness regulation signals A_{M_R1} and A_{M_R2} of R sub-pixels in the backlight subarea M are:

$$A_{M\_R1}*R_{M\_ave1}A_{M\_R2}*R_{M\_ave2};$$

$$2*A_{M\_R}*R_{M\_ave}=A_{M\_R1}*R_{M\_ave1}+A_{M\_R2}*R_{M\_ave2},$$

[0059] The formulas to calculate the backlight brightness regulation signals A_{M_G1} and A_{M_G2} of R sub-pixels in the backlight subarea M are:

$$A_{M\_G1}*G_{M\_ave1}A_{M\_G2}*G_{M\_ave2};$$

$$2*A_{M\_G}*G_{M\_ave}=A_{M\_G1}*G_{M\_ave1}+A_{M\_G2}*G_{M\_ave2},$$

[0060] The formulas to calculate the backlight brightness regulation signals A_{M_B1} and A_{M_B2} of R sub-pixels in the backlight subarea M are:

$$A_{M\_B1}*B_{M\_ave1}A_{M\_B2}*B_{M\_ave2};$$

$$2*A_{M\_B}*B_{M\_ave}=A_{M\_B1}*B_{M\_ave1}+A_{M\_B2}*B_{M\_ave2},$$

[0061] In Step S**130**, an average color chroma of a current picture region corresponding to each of the backlight subareas is calculated;

[0062] The color chroma is calculated based on CIE LCH color space system and referring to each function of the color space coordinates of the CIE specification. In particular, L=f1(R, G, B), C=f2(R, G, B), H=f3(R, G, B), the above function relationship can be learned from CIE specification. CIE LCH color space system is shown in FIG. **7**. FIG. **7** only shows the locations of the major and representative colors such as red, yellow, green and blue, without indications on the locations of other colors. As the CIE LCH color space system is a color space system known to a person of ordinary skill in the art, merely providing FIG. **7** should be sufficient for a person of ordinary skill in the art to understand the full situation of the CIE LCH color space system. In FIG. **7**, L is the brightness, C is the color chroma, representing the bright degree of the color. C is ranged from 0 to 100, whereby at 100 is the brightest. The value of C is, to certain extent, representing the voltage signal when the LCD is being driven, therefore, the average color chroma of each picture can be obtained by calculating the average driving voltage.

[0063] In particular, as to the calculation of the average color chroma, the average driving voltage for each color sub-pixel in the current picture region corresponding to each of the backlight subareas should be calculated first. That is, performing a summation of the average driving voltages for various color sub-pixels in the first frame image area and the second frame image area that are corresponding to each of the backlight subareas and averaging the same. In the present embodiment, as the driving voltage for the second frame image is a reverse of the driving voltage of the first frame image, i.e., the average driving voltages of the two frame images are the same. As such, it is only needed to calculate the average driving voltage of one frame image to obtain the average driving voltage for such type of color sub-pixels of the current picture region corresponding to the backlight subarea, the calculation formula are as follows:

$$R\_ave=Ave(R_{M\_1}+R_{M\_2}+ \ldots +R_{M\_n});$$

$$G\_ave=Ave(G_{M\_1}+G_{M\_2}+ \ldots +G_{M\_n});$$

$$B\_ave=Ave(B_{M\_1}+B_{M\_2}+ \ldots +B_{M\_n}).$$

[0064] M is the serial number of the backlight subarea, n is the serial number of the sub-pixel among all such type of color sub-pixels in the backlight subarea M. As such, according to the function relation C=f2(R, G, B), the average color chroma C can be obtained by substituting the above result:

$$C=f2(R\_ave,G\_ave,B\_ave).$$

[0065] In Step S**140**, it is determined whether the average color chroma of each of the backlight subareas is within a preset range.

[0066] The preset range, i.e., CTL and CTH can be set as required. To determine whether the average color chroma satisfy:

$$C_{TL} \leq C \leq C_{TH}.$$

[0067] If the average color chroma C of the current backlight subarea satisfies the above conditions, a step S**150** is executed to the backlight subarea, and a step S**160** is otherwise executed if not. By a determination of the average color chroma, the blink notable to the eyes and caused by the frequent starting of backlight source regulation can be avoided.

[0068] In Step S**150**, a brightness regulation to a backlight source of the backlight subarea in each of the frame images of a next picture is performed according to the backlight brightness regulation signal of the backlight subarea.

