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DISPLAY PANEL AND DISPLAY DEVICE

Abstract

The embodiments of the present application provide a display panel and a display device. The display panel includes data lines, pixel units, a plurality of gate driving units connected in cascade. At least one gate driving unit includes a pre-charging control module electrically connected with a pre-charging control signal terminal and a scanning signal output terminal of the present stage. The pre-charging control module outputs the pre-charging control signals to the scanning signal output terminal of the present stage, and the data lines output the pre-charging control signals to the corresponding pixel units.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a national stage of International Application No. PCT/CN2023/089018, filed on Apr. 18, 2023, which claims priority to Chinese Patent Application No. 202211430715.1, filed on Nov. 15, 2022. Both of the aforementioned applications are hereby incorporated by reference in their entireties.

TECHNICAL FIELD

[0002] The present application relates to a technical field of a display, in particular to a display panel and a display device.

BACKGROUND

[0003] Liquid crystal display (LCD) devices have been widely used in modern society. Currently, by equipping a timing control module, a cell, and a backlight module, image display is achieved in the LCD panel. The backlight module includes a LED array. In the LCD panel, different color effects are achieved by adjusting the brightness of the LEDs to control light passing through color filters. However, the existence of the color filters in the cell increases the cost and decreases the light efficiency. The conventional field sequence display method of color-mixing in time display images by turning on R/G/B LEDs one field at a time with color filters unneeded, therefore, the image displayed with color-mixing in time is realized. This method can achieve a same display effect of color image as that of color-mixing in space. Due to the limit of the refresh frequency of the LCD panels, the conventional field sequence display method will cause a phenomenon of color splitting, thus affecting the visual experience.

[0004] FIG. 1 is a schematic diagram of driving timing of a conventional display device. The backlight of the conventional field sequence display panel controls the global image displayed at different times to realize the image display of field sequence. However, since the image display in the conventional field sequence display panel is not controlled at different regions, when the grayscale values between adjacent sub-frame images change greatly, a phenomenon of abnormal color-mixing of image display caused by long response time of the liquid crystal appears. Therefore, a problem on how to control the image display at different regions, to reduce the response time of liquid crystal and to improve the abnormal color-mixing of image displayed with field sequence display method becomes urgent to be solved.

SUMMARY OF THE INVENTION

Technical Problem

[0005] An object of the embodiments of the present application is to reduce the response time of the liquid crystal and to improve the problem of abnormal color-mixing of image displayed with field sequence display method by providing a pre-charging control module to pre-charge pixel units corresponding to at least one gate driving unit before images displaying.

Technical Solution

[0006] The embodiments of the present application provide a display panel comprising a plurality of data lines, a plurality of pixel units electrically connected with the data lines and a plurality of gate driving units connected in cascade; wherein at least one of the gate driving units comprises a pre-charging control module, electrically connected with a pre-charging control signal terminal and a scanning signal output terminal of the present stage, to output pre-charging control signals to the scanning signal output terminal of the present stage; and the data lines are configured to output pre-charging control signals to the corresponding pixel units.

[0007] Optionally, in some embodiments of the present application, the plurality of the gate driving

units comprise a plurality of gate driving unit groups, each of the gate driving units comprising a pre-charging control module, and a plurality of the pre-charging control modules disposed in a gate driving unit group are electrically connected with a same pre-charging control signal terminal.

[0008] Optionally, in some embodiments of the present application, a plurality of the pre-charging control modules disposed in different gate driving unit groups are simultaneously turned on under a control of the pre-charging control signal outputted from the pre-charging control signal terminal.

[0009] Optionally, in some embodiments of the present application, a plurality of the pre-charging control modules disposed in different gate driving unit groups are sequentially turned on under the control of a plurality of the pre-charging control signals outputted from a plurality of the pre-charging control signal terminals.

[0010] Optionally, in some embodiments of the present application, a plurality of the pre-charging control modules disposed in at least two gate driving unit groups arranged at intervals are simultaneously turned on under the control of the pre-charging control signal outputted from the pre-charging control signal terminal, or a plurality of the pre-charging control modules disposed in at least two gate driving unit groups arranged at intervals are sequentially turned on under the control of the pre-charging control signals outputted from the pre-charging control signal terminals.

[0011] Optionally, in some embodiments of the present application, the pixel units corresponding to different gate driving unit groups are pre-charged in the same time period.

[0012] Optionally, in some embodiments of the present application, the gate driving unit further comprises a driving module, electrically connected with the cascade control signal terminal, the pre-charging control module and the scanning signal output terminal of the present stage; the driving module is configured to output driving signals to the scanning signal output terminal of the present stage and the gate driving unit of the subsequent stage after the data lines complete the output of the pre-charging voltage, and the data lines are configured to output the data voltages to the corresponding pixel units.

[0013] Optionally, in some embodiments of the present application, a peak value of the pre-charging voltages ranges between 50% and 90% of a peak value of the data voltages.

[0014] Optionally, in some embodiments of the present application, the display panel further comprises a judging unit electrically connected with the pre-charging control module and the data lines; the judging unit is configured to control the pre-charging control module to turn off when the difference value of the data voltages outputted from the data lines to the pixel units corresponding to the adjacent two gate driving unit groups is smaller than or equal to a predetermined threshold value, and configured to control the pre-charging control module to turn on when the difference value of the data voltages outputted from the data lines to the pixel units corresponding to the adjacent two gate driving unit groups is greater than the predetermined threshold value.

[0015] Optionally, in some embodiments of the present application, the plurality of the gate driving units connected in cascade comprise N gate driving unit groups; where $X \leq K \leq X * N$, and $K \leq T * 30\%$, X is a scanning time of a row of pixel units P, K is a total pre-charging time corresponding to a plurality of the gate driving unit groups, T is a display time of a frame of image, N is a positive integer and X, K and T are positive numbers.

