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Yang et al.(54) **DRIVING METHOD OF AN ORGANIC
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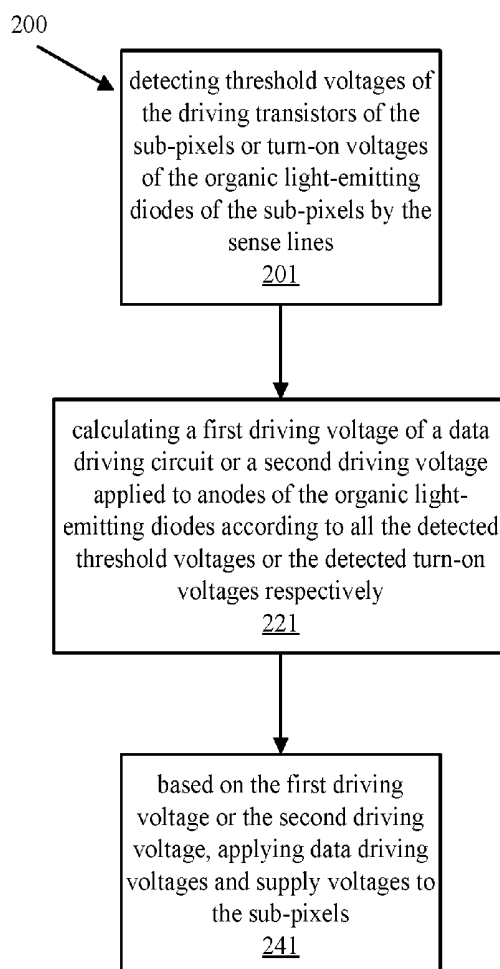
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ABSTRACT

A driving method of an organic light-emitting display device, the display device includes a plurality of sub-pixels, each of the sub-pixels includes a driving transistor, an organic light-emitting diode and a sense line connected to the driving transistor and the organic light-emitting diode, the method includes: detecting threshold voltages of driving transistors of the sub-pixels or turn-on voltages of organic light-emitting diodes of the sub-pixels by sense lines; calculating a first driving voltage of a data driving circuit or a second driving voltage applied to anodes of the organic light-emitting diodes according to all detected threshold voltages or detected turn-on voltages respectively; and based on the first driving voltage or the second driving voltage, applying data driving voltages and supply voltages to the sub-pixels.