[0069] In the present embodiment, independent backlight regulations can be performed to backlight sources of various color sub-pixels according to the generated plurality of groups of backlight brightness regulation signals. In the regulation, independent regulations are performed to the backlight sources of R sub-pixel, G sub-pixel and B sub-pixel in the backlight subarea M corresponding to the first frame image of the next picture according to A_{M_R2}, A_{M_G2} and A_{M_B2}, and independent regulations are performed to the backlight sources of R sub-pixel, G sub-pixel and B sub-pixel in the backlight subarea M corresponding to the second frame image of the next picture according to A_{M_R2}, A_{M_G2} and A_{M_B2}, such that the compensated image brightness is the same as that when no high low voltage compensation is performed (i.e., the traditional driving). Through an independent backlight source control, the uncomfortable blink notable to the eyes and caused by high and low voltage switching difference in the driving can be reduced, thereby effectively ameliorating the color shift deficiency of LCD in large viewing angle refractive rate mismatching.

[0070] In the present embodiment, Step S**150** includes the following sub-steps, as shown in FIG. **8**.

[0071] Step S**310**, an average display hue of a current picture region corresponding to the backlight subarea is calculated.

[0072] Referring to FIG. **7**, in the CIE LCH color space system, H is the display hue, that is the color representation. 0 to 360° is the color presentation of different hue, of which, it is defined that 0° is red, 90° is yellow, 180° is green and 270° is blue. The calculation of average display hue H is identical to the calculation of the average color chroma, both of which are to calculate the average driving voltages R_ave, G_ave and B_ave of such type of color sub-pixels in the current picture region corresponding to the backlight subarea and then obtained according to the function relation H=f3(R, G, B). In particular:

$$H=f3(R\_ave,G\_ave,B\_ave).$$

[0073] In Step S**320**, a backlight regulation object is determined according to the hue range where the average display hue belongs.

[0074] The hue value is pre-divided into a plurality of spectrum. The dividing method can be set as required. In the present embodiment, the hue value is divided into 6 spectrums, each of which is corresponding to a respective backlight regulation object. In particular, when $0° < H \leq 45°$ or $315° < H \leq 360°$, the object of the backlight regulation is the backlight source corresponding to the red sub-pixel; when $45° < H \leq 135°$, the backlight regulation objects are the backlight sources respectively corresponding to the red sub-pixel and the green sub-pixel; when $135° < H \leq 205°$, the backlight regulation object is the backlight source corresponding to the green sub-pixel; when $205° < H \leq 245°$, the backlight regulation objects are the backlight sources respectively corresponding to the green sub-pixel and the blue sub-pixel; when $245° < H \leq 295°$, the backlight regulation object is the backlight source corresponding to the blue sub-pixel; when $295° < H \leq 315°$, the backlight regulation objects are the backlight sources respectively corresponding to the blue sub-pixel and the red sub-pixel.

[0075] In Step S**330**, an independent brightness regulation to the backlight regulation object is performed according to the backlight brightness regulation signal corresponding to the backlight regulation object.

[0076] In particular, when $0° < H \leq 45°$ or $315° < H \leq 360°$, the backlight regulation object is the backlight source corresponding to the red sub-pixel, that is performing a backlight regulation to the red sub-pixel in the backlight subarea according to A_{M-R1} and A_{M_R2}, and do not perform a regulation to the backlight brightness of other color sub-pixels. When $45° < H \leq 135°$, the objects of the backlight regulation are the backlight sources respectively corresponding to the red sub-pixel and the green sub-pixel, that is performing independent backlight regulations to the red sub-pixel and blue sub-pixel according to A_{M_R1} and A_{M_R2}, A_{M_G1} and A_{M_G2}. The processes of other situations are omitted in brevity as they are similar to the above situations.

[0077] In Step S**160**, a backlight brightness regulation is not performed to the backlight subarea.

[0078] The above LCD driving method, by displaying each picture with two frame images sequentially, each of the frame images is driven by alternate high and low voltage signals, and the high and low driving voltages of the first frame image and second frame image are reverted, and the backlight brightness regulation signals of the next picture are generated in accordance to each driving voltage. In the meanwhile, average color chroma of the current picture region corresponding to each of the backlight subareas is calculated and a backlight regulation is merely performed to the backlight source in the backlight subarea corresponding to each of the frame images of the next picture when the average color chroma is determined to be within the preset range, such that the uncomfortable blink notable to the eyes and due to high and low driving voltage switch difference can be reduced, and the blink visible to the eyes and possibly caused by the frequent enabling of backlight source regulation can be avoided, thereby effectively ameliorating the color shift deficiency of the LCD in large view refractive rate mismatching.