[0016] Optionally, in some embodiments of the present application, further comprising a plurality of sub-backlight regions disposed along the direction of the scanning line and disposed corresponding to the gate driving unit group, the pre-charging voltages for the pixel units corresponding to the sub-backlight regions are negatively correlated with the brightness of the sub-backlight regions.

[0017] The embodiments of the present application also provide a display device comprising a display panel and a driving circuit disposed on the display panel, wherein the display panel comprises a plurality of data lines, a plurality of pixel units electrically connected with the data lines, and a plurality of gate driving units connected in cascade; wherein at least one of the gate driving units comprises a pre-charging control module, electrically connected with a pre-charging

control signal terminal and a scanning signal output terminal of the present stage, to output pre-charging control signals to the scanning signal output terminal of the present stage; and the data lines are configured to output pre-charging control signals to the corresponding pixel units.

[0018] Optionally, in some embodiments of the present application, the plurality of the gate driving units comprise a plurality of gate driving unit groups, each of the gate driving units comprising a pre-charging control module, and a plurality of the pre-charging control modules disposed in a gate driving unit group are electrically connected with a same pre-charging control signal terminal.

[0019] Optionally, in some embodiments of the present application, a plurality of the pre-charging control modules disposed in different gate driving unit groups are simultaneously turned on under a control of the pre-charging control signal outputted from the pre-charging control signal terminal.

[0020] Optionally, in some embodiments of the present application, a plurality of the pre-charging control modules disposed in different gate driving unit groups are sequentially turned on under the control of a plurality of the pre-charging control signals outputted from a plurality of the pre-charging control signal terminals.

[0021] Optionally, in some embodiments of the present application, a plurality of the pre-charging control modules disposed in at least two gate driving unit groups arranged at intervals are simultaneously turned on under the control of the pre-charging control signal outputted from the pre-charging control signal terminal, or a plurality of the pre-charging control modules disposed in at least two gate driving unit groups arranged at intervals are sequentially turned on under the control of the pre-charging control signals outputted from the pre-charging control signal terminals.

[0022] Optionally, in some embodiments of the present application, the pixel units corresponding to different gate driving unit groups are pre-charged in the same time period.

[0023] Optionally, in some embodiments of the present application, the gate driving unit further comprises a driving module, electrically connected with the cascade control signal terminal, the pre-charging control module and the scanning signal output terminal of the present stage; the driving module is configured to output driving signals to the scanning signal output terminal of the present stage and the gate driving unit of the subsequent stage after the data lines complete the output of the pre-charging voltage, and the data lines are configured to output the data voltages to the corresponding pixel units.

[0024] Optionally, in some embodiments of the present application, a peak value of the pre-charging voltages ranges between 50% and 90% of a peak value of the data voltages.

[0025] Optionally, in some embodiments of the present application, the display panel further comprises a judging unit electrically connected with the pre-charging control module and the data lines; the judging unit is configured to control the pre-charging control module to turn off when the difference value of the data voltages outputted from the data lines to the pixel units corresponding to the adjacent two gate driving unit groups is smaller than or equal to a predetermined threshold value, and configured to control the pre-charging control module to turn on when the difference value of the data voltages outputted from the data lines to the pixel units corresponding to the adjacent two gate driving unit groups is greater than the predetermined threshold value.

Advantageous Effects

[0026] In the display panel and the display device provided in the embodiments of the present application, the display panel includes a plurality of data lines, a plurality of pixel units and a plurality of gate driving units connected in cascade, a plurality of the pixel units are electrically connected with the data lines, at least one of the gate driving units includes a pre-charging control module, the pre-charging control module is electrically connected with the pre-charging control signal terminal and the scanning signal output terminal of the present stage, the pre-charging control module outputs the pre-charging control signal to the scanning signal output terminal of the present stage, and the data lines output pre-charging control signals to the corresponding pixel units. By providing the pre-charging control module to output the pre-charging control signal to the scanning signal output terminal of the present stage, pre-charging pixel unit corresponding to at

least one gate driving unit before images displaying can be realized, thereby reducing the response time of the liquid crystal and improving the problem of abnormal color-mixing of image displayed with field sequence display method.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] In order to describe the technical solution provided in the embodiments of the present application more clearly, the figures used in the description of embodiments of the present application will be briefly described below. Apparently, the figures described below are only a part of figures of the embodiments of the present application, other figures can be obtained without creative efforts by those skilled in the art.

[0028] FIG. 1 is a schematic diagram of driving timing of a conventional display device;

[0029] FIG. 2a is a structural schematic diagram of a display panel provided in the present application;

[0030] FIG. 2b is one of first structural diagrams of a gate driving unit of the display panel provided in the present application;

[0031] FIG. 2c is another first structural schematic diagram of the gate driving unit of the display panel provided in the present application;

[0032] FIG. 3a is a structural schematic diagram of a first display panel provided in the embodiments of the present application;

[0033] FIG. 3b is a schematic diagram of first sub-regions of the display panel provided in the embodiments of the present application;

[0034] FIG. 3c is a schematic diagram of second sub-regions of the display panel provided in the embodiments of the present application;

[0035] FIG. 3d is a schematic diagram of a gate driving unit group of the display panel provided in the embodiments of the present application;

[0036] FIG. 3e is a structural schematic diagram of a second display panel provided in the embodiments of the present application;

[0037] FIG. 3f is a schematic diagram of pixel arrangement corresponding to the display panel provided in the embodiments of the present application;