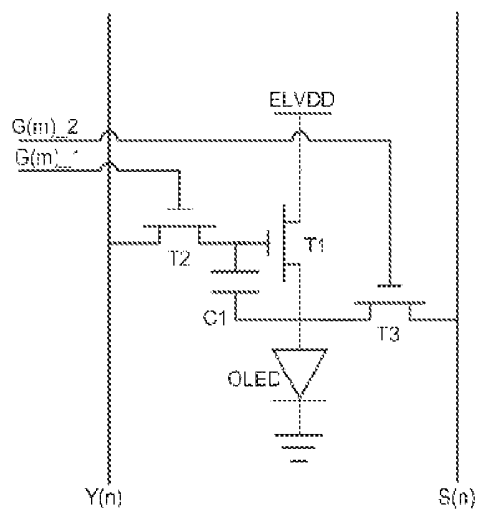


Fig. 1A

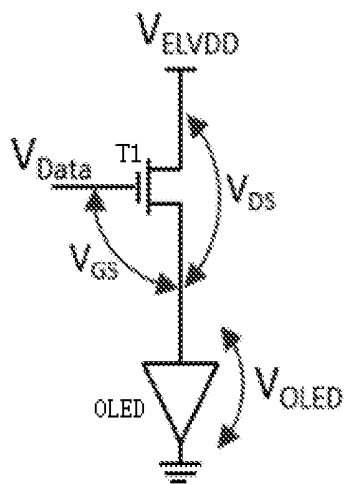


Fig. 1B

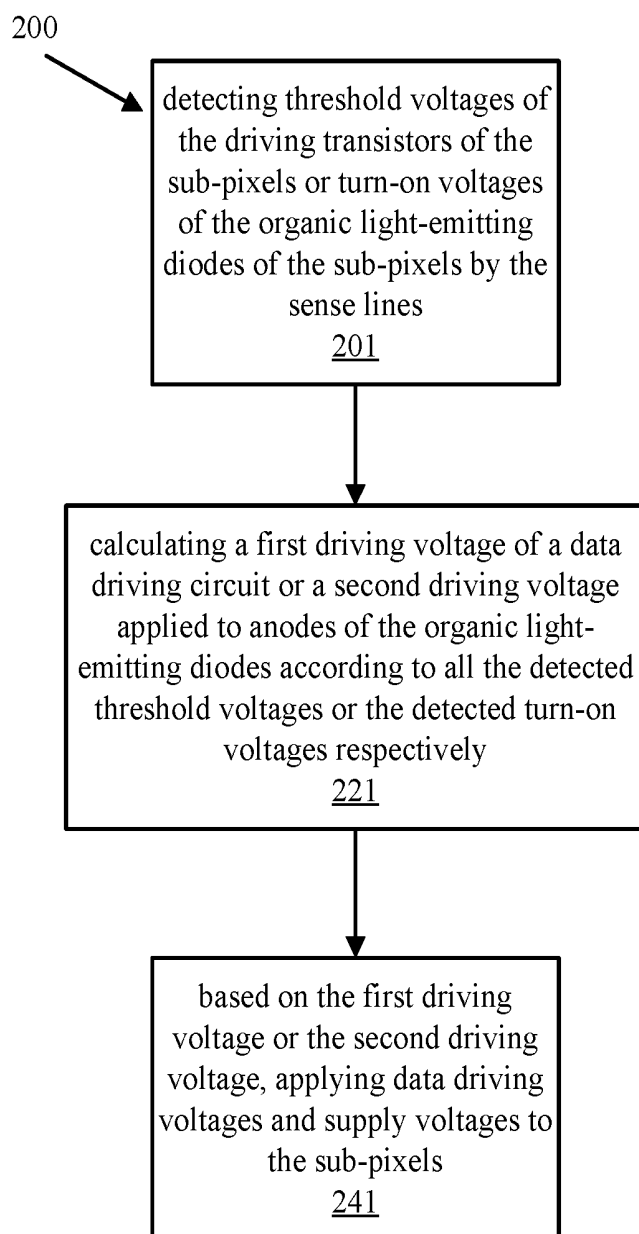


Fig. 2

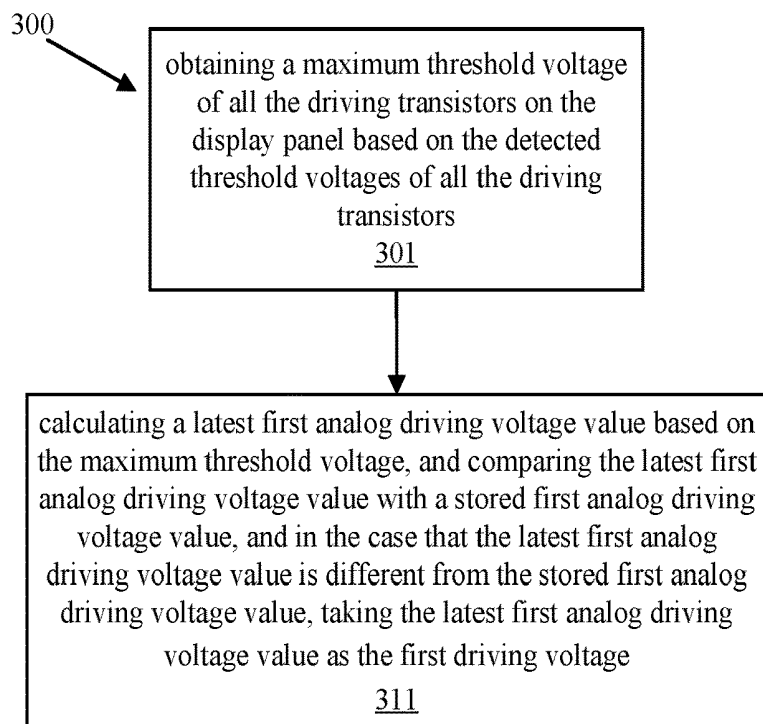


Fig. 3

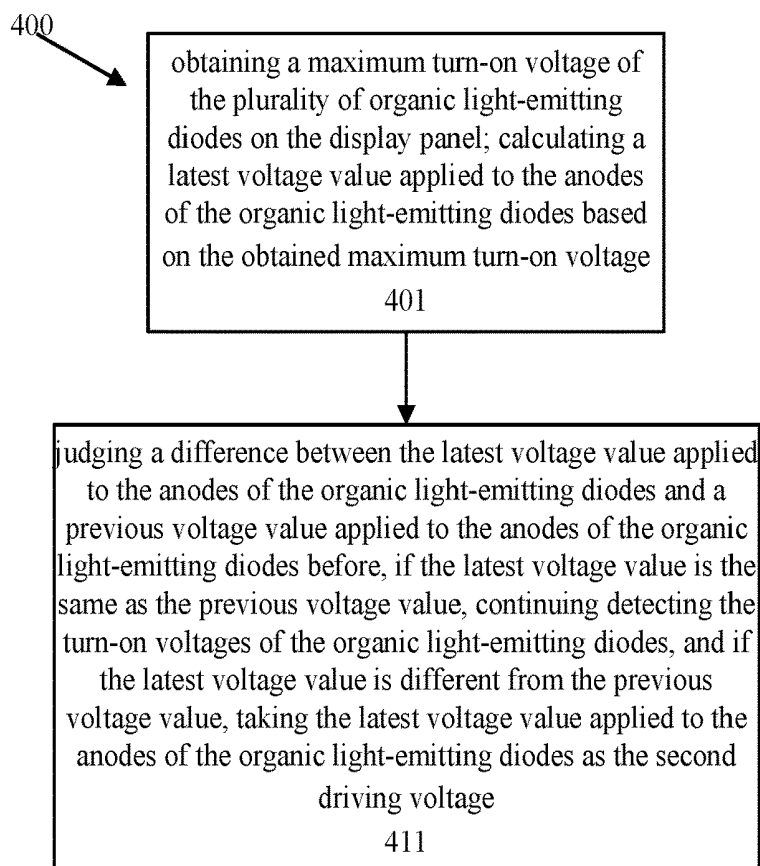


Fig. 4

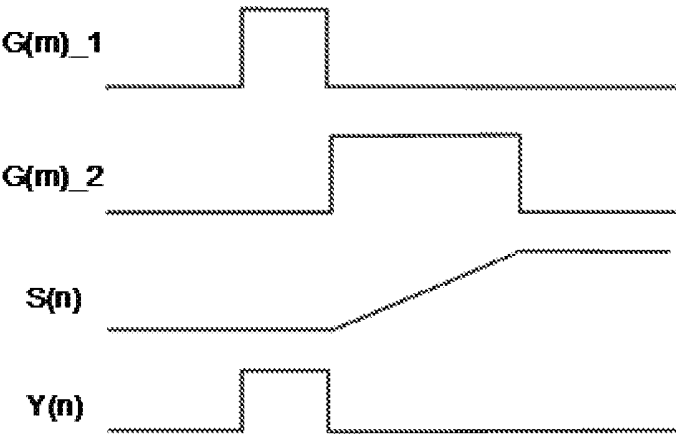


Fig. 5A

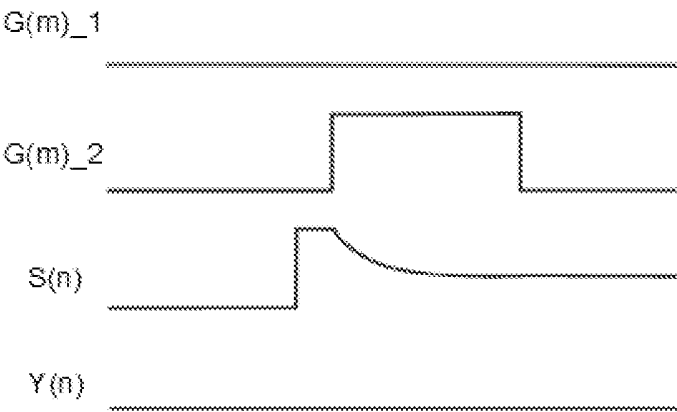


Fig. 5B

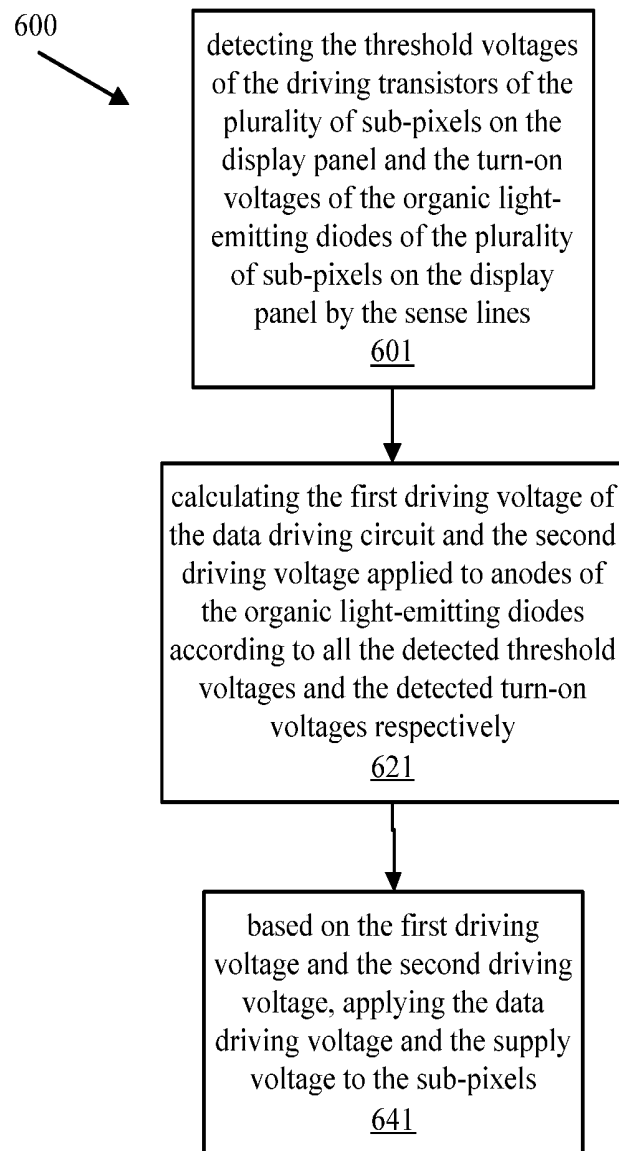


Fig. 6

DRIVING METHOD OF AN ORGANIC LIGHT-EMITTING DISPLAY DEVICE

TECHNICAL FIELD

[0001] Embodiments of the present disclosure relate to a driving method of an organic light-emitting display device.

BACKGROUND

[0002] At present, human beings not only have a high demand for appearance and quality of a product, but also pay more attention to the price and practicability of the product. In the display field, especially in the organic light-emitting diode (OLED) display field, due to factors such as the instability of a driving transistor and the aging of the OLED, for the same image data voltage, the currents flowing through the OLED are different at different times, so that the display panel has non-uniform brightness as a whole or presents ghost.