[0079] The above driving method, aided with a compensation to the brightness of the backlight subarea M, not only can maintain the overall panel brightness to be the same with the brightness of the uncompensated conventional driving, but also can effect a low color shift viewing angle compensation and avoid the original uncomfortable blink notable to the eyes and caused by high and low voltage switching difference in the driving, thereby effectively ameliorating the color shift deficiency of LCD in large viewing angle refractive rate mismatching. The above driving method can effect a coordinated driving in timing and space. Also, by employing the method for driving above, the pixels of the LCD device are no longer needed to be divided into primary and secondary sub-pixels, thereby greatly reducing the process complexity and remarkably increasing the penetration rate and resolution of the LCD panel and reducing the cost of backlight design.

[0080] The present application also provides an LCD as illustrated in FIG. **9**. The LCD can execute the above driving method. The LCD includes a display panel **810**, a backlight module **820**, a driving element **830**, a backlight control element **840**, and a backlight regulation element **850**. The display panel **810** and the driving element **830** can be integrated on the display panel, while the backlight module **820**, the backlight control element **840** and the backlight regulation element **850** can be integrated on the backlight module. It should be understood that the integrating of each elements is not limited thereto.

[0081] The display panel **810** can adopt TN, OCB, VA, thin film transistor (TFT) and color filter on array (COA) display panel, but not limited thereto. The display panel **810** can be a display panel with a curved panel.

[0082] The backlight module **820** is configured to provide backlight. The backlight module **820** may apply straight down backlight, the backlight source can be white, RGB three color light source, RGBW four color light source or RGBY four color light source, but not limited thereto. The backlight area of the backlight module is divided into a plurality of backlight subareas as illustrated in FIG. **2**.

[0083] The driving element **830** is connected to the display panel **810**. The driving element **830** is configured to display each picture with two frame images. The two frame images are respectively a first frame image and a second frame image. Through a mutual compensation between the first frame image and the second frame image, a picture corresponding to the input signal is displayed for a user. In the present embodiment, driving voltages for two adjacent sub-pixels in each of the frame images are different, and driving voltages for each of the sub-pixels in the first frame image and the second frame image are different; i.e., the driving voltage for each sub-pixel of the first frame image is reverted to be the driving voltage for each sub-pixel in the second fame image. The driving voltage of the driving part **730** driving each sub-pixel can be found and acquired utilizing the LUT. In particular, in the LCD device, the LUT will be pre-stored in the hardware frame buffer. The LUT is a correspondence table on the picture input signals and the driving voltages for each of the sub-pixels in the first frame image and the second frame image that are corresponding to the input signals. The driving element **730** includes a timing controller (TCON) circuit. In an embodiment, the LCD further includes a memory device **860** configured to store the LUT.

[0084] The backlight control part **840** is connected to the driving element **830**. The backlight control element **840** is configured to determine the backlight brightness regulation signals for each of the backlight subareas according to driving voltages of a first frame image area and a second frame image area that are corresponding to each of the backlight subareas. In one embodiment, the backlight compensation control part **840** includes a memory and one or more processors. The memory has stored computer-readable instructions that can be executed by the one or more processors. The computer-readable instructions are executed by one or more processors to perform operations of determining the backlight brightness regulation signals for each of the backlight subareas according to the driving voltages of a first frame image area and a second frame image area that are corresponding to each of the backlight subareas. The backlight brightness regulation signals are grouped signals (A_{M_P1} and A_{M_P2}, P is the target color sub-pixel) to respectively regulate the backlight brightness of the backlight subareas corresponding to the first frame image and the second frame image, and the groups of backlight brightness regulation signals and the types of color sub-pixels are identical in number, so as to perform an independent backlight brightness control to various color sub-pixels. For instance, in the present embodiment, color sub-pixels include red sub-pixels (R sub-pixels), green sub-pixels (G sub-pixels) and blue sub-pixels (B sub-pixels), therefore each group of backlight brightness regulation signals includes an R sub-pixel backlight brightness regulation signal group, a G sub-pixel backlight brightness regulation signal group, and a B sub-pixel backlight brightness regulation signal group to perform independent backlight brightness regulation control to various color sub-pixels in each of the backlight subareas.

[0085] Furthermore, when the computer executable instructions stored in the memory device of the backlight control element **840** are to be executed by the one or more processors, the one or more processors will be caused to perform operations in the following units, as illustrated in FIG. **10**. The formula the statistic unit **842** is configured with to calculate the average driving voltages for various color sub-pixels in the first frame image area corresponding to each of the backlight subareas is as follows:

$$PM\_{ave1}=(P_{M\_n\_TL},P_{M\_n+1\_TH},P_{M\_n+2\_TL},\ldots),n=1,2,3\ldots$$

[0086] Therein, P is the target color subpixel, M is the serial number for the backlight subarea, ave1 is the average driving voltage value of the first frame image, and n is the serial number of P sub-pixel in backlight subarea M.