[0038] FIG. 4a is a comparison diagram between the driving timing of the display panel provided in the present application and the conventional driving timing;

[0039] FIG. 4b is a first driving timing diagram of the display panel provided in the embodiments of the present application;

[0040] FIG. 5a is one of second driving timing diagram of the display panel provided in the embodiments of the present application;

[0041] FIG. 5b is another second driving timing diagrams of the display panel provided in the embodiments of the present application;

[0042] FIG. 6 is a third driving timing diagram of the display panel provided in the embodiments of the present application;

[0043] FIG. 7 is a fourth driving timing diagram of the display panel provided in the embodiments of the present application;

[0044] FIG. 8 is a fifth driving timing diagram of the display panel provided in the embodiments of the present application;

[0045] FIG. 9 is a schematic diagram of a second structure of the gate driving unit of the display panel provided in the embodiments of the present application.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0046] The technical solution provided in the embodiments of the present application will be

clearly and completely described in the following with reference to the figures provided in the embodiments of the present application. Apparently, the embodiments described herein are only a part of and not all of the embodiments of the present application. Based on the embodiments of the present application, other embodiments obtained by those skilled in the art without creative efforts shall fall within the protection scope of the present application.

[0047] The embodiments of the present application provide a display panel and a display device. With a pre-charging control module provided in the display panel, pre-charging for pixel units P corresponding to at least one gate driving unit before image displaying can be realized, thereby reducing the response time of liquid crystal and improving the problem of abnormal color-mixing of image displayed with field sequence display method, which will be described in detail below. It should be noted that, the order of description of the following embodiments is not a limitation to the preferred order of the protection scope of the present application. In addition, in the description of the present application, the term “including” means “including but not limited to”. The terms “first”, “second”, “third”, etc. are used only as indications for distinguishing different objects but not for describing a specific order.

[0048] Refer to FIGS. **2a** to **4b**, the present application provides a display panel **100** including a plurality of data lines D (**1**, **2**, **3** . . .), a plurality of pixel units P, and a plurality of gate driving units (GOA_{n-1} , GOA_n , GOA_{n+1} . . . GOA_{2n-1} , GOA_{2n} , GOA_{2n+1} . . .) connected in cascade. A plurality of the pixel units P are electrically connected with the data lines D (**1**, **2**, **3** . . .). At least one gate driving unit includes a pre-charging control module **10**. The pre-charging control module **10** is electrically connected with a pre-charging control signal terminal Cont and a scanning signal output terminal Gout ($Gout_{n-1}$, $Gout_n$, $Gout_{n+1}$. . . $Gout_{2n-1}$, $Gout_{2n}$, $Gout_{2n+1}$. . .) of the present stage. The pre-charging control module **10** outputs pre-charging control signals Cont to the scanning signal output terminal Gout of the present stage. The data lines D (**1**, **2**, **3** . . .) output pre-charging control signals Cont to the corresponding pixel units P. The display panel **100** also includes a plurality of scanning lines G (**1**, **2**, **3** . . .), a plurality of the scanning lines G (**1**, **2**, **3** . . .) are electrically connected with the pixel units correspondingly.

[0049] In the display panel **100** provided in the embodiments of the present application, by providing a pre-charging control module **10** in at least one gate drive unit GOA to output the pre-charging control signals Cont to a scanning signal output terminal Gout of the present stage, and pre-charging pixel units P corresponding to at least one gate driving unit before image displaying can be realized, thereby reducing the response time of liquid crystal and improving the problem of abnormal color-mixing of image displayed with field sequence display method.

[0050] In the embodiments of the present application, the gate driving unit further includes a driving module **20** electrically connected with cascade control signal terminals CK/XCK (the gate driving unit of the first stage includes cascade control signal terminals CK/XCK/STV), a pre-charging control module **10** and a scanning signal output terminal Gout of the present stage. The driving module **20** is configured to output driving signals to the scanning signal output terminal Gout of the present stage and the gate driving unit of the subsequent stage after the data lines D (**1**, **2**, **3** . . .) complete the output of the pre-charging voltages. The data lines D (**1**, **2**, **3** . . .) output data voltages to the corresponding pixel units P. Specifically, the pre-charging control module **10** can include at least one transistor.

[0051] In the embodiments of the present application, the peak value of the pre-charging voltages ranges between 50% and 90% of the peak value of the data voltages. With this design, the difference of grayscale values between adjacent sub-frame images is minimized, thereby reducing the response time of liquid crystal shifting caused by sub-frame images switching to the largest extent, and avoiding abnormal image displayed with field sequence display method caused by color-mixing.

[0052] Specifically, as shown in FIG. **2b**, the driving module **20** includes a pull-up control module **21**, an output module **22**, a pull-down module **23**, a pull-down maintenance module **24** and a

feedback module **25**. The pull-up control module **21** is electrically connected with the output module **22** and the feedback module **25** and is configured to pre-charge the point Qn. The output module **22** is electrically connected with the pull-down module **23** and the pre-charging control module **10** and is configured to output signals Gn. The pull-down module **23** is electrically connected with the pull-down maintenance module **24** and the feedback module **25** and is configured to pull down the potential of the point Qn and disconnecting the output of signals Gn. The pull-down maintenance module **24** is electrically connected with the feedback module **25** and is configured to maintain the point Qn a low potential and maintaining the disconnection of the output of signals Gn. The feedback module **25** is configured to pull up the potential of the point Qn. [0053] Refer to FIGS. **2b** and **3a**, as a specific embodiment of the present application, the display panel **100** includes a plurality of gate driving units (GOAn-1, GOAn, GOAn+1 . . . GOA2n-1, GOA2n, GOA2n+1 . . .) connected in cascade, each gate driving unit is provided with a pre-charging control module **10**, and each pre-charging control module **10** is electrically connected with a corresponding pre-charging control signal terminal Cont (1, 2, 3 . . .) and a scanning signal output terminal Gout (Goutn-1, Goutn, Goutn+1 . . . Gout2n-1, Gout2n, Gout2n+1 . . .). The pre-charging control module **10** is configured to output the pre-charging control signals Cont to the scanning signal output terminal Gout under the control of the corresponding pre-charging control signal terminal Cont (1, 2, 3 . . .).