SUMMARY

[0003] At least one embodiment of the present disclosure provides a driving method of an organic light-emitting display device, the display device comprises a plurality of sub-pixels, each of the sub-pixels comprises a driving transistor, an organic light-emitting diode and a sense line connected to the driving transistor and the organic light-emitting diode, the method comprises: detecting threshold voltages of driving transistors of the sub-pixels or turn-on voltages of organic light-emitting diodes of the sub-pixels by sense lines; calculating a first driving voltage of a data driving circuit or a second driving voltage applied to anodes of the organic light-emitting diodes according to all detected threshold voltages or detected turn-on voltages respectively; and based on the first driving voltage or the second driving voltage, applying data driving voltages and supply voltages to the sub-pixels.

[0004] For instance, in some embodiments of the method, detecting the threshold voltages of the driving transistors of the sub-pixels by the sense lines comprises: writing an image data voltage to gate electrodes of the driving transistors; and reading stable voltages of the sense lines, calculating values of the threshold voltages of the driving transistors based on the stable voltages.

[0005] For instance, in some embodiments of the method, calculating the first driving voltage of the data driving circuit according to all the detected threshold voltages comprises: obtaining a maximum threshold voltage of all the driving transistors on the display panel based on the detected threshold voltages of all the driving transistors.

[0006] For instance, in some embodiments of the method, a latest first analog driving voltage value is calculated based on the maximum threshold voltage, the latest first analog driving voltage value is compared with a stored first analog driving voltage value, and in a case that the latest first analog driving voltage value is different from the stored first analog driving voltage value, the latest first analog driving voltage value is taken as the first driving voltage.

[0007] For instance, in some embodiments of the method, calculating the latest first analog driving voltage value based on the maximum threshold voltage comprises: obtaining a corresponding image data voltage when all the organic light-emitting diodes on the display panel produce a maximum brightness; obtaining a first difference; and calculating

a sum of the corresponding image data voltage, the first difference and the maximum threshold voltage, and taking a calculated result as the first driving voltage.

[0008] For instance, in some embodiments of the method, the driving method of the organic light-emitting display device further comprises: in the case that the latest first analog driving voltage value is the same as the stored first analog driving voltage value, continuing to detect the threshold voltages of the driving transistors on the display panel.

[0009] For instance, in some embodiments of the method, the first driving voltage is transmitted to a voltage generating circuit of the data driving circuit by a TTL signal, an I2C signal or a differential signal.

[0010] For instance, in some embodiments of the method, the driving method of the organic light-emitting display device further comprises: detecting whether a command of closing a detecting process is received or not, and if the command is received, closing the detecting process; otherwise, continuing to detect the threshold voltages of the driving transistors on the display panel.

[0011] For instance, in some embodiments of the method, detecting the turn-on voltages of the organic light-emitting diodes of the sub-pixels by the sense lines comprises: applying a preset voltage to the organic light-emitting diodes to make the organic light-emitting diodes turn on; and reading stable voltages on the sense lines, calculating the turn-on voltages of the organic light-emitting diodes based on the stable voltages.

[0012] For instance, in some embodiments of the method, calculating the second driving voltage of the anodes of the organic light-emitting diodes according to all the detected turn-on voltages comprises: obtaining a maximum turn-on voltage of the plurality of organic light-emitting diodes on the display panel; calculating a latest voltage value applied to the anodes of the organic light-emitting diodes based on the maximum turn-on voltage that is obtained.

[0013] For instance, in some embodiments of the method, the method further comprises: determining a difference between the latest voltage value applied to the anodes of the organic light-emitting diodes and a previous voltage value applied to the anodes of the organic light-emitting diodes before, if the latest voltage value is the same as the previous voltage value, continuing to detect the turn-on voltages of the organic light-emitting diodes, and if the latest voltage value is different from the previous voltage value, taking the latest voltage value applied to the anodes of the organic light-emitting diodes as the second driving voltage.