[0087] In particular, the average driving voltage for various color sub-pixels is calculated as:

$$R_{M\_ave1}=(R_{M\_n\_TL},R_{M\_n+1\_TH},R_{M\_n+2\_TL},\ldots),n=1,2,3\ldots$$

$$G_{M\_ave1}=(G_{M\_n\_TH},G_{M\_n+1\_TL},G_{M\_n+2\_TH},\ldots),n=1,2,3\ldots$$

$$B_{M\_ave1}=(B_{M\_n\_TL},B_{M\_n+1\_TH},B_{M\_n+2\_TL},\ldots),n=1,2,3\ldots$$

[0088] The calculation unit **844** is configured to calculate a backlight brightness regulation signal according to the average driving voltage, a reference backlight brightness signal and a reference driving voltage of each of the backlight subareas. The reference backlight brightness signal refers to a backlight brightness signal that is required when a high low voltage compensation is not performed (i.e., in conventional driving method). The reference driving voltage refers to the driving voltage for various sub-pixels when the high low voltage compensation is not performed. As backlight sources corresponding to various color sub-pixels in each subarea are controlled independently, the backlight brightness regulation signals of the backlight sources corresponding to various color sub-pixels in each subarea need to be calculated. The formulas to calculate the backlight brightness regulation signal of each color sub-pixel in each of the backlight subareas M are:

$$A_{M\_P1}*P_{M\_ave1}A_{M\_P2}*P_{M\_ave2};$$

$$2*A_{M\_P}*P_{M\_ave}=A_{M\_P1}*P_{M\_ave1}+A_{M\_P2}*P_{M\_ave2},$$

[0089] Therein, P is the target color sub-pixel; M is the serial number of the backlight subarea. A_{M_P1} is the backlight brightness regulation signal to perform the backlight brightness regulation to the backlight source of the P sub-pixel in the backlight subarea M corresponding to the first frame image of the next picture. A_{M_P2} is the backlight brightness regulation signal to perform the backlight brightness regulation to the backlight source of the P sub-pixel in the backlight subarea M corresponding to the second frame image of the next picture. P_{M_ave1} is the average value of the driving voltage of the P sub-pixel in the backlight subarea M corresponding to the first frame image of the next picture. In the present embodiment, as the driving voltage of sub-pixel is matched with the input signal (i.e., the gray scale of the corresponding color), thereby allowing the average value of the driving voltage to be an evaluating index of the viewing angle brightness of the color sub-pixel. P_{M_ave2} is the average value of the driving voltage of the P sub-pixel in the backlight subarea M corresponding to the second frame image of the next picture. A_{M_P} is the reference backlight brightness signal of the P sub-pixel in the backlight subarea M corresponding to the image of the current picture. P_{M_ave} is the average value of the reference driving voltage of the P sub-pixel in the frame image region corresponding to the backlight subarea M on the image of the current picture. In particular, $P_{M\_ave1}=\text{Ave}(P_n+P_{n+1}\pm P_{n+2}+\ldots)$, n=1, 2, 3 . . . .

[0090] Furthermore, when the computer-executable instructions stored in the memory device are to be executed by the one or more processors, the one or more processors execute the instructions to perform the steps in the determination unit **846**. In the present embodiment, the calculation unit **844** is configured to calculate the average color chroma of a current picture region corresponding to each of the backlight subareas. The determination unit **846** is configured to determine whether the average color chroma of each of the backlight subareas is within the preset range, and merely control the backlight regulation element **850** to perform a brightness regulation to the backlight source of the backlight subarea in each of the frame images of the next picture according to the backlight brightness regulation signal of the backlight subarea when it is determined that the average color chroma of each of the backlight subareas is within the preset range and otherwise do not control the backlight regulation element **850** to perform a backlight brightness regulation to the backlight subarea. In an embodiment, the backlight regulation element **850** performs independent brightness regulations to the backlight sources of various color sub-pixels in the backlight subarea corresponding to each of the frame images of the next picture according to the backlight brightness regulation signal of each of the backlight subareas, such that the compensated image brightness is the same with the image brightness that is not being high and low voltage compensated.

[0091] In the present embodiment, the backlight control element **840** is also configured, when it is determined that the backlight subarea needs a backlight brightness compensation, to first calculate the average display hue of the current picture region corresponding to the backlight subarea through the calculation unit **844** and then determine the object of the backlight regulation according to such average display hue. The backlight regulation object includes a backlight source including at least one of a red sub-pixel, a green sub-pixel and a blue sub-pixel. The backlight regulation element **850** performs an independent brightness regulation to the backlight regulation object according to the backlight regulation signal corresponding to the backlight regulation object, such that the uncomfortable blink notable to the eyes and due to high and low driving voltage switch difference can be reduced, and the blink visible to the eyes and possibly caused by the frequent enabling of backlight source regulation can be avoided, thereby effectively ameliorating the color shift deficiency of the LCD in large view refractive rate mismatching.