[0054] In the embodiments of the present application, the display panel **100** further includes a plurality of sub-backlight regions, a plurality of the sub-backlight regions arranged along the direction of the scanning lines G (1, 2, 3 . . .) are arranged corresponding to a gate driving unit group. The pre-charging voltages for the pixel units P corresponding to the sub-backlight regions are negatively correlated with the brightness of the sub-backlight regions. That is, the greater the brightness of the sub-backlight region, the smaller the pre-charging voltage value outputted from the data lines D (1, 2, 3 . . .) electrically connected with the corresponding pixel units P.

[0055] Specifically, as shown in FIG. **3b**, the display panel is provided with a R/G/B mini-LED backlight. The backlight includes M*N sub-backlight regions, that is, the backlight is divided into N sub-regions vertically and M sub-regions horizontally. Each sub-region emits backlight of three colors. Corresponding to the backlight, the display panel is divided into M*N regions, each region includes X/M pixels in the horizontal direction and Y/N pixels in the vertical direction. Before the image data of each frame are inputted, the display panel is pre-charged in N times. Y/N rows of pixels are turned on simultaneously for each time. The data pre-charged for each time are generated from the Y/N rows of the image data. The time of pre-charging each sub-region is equal to the scanning time of a row of pixels.

[0056] Specifically, as shown in FIGS. **3c** and **3d**, the display panel is divided into N sub-regions vertically, each sub-region corresponds to M gate driving units. Before the image data of each frame are inputted, the display panel is pre-charged in N times. Y/N rows of pixels are turned on simultaneously for each time. The data pre-charged for each time are generated from the Y/N rows of image data. The time of pre-charging each sub-region is equal to the scanning time of a row of pixels.

[0057] It should be noted that, in the pre-charging phase, the backlight is turned off, or the sub-backlight region corresponding to the sub-region of the display panel under pre-charging is turned off.

[0058] In the embodiments of the present application, as shown in FIG. **3e**, a plurality of gate driving units connected in cascade are divided into a plurality of gate driving unit groups **30**. Correspondingly, the display panel is divided into a plurality of longitudinal sub-regions. Each gate driving unit includes a pre-charging control module **10**. A plurality of the pre-charging control modules **10** disposed in the same gate driving unit group **30** are electrically connected with a same pre-charging control signal terminal Cont. Specifically, the gate driving unit group **30** includes at least two gate driving units. The gate driving units disposed in the same gate driving unit group **30**

turn on simultaneously and output the pre-charging control signals Cont to the corresponding scanning signal output terminals Gout under the control of a pre-charging control signal Cont outputted from the same pre-charging control signal terminal Cont, and turn off simultaneously. That is, the time of a plurality of the pre-charging control modules **10** disposed in the same gate driving unit group **30** being turned on are the same, and the time of duration of the plurality of the pre-charging control modules **10** disposed in the same gate driving unit group **30** being turned on are the same. Since a plurality of the pre-charging control modules **10** disposed in the same gate driving unit group **30** are electrically connected with the same pre-charging control signal terminal Cont, the circuit layout is simplified, the wiring space is saved and the impact between signal lines is reduced.

[0059] Specifically, a plurality of the gate driving units connected in cascade are divided into N gate driving unit groups. $X \leq K \leq X \cdot N$, and $K \leq T \cdot 30\%$, wherein X is the scanning time of a row of pixel units P, K is a total pre-charging time corresponding to the plurality of gate driving unit groups, T is a display time of a frame of image, N is a positive integer and X, K and T are positive numbers.

[0060] Refer to FIG. **3f**, in the embodiments of the present application, X pixel grayscale values can be inputted at a time for pre-charging. Specifically, the grayscale values of X pixels generated from all of the image data can be the same.

[0061] X pixel grayscale values can be divided into M values corresponding to the horizontal sub-regions, and each value can be generated from all of grayscale values, such as $(X/M) \cdot (Y/N)$ grayscale values, of the current sub-region, and the grayscale values corresponding to sub-regions can be different.

[0062] X pixel grayscale values can be divided into X values by column, and each value is generated from the grayscale values, such as $1 \text{ column} \cdot Y/N$ grayscale values, of the current column.

[0063] Refer to FIG. **4a**, compared with the conventional display method which includes an image display phase and a blanking phase, in the embodiments of the present application, a pre-charging phase pre is arranged before the image display phase display in the present application to buffer the grayscale value changes between two adjacent sub-frame images, thereby minimizing the response time of the grayscale values in the buffer time and the grayscale values of the next sub-frame image.

[0064] Specifically, as shown in FIG. **4b**, a driving period of a frame image includes a pre-charging phase t1, a display phase t2, and a blanking phase t3. A frame image includes a plurality of sub-frame images, such as a red sub-frame image, a green sub-frame image, and a blue sub-frame image. The pre-charging phase t1 is arranged before the display phase t2. The pre-charging control module **10** is configured to output the pre-charging control signals Cont to the scanning signal output terminal Gout of the present stage in the pre-charging phase t1 to buffer the grayscale value changes between two adjacent sub-frame images, thereby minimizing the difference between the grayscale values of the previous sub-frame image and the grayscale values of the next sub-frame image, reducing the response time of liquid crystal shifting caused by sub-frame images switching and improving the display quality. In the display phase t2, the driving module **20** is turned on under the control of the cascade control signals CK/XCK/STV outputted from the cascade control signal terminal CK/XCK/STV, the pre-charging control module **10** is turned off, the driving module **20** outputs driving signals to the scanning signal output terminal Gout of the present stage and the gate driving unit of the subsequent stage, and the data lines D (1, 2, 3 . . .) output data voltages to the corresponding pixel units P.