[0092] The above LCD, by displaying each picture with two frame images sequentially, each of the frame images is driven by alternate high and low voltage signals, and the high and low driving voltages of the first frame image and second frame image are reverted, and the backlight brightness regulation signals of the next picture are generated in accordance to each driving voltage. In the meanwhile, average color chroma of the current picture region corresponding to each of the backlight subareas is calculated and an independent backlight regulation is merely performed to the backlight source of various color sub-pixels in the backlight subarea corresponding to each of the frame images of the next picture when the average color chroma is determined to be within the preset range, such that the uncomfortable blink notable to the eyes and due to high and low driving voltage switch difference can be reduced, and the blink visible to the eyes and possibly caused by the frequent enabling of backlight source regulation can be avoided, thereby effectively ameliorating the color shift deficiency of the LCD in large view refractive rate mismatching.

[0093] The above LCD, aided with a compensation to the brightness of each of the backlight subareas M, not only can maintain the overall panel brightness to be the same with the brightness of the uncompensated conventional driving, but also can effect a low color shift viewing angle compensation and avoid the original uncomfortable blink notable to the eyes and caused by high and low voltage switching difference in the driving, thereby effectively ameliorating the color shift deficiency of LCD in large viewing angle refractive rate mismatching. The above LCD can effect a coordinated driving in timing and space. Also, by employing the LCD above, the pixels of the LCD device are no longer needed to be divided into primary and secondary sub-pixels, thereby greatly reducing the process complexity and remarkably increasing the penetration rate and resolution of the LCD panel and reducing the cost of backlight design.

[0094] A person skilled in the art should understand the processes of the methods in the above embodiments can be, in full or in part, implemented by computer programs instructing underlying hardware, the programs can be stored in a computer-readable storage medium, the program can include the processes in the embodiments of the various methods when it is being executed. The storage medium can be a disk, a CD, a Read-Only Memory (ROM) and other non-volatile storage mediums or Random Access Memory (RAM) and so on.

[0095] The different technical features of the above embodiments can have various combinations which are not described for the purpose of brevity. Nevertheless, to the extent the combining of the different technical features does not conflict with each other, all such combinations must be regarded as within the scope of the disclosure.

[0096] The foregoing implementations are merely specific embodiments of the present disclosure, and are not intended to limit the protection scope of the present disclosure. It should be noted that any variation or replacement readily figured out by persons skilled in the art within the technical scope disclosed in the present disclosure shall all fall within the protection scope of the present disclosure. Therefore, the protection scope of the present disclosure shall be subject to the protection scope of the claims.

What is claimed is:

1. A method for driving a liquid crystal display (LCD) device comprising:

displaying each picture with two frame images sequentially; wherein the two frame images comprise a first frame image and a second frame image; driving voltages for two adjacent sub-pixels in each of the frame images are different, and the driving voltages for each of the sub-pixels in the first frame image and the second frame image are different;

determining backlight brightness regulation signals for each of backlight subareas according to the driving voltages of a first frame image area and a second frame image area, wherein the first frame image area and the second frame image are corresponding to each of the backlight subareas; the backlight brightness regulation signals are grouped signals, the number of the groups is identical to the number of types of color sub-pixels;

calculating an average color chroma of a current picture region corresponding to each of the backlight subareas;

determining whether the average color chroma of each of the backlight subareas is within a preset range; and

if the average color chroma of each of the backlight subareas is within a preset range, performing a brightness regulation to a backlight source of the backlight subarea in each of the frame images of a next picture according to the backlight brightness regulation signal of the backlight subarea.

2. The method according to claim **1**, wherein the driving voltages for each of the sub-pixels in the first frame image and the second frame image are found and acquired utilizing a Look-up table (LUT) according to an input signal of the picture.

3. The method according to claim **2**, further comprising a step of pre-storing the LUT.

4. The method according to claim **1**, wherein the step of determining backlight brightness regulation signals for each of the backlight subareas according to the driving voltages of the first frame image area and the second frame image area comprises:

calculating average driving voltages for various color sub-pixels in the first frame image area and the second frame image area, wherein the first frame image area and the second frame image are corresponding to each of the backlight subareas; and

calculating the backlight brightness regulation signal according to the average driving voltage, a reference backlight brightness signal and a reference driving voltage.

5. The method according to claim **4**, wherein in the step of calculating the backlight brightness regulation signal according to the average driving voltage, the reference backlight brightness signal and the reference driving voltage, the formulas to calculate the backlight brightness regulation signal of each color sub-pixel in each of the backlight subareas are:

$$A_{M\_P1}*P_{M\_ave1}A_{M\_P2}*P_{M\_ave2};$$

$$2*A_{M\_P}*P_{M\_ave}=A_{M\_P1}*P_{M\_ave1}+A_{M\_P2}*P_{M\_ave2},$$

wherein P is a target color sub-pixel; M is a serial number of the backlight subarea, A_{M_P1} is the backlight brightness regulation signal to perform the backlight brightness regulation to the backlight source of a P sub-pixel in a backlight subarea M corresponding to the first frame image of the next picture; A_{M_P2} is the backlight brightness regulation signal to perform a backlight brightness regulation to the backlight source of the P sub-pixel in the backlight subarea M corresponding to the second frame image of the next picture; P_{M_ave1} is an average value of the driving voltage of the P sub-pixel in the backlight subarea M corresponding to the first frame image of the current picture; P_{M_ave2} is an average value of the driving voltage of the P sub-pixel in the backlight subarea M corresponding to the second frame image of the current picture; A_{M_P} is the reference backlight brightness signal of the P sub-pixel in the backlight subarea M corresponding to the image of the current picture; P_{M_ave} is the average value of the reference driving voltage of the P sub-pixel in the frame image area corresponding to the backlight subarea M on the image of the current picture.

6. The method according to claim **1**, wherein in the step of determining whether the average color chroma of each of the backlight subareas is within the preset range, if the average color chroma is not within the preset range, a brightness regulation will not be performed to the backlight source of the backlight subarea.

7. The method according to claim **1**, wherein the step of performing the brightness regulation to the backlight source of the backlight subarea in each of the frame images of the next picture according to the backlight brightness regulation signal of the backlight subarea comprises:

calculating an average display hue of a current picture region corresponding to the backlight subarea;

determining a backlight regulation object according to the hue range where the average display hue belongs; wherein the backlight regulation object comprises a backlight source of at least one of a red sub-pixel, a green sub-pixel and a blue sub-pixel; and

performing an independent brightness regulation to the backlight regulation object according to the backlight brightness regulation signal corresponding to the backlight regulation object.

8. The method according to claim **7**, wherein in the step of determining a backlight regulation object according to the hue range where the average display hue belongs, when the average display hue is 0°<H≤45° or 315°<H≤360°, the object of the backlight regulation is the backlight source corresponding to the red sub-pixel;

when the average display hue is 45°<H≤135°, the object of the backlight regulation are the backlight sources respectively corresponding to the red sub-pixel and the green sub-pixel;

when the average display hue is 135°<H≤205°, the object of the backlight regulation is the backlight source corresponding to the green sub-pixel;

when the average display hue is 205°<H≤245°, the object of the backlight regulation are the backlight sources respectively corresponding to the green sub-pixel and the blue sub-pixel;

when the average display hue is 245°<H≤295°, the object of the backlight regulation is the backlight source corresponding to the blue sub-pixel; and

when the average display hue is 295°<H≤315°, the object of the backlight regulation are the backlight sources respectively corresponding to the blue sub-pixel and the red sub-pixel; wherein H is the average display hue.

9. An LCD device, comprising:

a display panel;

a backlight module configured to provide backlight to the display panel; wherein the backlight module is divided into a plurality of backlight subareas;

a driving element connected to the display panel and configured to display each picture with two frame images sequentially; wherein the two frame images comprise a first frame image and a second frame image; driving voltages for two adjacent sub-pixels in each of the frame images are different, and driving voltages for each of the sub-pixels in the first frame image and the second frame image are different;

a backlight control element connected to the driving element and comprising one or more processors, and memory storing instructions, which, when executed by the one or more processors cause the one or more processors to perform operations comprising:

determining backlight brightness regulation signals for each of the backlight subareas according to the driving voltages of a first frame image area and a second frame image area, wherein the first frame image area and the second frame image are corresponding to each of the backlight subareas; wherein the backlight brightness regulation signals are grouped signals, the number of the groups is identical to the number of types of the color sub-pixels; and

calculating an average color chroma of a current picture region corresponding to each of the backlight subareas, and determining whether the average color chroma of each of the backlight subareas is within a preset range; and

a backlight regulation element connected to the backlight control element and the backlight module respectively; wherein the backlight regulation element is configured to perform a brightness regulation to a backlight source of the backlight subarea in each of the frame images of a next picture according to the backlight brightness regulation signal of the backlight subarea when the average color chroma of the backlight subarea is determined by the backlight control element to be in the preset range.