[0065] In the embodiments of the present application, the time of duration of a plurality of the pre-charging control modules **10** in different gate driving unit groups **30** outputting the pre-charging control signals Cont to the corresponding scanning signal output terminal Gout are the same, that is, the time of duration of a plurality of the pre-charging control modules **10** in different gate

driving unit groups **30** being turned on are the same. Under the control of the pre-charging control signal Cont outputted from a same pre-charging control signal terminal Cont, a plurality of the gate driving units disposed in different gate driving unit groups **30** turn on at the same time, output pre-charging control signal Cont to the corresponding scanning signal output terminals Gout, and then turn off at the same time. Or, under the control of different pre-charging control signals Cont, a plurality of the gate driving units disposed in different gate driving unit groups **30** turn on at the same time, output the pre-charging control signals Cont to the corresponding scanning signal output terminals Gout, and turned off simultaneously.

[0066] In the embodiments of the present application, a plurality of the pre-charging control modules **10** disposed in different gate driving unit groups **30** are simultaneously turned on under the control of pre-charging control signals Cont (1, 2, 3 . . .) outputted from the pre-charging control signal terminals Cont. A plurality of the gate driving unit groups **30** which are simultaneously turned on are continuously arranged. The time of duration of a plurality of the pre-charging control modules **10** disposed in different gate driving unit groups **30** being turned on are the same. With this design, the time of duration of the pre-charging phase t₁ is the shortest and the impact on the time of duration of display phase t₂ is the weakest, thereby reducing the response time of liquid crystal and ensuring the display time, and further improving the display quality.

[0067] In the embodiments of the present application, the display panel further includes a plurality of the scanning lines G (1, 2, 3 . . .). A plurality of the scanning lines G (1, 2, 3 . . .) are electrically connected with a plurality of the gate driving units in one-to-one correspondence. The time of duration of the pre-charging control module **10** disposed in each of the gate driving units being turned on is equal to the scanning time of the scanning lines G (1, 2, 3 . . .) electrically connected with gate driving units. With this design, the time at which the pre-charging control module **10** outputs the pre-charging control signals Cont and the scanning time of the scanning lines G (1, 2, 3 . . .) are consistent, thereby avoiding the impact of too long pre-charging time on the stability of the display device, and also avoiding the abnormal image display such as color shift due to insufficient pre-charging time.

[0068] Refer to FIGS. 5a and 5b, in the display panel provided in the present application, a plurality of the pre-charging control modules **10** disposed in different gate driving unit groups **30** are sequentially turned on under the control of a plurality of the pre-charging control signals Cont (1, 2, 3 . . .) outputted from a plurality of the pre-charging control signal terminals Cont. As an example, FIG. 5 illustrates that a plurality of the gate driving units disposed in the first gate driving unit group **30** are simultaneously turned on under the control of the pre-charging control signals Cont₁, and then a plurality of the gate driving units of the second gate driving unit group **30** are simultaneously turned on under the control of the pre-charging control signals Cont₂. Specifically, those skilled in the art may divide the gate driving units into different number of gate drive unit groups according to the actual needs, and the present application does not specifically limit the number of gate drive unit groups herein.

[0069] In the embodiments of the present application, as shown in FIG. 5b, a plurality of the gate driving units are divided into M gate drive unit groups **30**, wherein M is a positive integer greater than or equal to 3. Specifically, when M is a positive integer of 3, a plurality of the pre-charging control modules **10** corresponding to a plurality of the gate driving units disposed in the three gate driving unit groups **30** are turned on in sequence, that is, the time of a plurality of the pre-charging control modules **10** corresponding to the plural gate driving units disposed in different gate driving unit groups **30** being turned on are different. A plurality of the gate driving unit groups **30** which are simultaneously turned on are arranged continuously. Specifically, a plurality of the pre-charging control modules **10** corresponding to a plurality of the gate driving units disposed in a gate driving unit group **30** are electrically connected with the same pre-charging control signal terminal Cont, so that the time of a plurality of the pre-charging control modules **10** corresponding to a plurality of the gate driving units disposed in a gate driving unit group **30** being turned on are the same, and the

time of duration of a plurality of the pre-charging control modules **10** corresponding to a plurality of the gate driving units disposed in a gate driving unit group **30** being turned on are the same. Specifically, the time of duration of the plurality of pre-charging control modules **10** corresponding to one gate driving unit group **30** being turned on is equal to the scanning time of scanning lines G (1, 2, 3 . . .) G electrically connected with gate driving units, thereby reducing the loading of the pre-charging control signal terminal Cont, ensuring the stability of the pre-charging voltage outputted by the plurality of pre-charging control modules **10** disposed in each gate driving unit group **30**, and further ensuring the pre-charging effect, reducing the response time of the liquid crystal, and improving the display quality.