10. The LCD device according to claim **9**, further comprising a storage element configured to store an LUT; wherein the LUT is a correspondence table on input signals and the driving voltages for each of the sub-pixels in the first frame image and the second frame image, wherein the first frame image area and the second frame image are corresponding to the input signals; the driving element acquires the driving voltages for each of the sub-pixels of the first frame image and the second frame image by looking up in the LUT.

11. The LCD device according to claim **9**, wherein the one or more processors further execute the instructions to provide steps in following units:

a statistic unit configured to calculate average driving voltages for various color sub-pixels in the first frame image area and the second frame image area, wherein the first frame image area and the second frame image are corresponding to each of the backlight subareas; and

a calculation unit configured to calculate the backlight brightness regulation signal according to the average driving voltage, a reference backlight brightness signal and a reference driving voltage of each of the backlight subareas.

12. The LCD device according to claim **11**, wherein the formulas to calculate the backlight brightness regulation signal of each of the color sub-pixels in each of the backlight subareas are:

$$A_{M\_P1}{*}P_{M\_ave1}A_{M\_P2}{*}P_{M\_ave2};$$

$$2{*}A_{M\_P}{*}P_{M\_ave}=A_{M\_P1}{*}P_{M\_ave1}+A_{M\_P2}{*}P_{M\_ave2},$$

wherein P is a target color sub-pixel; M is a serial number of the backlight area, A_{M_P1} is a backlight brightness regulation signal to perform a backlight brightness regulation to a backlight source of a P sub-pixel in a backlight area M corresponding to the first frame image of the next picture; A_{M_P2} is a backlight brightness regulation signal to perform a backlight brightness regulation to a backlight source of the P sub-pixel in the backlight area M corresponding to the second frame image of the next picture; P_{M_ave1} is an average value of a driving voltage of the P sub-pixel in the backlight area M corresponding to the first frame image of the current picture; P_{M_ave2} is an average value of the driving voltage of the P sub-pixel in the backlight area M corresponding to the second frame image of the current picture; A_{M_P} is a reference backlight brightness signal of the P sub-pixel in the backlight area M corresponding to the image of the current picture; P_{M_ave} is an average value of a reference driving voltage of the P sub-pixel in the frame image area corresponding to the backlight area M on the image of the current picture.

13. The LCD device according to claim **9**, wherein the one or more processors further execute the instructions to provide a step of controlling the backlight regulation element not to perform a backlight regulation to the backlight source in the backlight subarea when the average color chroma of the backlight subarea is determined by the one or more processors to be out of the preset range.

14. The LCD device according to claim **9**, wherein the one or more processors further execute the instructions to provide a step of calculating the average display hue of the current picture region corresponding to the backlight and determining a backlight regulation object according to the range where the average display hue belongs when the average color chroma is determined by the at least processor to be within the preset range; wherein the backlight regulation object comprises a backlight source of at least one of a red sub-pixel, a green sub-pixel and a blue sub-pixel;

wherein the backlight regulation element is further configured to perform an independent brightness regulation to the backlight regulation object according to the backlight regulation signal corresponding to the backlight regulation object.

15. The LCD device according to claim **14**, wherein the one or more processors further execute the instructions to provide steps of:

determining the object of the backlight regulation to be the backlight source corresponding to the red sub-pixel when the average display hue is 0°<H≤45° or 315°<H≤360';

determining the object of the backlight regulation to be the backlight sources respectively corresponding to the red sub-pixel and the green sub-pixel when the average display hue is 45°<H≤135°;

determining the object of the backlight regulation to be the backlight source corresponding to the green sub-pixel when the average display hue is 135°<H≤205°;

determining the object of the backlight regulation to be the backlight sources respectively corresponding to the green sub-pixel and the blue sub-pixel when the average display hue is 205°<H≤245°;

determining the object of the backlight regulation to be the backlight source corresponding to the blue sub-pixel when the average display hue is 245°<H≤295°; and

determining the object of the backlight regulation to be the backlight sources respectively corresponding to the blue sub-pixel and the red sub-pixel when the average display hue is 295°<H≤315°; wherein H is the average display hue.

16. The LCD device according to claim **9**, wherein the backlight source is a white backlight source, an RGB backlight source, an RGBW backlight source or an RGBY backlight source.