[0070] It should be noted that, the pre-charging control modules **10** corresponding to a plurality of the gate drive units disposed in a part of gate drive unit groups **30** of the M gate drive unit groups **30** are turned on at the pre-charging phase t1, and the pre-charging control modules **10** corresponding to a plurality of the gate drive units disposed in the other gate drive unit groups **30** are turned off at the pre-charging phase t1. A plurality of the pre-charging control modules **10** turned on in the pre-charging phase t1 are disposed in a plurality of the gate driving unit groups **30**, a plurality of the gate driving unit groups **30** are disposed continuously. That is, in the display panel provided in the present application, by providing a pre-charging control module **10** in a gate driving unit, and dividing a plurality of the gate driving units into M gate driving unit groups **30**, and further turning on the pre-charging control modules **10** corresponding to a plurality of the gate driving units disposed in a part of the gate driving unit group **30** or all of the gate driving unit group **30** in the pre-charging phase t1, and turning off the pre-charging control modules **10** corresponding to a plurality of the gate driving units disposed in the other gate driving unit group **30** in the pre-charging phase t1, to buffer the grayscale value changes between two adjacent sub-frame images, the difference between the grayscale value of the previous sub-frame image and the grayscale value of the next sub-frame image can be minimized, and the response time of liquid crystal shifting caused by sub-frame images switching can be reduced and the display quality can be improved.

[0071] Refer to FIGS. **6** to **8**, in the display panel provided in the present application, a plurality of the pre-charging control modules **10** disposed in at least two gate driving unit groups **30** arranged at intervals are simultaneously turned on under the control of pre-charging control signals Cont outputted from a pre-charging control signal terminal Cont, and/or, a plurality of the pre-charging control modules **10** disposed in at least two gate driving unit groups **30** arranged at intervals are sequentially turned on under the control of the pre-charging control signals Cont outputted from pre-charging control signal terminals Cont.

[0072] In the embodiments of the present application, a plurality of the gate driving units are divided into M gate drive unit groups **30**, wherein M is a positive integer greater than or equal to 5. Specifically, when M is equal to 5, as shown in FIG. **6**, a plurality of the pre-charging control modules **10** disposed in the three gate driving unit groups **30** arranged at intervals are simultaneously turned on under the control of the pre-charging control signals Cont (1, 3, 5 . . .) outputted from the pre-charging control signal terminal Cont. That is, the time of a plurality of the pre-charging control modules **10** disposed in the three gate driving unit groups **30** being turned on are the same. With this design, the time of duration of pre-charging phase t1 is the shortest, and the impact on the time of duration of display phase t2 is the weakest, thereby reducing the response time of liquid crystal and ensuring the display time, and further improving the display quality.

[0073] In the embodiments of the present application, as shown in FIG. **7**, the pre-charging control modules **10** disposed in the three gate driving unit groups **30** arranged at intervals are sequentially turned on under the control of the pre-charging control signals Cont (1, 3, 5 . . .) outputted from the pre-charging control signal terminal Cont, that is, the time of the pre-charging control modules **10** disposed in the three gate driving unit groups **30** being turned on are different. With this design, the loading of the pre-charging control signal terminal Cont is reduced, the stability of the pre-

charging voltage outputted by a plurality of the pre-charging control modules **10** disposed in each gate driving unit group **30** is ensured, thereby ensuring the pre-charging effect, reducing the response time of the liquid crystal and improving the display quality.

[0074] In the embodiments of the present application, as shown in FIG. **8**, the pre-charging control modules **10** disposed in two of three gate driving unit groups **30** arranged at intervals are simultaneously turned on under the control of the pre-charging control signals Cont (1, 3, . . .) outputted from the pre-charging control signal terminal Cont, and the pre-charging control modules **10** disposed in the other two of three gate driving unit groups **30** arranged at intervals are sequentially turned on under the control of the pre-charging control signals Cont (3, 5 . . .) outputted from the pre-charging control signal terminal Cont. It should be noted that, the time of duration of the pre-charging control signals Cont outputted by the pre-charging control module **10** corresponding to the plurality of gate driving units disposed in the plurality of gate driving unit groups **30** can also be different. Specifically, the time of duration can be determined according to the difference between the grayscale values of the previous sub-frame image and the grayscale values of the next sub-frame image. If the grayscale value difference between the two sub-frame images is larger, the time of duration of the pre-charging control signals Cont outputted by the pre-charging control module **10** is longer, and vice versa is shorter, thereby reducing the response time of liquid crystal shifting caused by sub-frame images switching, and improving the display quality.

[0075] Refer to FIG. **9**, compared with the display panel **100**, the display panel **200** provided in the present application further includes a judging unit **40** electrically connected with the pre-charging control module **10**. The judging unit **40** is configured to turn on or turn off the pre-charging control module **10** according to the difference of the driving voltages of the scanning signal output terminal Gout of the present stage outputted from the corresponding gate driving units disposed in the adjacent two gate driving unit groups **30**.

[0076] In the embodiments of the present application, if the grayscale values of the adjacent sub-frame images are changing greatly, such as the black-and-white images switching, the difference between the driving voltages outputted by the gate driving units disposed in the adjacent two gate driving unit groups **30** corresponding to the sub-frame images to the corresponding scanning signal output terminal Gout of the present stage is large. Then, in the pre-charging phase t1, a plurality of the pre-charging control modules **10** disposed in the gate driving unit group **30** corresponding to adjacent sub-frames are turned on under the control of the pre-charging control signals Cont outputted from a pre-charging control signal terminal Cont, and output the pre-charging control signals Cont to the scanning signal output terminal Gout of the present stage, to buffer the grayscale value changes between adjacent sub-frame images, thereby minimizing the difference between the grayscale values of the previous sub-frame image and the grayscale values of the next sub-frame image, and further reducing the response time of liquid crystal shifting caused by sub-frame images switching and improving the display quality. On the contrary, if the grayscale values between adjacent sub-frame images changes little or the image is still, the pre-charging control modules **10** are turned off, that is, the pre-charging control signals Cont are not outputted.

[0077] The present application also provides a driving method for driving the display panel as described above, a frame driving period includes a pre-charging phase t1, a display phase t2, and a blanking phase t3.

[0078] In the pre-charging phase t1, the pre-charging control module **10** is turned on and outputs the pre-charging control signals Cont to the scanning signal output terminal Gout.

[0079] In the embodiments of the present application, the display panel includes a plurality of data lines D (1, 2, 3 . . .), a plurality of pixel units P, and a plurality of gate driving units connected in cascade. The gate driving unit includes a pre-charging control module **10** and a driving module **20**. The pre-charging control module **10** is electrically connected with the pre-charging control signal terminal Cont and the scanning signal output terminal Gout of the present stage, the pre-charging control module **10** is configured to output the pre-charging control signals Cont to the scanning

signal output terminal Gout of the present stage. The driving module **20** is electrically connected with the cascade control signal terminals CK/XCK/STV, the pre-charging control module **10** and the scanning signal output terminal Gout of the present stage. The driving module **20** is configured to output the driving signals to the scanning signal output terminal Gout of the present stage and the gate driving unit of the subsequent stage after the data lines D (1, 2, 3 . . .) complete the output of the pre-charging voltages. Then the data lines D (1, 2, 3 . . .) output data voltages to the corresponding pixel units P.

[0080] In the embodiments of the present application, a frame image includes a plurality of sub-frame images, such as red sub-frame images, green sub-frame images and blue sub-frame images. The pre-charging phase t₁ is arranged before the display phase t₂. The pre-charging control module **10** is configured to output the pre-charging control signals Cont to the scanning signal output terminal Gout of the present stage in the pre-charging phase t₁ to buffer the grayscale value changes between two adjacent sub-frame images, thereby minimizing the difference between the grayscale values of the previous sub-frame image and the grayscale values of the next sub-frame image, and further reducing the response time of liquid crystal shifting caused by sub-frame images switching and improving the display quality.

[0081] In the embodiments of the present application, a plurality of the gate driving units connected in cascade are divided into a plurality of the gate driving unit groups **30**. The gate driving unit includes a pre-charging control module **10**. A plurality of the pre-charging control modules **10** disposed in the same gate driving unit group **30** are electrically connected with a same pre-charging control signal terminal Cont. The time of a plurality of the pre-charging control modules **10** disposed in the same gate driving unit group **30** being turned on are the same, and the time of duration of a plurality of the pre-charging control modules **10** disposed in the same gate driving unit group **30** being turned on are the same.

[0082] In the embodiments of the present application, preferably, the time of duration of a plurality of the pre-charging control modules **10** disposed in different gate driving unit groups **30** outputting the pre-charging control signals Cont to the corresponding scanning signal output terminal Gout are the same. A plurality of the pre-charging control modules **10** disposed in different gate driving unit groups **30** are simultaneously turned on or sequentially turned on under the control of the pre-charging control signals Cont outputted from a pre-charging control signal terminal Cont. A plurality of the gate driving unit groups **30** are arranged continuously or arranged at intervals.

[0083] In the display phase t₂, the driving module **20** is turned on under the control of the cascade control signals CK/XCK/STV outputted from the cascade control signal terminals CK/XCK/STV, the pre-charging control module **10** is turned off, and the driving module **20** outputs driving signals to the scanning signal output terminal Gout of the present stage and the gate driving unit of the subsequent stage.

[0084] An image with fixed grayscale values is arranged in the blanking phase t₃, such as the phase between two frames of image, to accelerate the speed of the liquid crystal reaching a preset state.

[0085] On the other hand, the present application provides a display device including the display panel as described above. The display device further includes a driving circuit disposed in the display panel, the driving circuit is configured to drive the display panel.

[0086] In the display panel and the display device provided in the embodiments of the present application, the display panel includes a plurality of data lines D (1, 2, 3 . . .), a plurality of pixel units P, and a plurality of gate driving units connected in cascade. A plurality of the pixel units P are electrically connected with the data lines D (1, 2, 3 . . .). At least one gate driving unit includes a pre-charging control module, the pre-charging control module is electrically connected with a pre-charging control signal terminal and a scanning signal output terminal of the present stage. The pre-charging control module outputs pre-charging control signals to the scanning signal output terminal of the present stage, and the data lines D (1, 2, 3 . . .) output pre-charging control signals Cont to the corresponding pixel units P. By providing the pre-charging control module to output the pre-

charging control signals to the scanning signal output terminal of the present stage, pre-charging the pixel units P corresponding to at least one the gate driving unit before images displaying can be realized, thereby reducing the response time of the liquid crystal and improving the problem of abnormal color mixing of image displayed with field sequence display method.

[0087] A display panel and a display device provided in the embodiments of the present application are described in detail above. The principle and implementation method of the present application are described with specific embodiments herein. The above embodiments are for understanding the method and the core idea of the present application only. Those skilled in the art can make changes in the specific implementation method and application scope according to the idea of the present application. The description of the present specification should not be considered as a limitation to the present application.