17. An LCD device, comprising:

a display panel;

a backlight module configured to provide backlight to the display panel; wherein the backlight module is divided into a plurality of backlight subareas;

a driving element connected to the display panel and configured to display each picture with two frame images sequentially; wherein the two frame images comprise a first frame image and a second frame image; driving voltages for two adjacent sub-pixels in each of the frame images are different, and driving voltages for each of the sub-pixels in the first frame image and the second frame image are different;

a backlight control element connected to the driving element, comprising one or more processors and memory storing instructions, which, when executed by the one or more processors cause the one or more processors to perform operations comprising:

determining backlight brightness regulation signals for each of the backlight subareas according to the driving voltages of a first frame image area and a second frame image area, wherein the first frame image area and the second frame image are corresponding to each of the backlight subareas; wherein the backlight brightness regulation signals are grouped signals, the number of the groups is identical to the number of types of the color sub-pixels; and

calculating an average color chroma of a current picture region corresponding to each of the backlight subareas, and determining whether the average color chroma of each of the backlight subareas is within a preset range; and

a backlight regulation element connected to the backlight control element and the backlight module respectively, wherein the backlight regulation element is configured to perform a brightness regulation to a backlight source of the backlight subarea in each of the frame images of a next picture according to the backlight brightness regulation signal of the backlight subarea when the average color chroma of the backlight subarea is determined by the backlight control element to be in the preset range;

wherein the one or more processors further execute the instructions to provide steps in following units:

a statistic unit configured to calculate average driving voltages for various color sub-pixels in the first frame image area and the second frame image area, wherein the first frame image area and the second frame image are corresponding to each of the backlight subareas; and

a calculation unit configured to calculate the backlight brightness regulation signal according to the average driving voltage, a reference backlight brightness signal and a reference driving voltage of each of the backlight subareas, the calculation formulas are as follows:

$$A_{M\_P1}*P_{M\_ave1}A_{M\_P2}*P_{M\_ave2};$$

$$2*A_{M\_P}*P_{M\_ave}=A_{M\_P1}*P_{M\_ave1}+A_{M\_P2}*P_{M\_ave2},$$

wherein P is a target color sub-pixel; M is a serial number of the backlight subarea, A_{M_P1} is the backlight brightness regulation signal to perform a backlight brightness regulation to a backlight source of a P sub-pixel in a backlight subarea M corresponding to the first frame image of the next picture; A_{M_P2} is the backlight brightness regulation signal to perform a backlight brightness regulation to a backlight source of the P sub-pixel in the backlight subarea M corresponding to the second frame image of the next picture; P_{M_ave1} is an average value of a driving voltage of the P sub-pixel in the backlight subarea M corresponding to the first frame image of the current picture; P_{M_ave2} is an average value of the driving voltage of the P sub-pixel in the backlight subarea M corresponding to the second frame image of the current picture; A_{M_P} is a reference backlight brightness signal of the P sub-pixel in the backlight subarea M corresponding to the image of the current picture; P_{M_ave} is an average value of a reference driving voltage of the P sub-pixel in the frame image area corresponding to the backlight subarea M on the image of the current picture.

18. The LCD device according to claim **17**, wherein the one or more processors further execute the instructions to provide a step of calculating the average display hue of the current picture region corresponding to the backlight and determining a backlight regulation object according to the range where the average display hue belongs when the average color chroma is determined by the at least processor to be within the preset range; wherein the backlight regulation object comprises a backlight source of at least one of a red sub-pixel, a green sub-pixel and a blue sub-pixel;

wherein the backlight regulation element is further configured to perform an independent brightness regulation to the backlight regulation object according to the backlight regulation signal corresponding to the backlight regulation object.

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patsnap

专利名称(译)	液晶显示装置及其驱动方法		
公开(公告)号	US20180374428A1	公开(公告)日	2018-12-27
申请号	US15/743954	申请日	2017-05-22
[标]申请(专利权)人(译)	惠科股份有限公司 重庆惠科金渝光电科技有限公司		
[标]发明人	CHEN YU JEN		
发明人	CHEN, YU-JEN		
IPC分类号	G09G3/34 G09G3/36		
CPC分类号	G09G3/342 G09G3/3607 G09G3/3413 G09G2320/0242 G09G2320/029 G09G2360/16 G09G2320/0626 G09G3/3614 G09G3/3426 G09G2320/0285		
优先权	201611228633.3 2016-12-27 CN		
其他公开文献	US10546543		
外部链接	Espacenet USPTO		

摘要(译)

一种用于驱动LCD装置的方法，包括顺序地显示具有两个帧图像的每个图像;每个帧图像中两个相邻子像素的驱动电压不同，第一帧图像和第二帧图像中每个子像素的驱动电压不同;确定每个背光子区域的背光亮度调节信号;背光亮度调节信号是分组信号，组的数量与彩色子像素的类型数量相同;计算与每个背光子区域对应的当前图片区域的平均色度;确定每个背光子区域的平均色度是否在预设范围内;若是，则根据背光子区域的背光亮度调节信号对下一图片的每个帧图像中的背光子区域的背光源进行亮度调节。