Claims

1. A display panel comprising: a plurality of data lines; a plurality of pixel units electrically connected with the data lines; and a plurality of gate driving units connected in cascade; wherein at least one of the gate driving units comprises a pre-charging control module, electrically connected with a pre-charging control signal terminal and a scanning signal output terminal of the present stage, to output pre-charging control signals to the scanning signal output terminal of the present stage; and the data lines are configured to output pre-charging control signals to the corresponding pixel units.
2. The display panel according to claim 1, wherein the plurality of the gate driving units comprise a plurality of gate driving unit groups, each of the gate driving units comprising a pre-charging control module, and a plurality of the pre-charging control modules disposed in a gate driving unit group are electrically connected with a same pre-charging control signal terminal.
3. The display panel according to claim 2, wherein a plurality of the pre-charging control modules disposed in different gate driving unit groups are simultaneously turned on under a control of the pre-charging control signal outputted from the pre-charging control signal terminal.
4. The display panel according to claim 2, wherein a plurality of the pre-charging control modules disposed in different gate driving unit groups are sequentially turned on under the control of a plurality of the pre-charging control signals outputted from a plurality of the pre-charging control signal terminals.
5. The display panel according to claim 2, wherein a plurality of the pre-charging control modules disposed in at least two gate driving unit groups arranged at intervals are simultaneously turned on under the control of the pre-charging control signal outputted from the pre-charging control signal terminal, or a plurality of the pre-charging control modules disposed in at least two gate driving unit groups arranged at intervals are sequentially turned on under the control of the pre-charging control signals outputted from the pre-charging control signal terminals.
6. The display panel according to claim 2, wherein the pixel units corresponding to different gate driving unit groups are pre-charged in the same time period.
7. The display panel according to claim 1, wherein the gate driving unit further comprises a driving module, electrically connected with the cascade control signal terminal, the pre-charging control module and the scanning signal output terminal of the present stage; the driving module is configured to output driving signals to the scanning signal output terminal of the present stage and the gate driving unit of the subsequent stage after the data lines complete the output of the pre-charging voltage, and the data lines are configured to output the data voltages to the corresponding pixel units.
8. The display panel according to claim 7, wherein a peak value of the pre-charging voltages ranges between 50% and 90% of a peak value of the data voltages.
9. The display panel according to claim 7, wherein the display panel further comprises a judging

unit electrically connected with the pre-charging control module and the data lines; the judging unit is configured to control the pre-charging control module to turn off when the difference value of the data voltages outputted from the data lines to the pixel units corresponding to the adjacent two gate driving unit groups is smaller than or equal to a predetermined threshold value, and configured to control the pre-charging control module to turn on when the difference value of the data voltages outputted from the data lines to the pixel units corresponding to the adjacent two gate driving unit groups is greater than the predetermined threshold value.

10. The display panel according to claim 2, wherein the plurality of the gate driving units connected in cascade comprise N gate driving unit groups; where $X \leq K \leq X * N$, and $K \leq T * 30\%$, X is a scanning time of a row of pixel units P, K is a total pre-charging time corresponding to a plurality of the gate driving unit groups, T is a display time of a frame of image, N is a positive integer and X, K and T are positive numbers.

11. The display panel according to claim 1, further comprising a plurality of sub-backlight regions disposed along the direction of the scanning line and disposed corresponding to the gate driving unit group, the pre-charging voltages for the pixel units corresponding to the sub-backlight regions are negatively correlated with the brightness of the sub-backlight regions.

12. A display device comprising: a display panel; and a driving circuit disposed on the display panel, wherein the display panel comprises: a plurality of data lines; a plurality of pixel units electrically connected with the data lines; and a plurality of gate driving units connected in cascade; wherein at least one of the gate driving units comprises a pre-charging control module, electrically connected with a pre-charging control signal terminal and a scanning signal output terminal of the present stage, to output pre-charging control signals to the scanning signal output terminal of the present stage; and the data lines are configured to output pre-charging control signals to the corresponding pixel units.

13. The display device according to claim 12, wherein the plurality of the gate driving units comprise a plurality of gate driving unit groups, each of the gate driving units comprising a pre-charging control module, and a plurality of the pre-charging control modules disposed in a gate driving unit group are electrically connected with a same pre-charging control signal terminal.

14. The display device according to claim 13, wherein a plurality of the pre-charging control modules disposed in different gate driving unit groups are simultaneously turned on under a control of the pre-charging control signal outputted from the pre-charging control signal terminal.

15. The display device according to claim 13, wherein a plurality of the pre-charging control modules disposed in different gate driving unit groups are sequentially turned on under the control of a plurality of the pre-charging control signals outputted from a plurality of the pre-charging control signal terminals.

16. The display device according to claim 13, wherein a plurality of the pre-charging control modules disposed in at least two gate driving unit groups arranged at intervals are simultaneously turned on under the control of the pre-charging control signal outputted from the pre-charging control signal terminal, or a plurality of the pre-charging control modules disposed in at least two gate driving unit groups arranged at intervals are sequentially turned on under the control of the pre-charging control signals outputted from the pre-charging control signal terminals.

17. The display device according to claim 13, wherein the pixel units corresponding to different gate driving unit groups are pre-charged in the same time period.

18. The display device according to claim 12, wherein the gate driving unit further comprises a driving module, electrically connected with the cascade control signal terminal, the pre-charging control module and the scanning signal output terminal of the present stage; the driving module is configured to output driving signals to the scanning signal output terminal of the present stage and the gate driving unit of the subsequent stage after the data lines complete the output of the pre-charging voltage, and the data lines are configured to output the data voltages to the corresponding pixel units.

19. The display device according to claim 18, wherein a peak value of the pre-charging voltages ranges between 50% and 90% of a peak value of the data voltages.

20. The display device according to claim 18, wherein the display panel further comprises a judging unit electrically connected with the pre-charging control module and the data lines; the judging unit is configured to control the pre-charging control module to turn off when the difference value of the data voltages outputted from the data lines to the pixel units corresponding to the adjacent two gate driving unit groups is smaller than or equal to a predetermined threshold value, and configured to control the pre-charging control module to turn on when the difference value of the data voltages outputted from the data lines to the pixel units corresponding to the adjacent two gate driving unit groups is greater than the predetermined threshold value.