[0014] For instance, in some embodiments of the method, calculating the latest voltage value applied to the anodes of the organic light-emitting diodes based on the obtained maximum turn-on voltage comprises: obtaining a corresponding light-emitting supply voltage when the organic light-emitting diodes on the display panel produce a maximum brightness; obtaining a second difference; and calculating a sum of the corresponding light-emitting supply voltage, the second difference and the maximum turn-on voltage, taking a calculated result as a latest ELVDD value.

[0015] For instance, in some embodiments of the method, the driving method of the organic light-emitting display device further comprises: in the case that the latest voltage value applied to the anodes of the organic light-emitting diodes is the same as the previous voltage value applied to

the anodes of the organic light-emitting diodes before, continuing to detect the turn-on voltages of the organic light-emitting diodes.

[0016] For instance, in some embodiments of the method, the second driving voltage is transmitted to a voltage generating circuit by a TTL signal, an I2C signal or a differential signal.

[0017] For instance, in some embodiments of the method, the driving method of the organic light-emitting display device further comprises: detecting whether a command of closing a detecting process is received or not, if the command is received, closing the detecting process; otherwise, continuing to detect the turn-on voltages of all the organic light-emitting diodes on the display panel.

[0018] For instance, in some embodiments of the method, the driving method of the organic light-emitting display device comprises: detecting the threshold voltages of the driving transistors of the sub-pixels on the display panel and the turn-on voltages of the organic light-emitting diodes of the sub-pixels on the display panel by the sense lines; calculating the first driving voltage of the data driving circuit and the second driving voltage applied to anodes of the organic light-emitting diodes according to all the detected threshold voltages and the detected turn-on voltages respectively; and based on the first driving voltage and the second driving voltage, applying the data driving voltages and the supply voltages to the sub-pixels.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] In order to clearly illustrate the technical solution of the embodiments of the present disclosure, the drawings of the embodiments will be briefly described in the following; it is obvious that the described drawings are only related to some embodiments of the present disclosure and thus are not limitative of the present disclosure.

[0020] FIG. 1A is a schematic diagram of a sub-pixel driving circuit provided by an embodiment of the present disclosure;

[0021] FIG. 1B is an enlarged schematic diagram of a driving transistor and an OLED of a sub-pixel driving circuit provided by an embodiment of the present disclosure;

[0022] FIG. 2 is a flow chart of a driving method of an organic light-emitting display device provided by an embodiment of the present disclosure;

[0023] FIG. 3 is a flow chart of another driving method of an organic light-emitting display device provided by an embodiment of the present disclosure;

[0024] FIG. 4 is a flow chart of further another driving method of an organic light-emitting display device provided by an embodiment of the present disclosure;

[0025] FIG. 5A is an oscillogram when detecting a threshold voltage of a driving transistor provided by an embodiment of the present disclosure;

[0026] FIG. 5B is an oscillogram when detecting a turn-on voltage of an organic light-emitting diode provided by an embodiment of the present disclosure; and

[0027] FIG. 6 is a flow chart of another driving method of an organic light-emitting display device provided by an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0028] In order to make objects, technical details and advantages of the embodiments of the disclosure apparent,

the technical solutions of the embodiments will be described in a clearly and fully understandable way in connection with the drawings related to the embodiments of the disclosure. Apparently, the described embodiments are just a part but not all of the embodiments of the disclosure. Based on the described embodiments herein, those skilled in the art can obtain other embodiment(s), without any inventive work, which should be within the scope of the disclosure.

[0029] Unless otherwise defined, all the technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art to which the present disclosure belongs. The terms “first,” “second,” etc., which are used in the present disclosure, are not intended to indicate any sequence, amount or importance, but distinguish various components. The terms “comprise,” “include,” etc., are intended to specify that the elements or the objects stated before these terms encompass the elements or the objects and equivalents thereof listed after these terms, but do not preclude the other elements or objects. The phrases “connect”, “connected”, etc., are not intended to define a physical connection or mechanical connection, but may include an electrical connection, directly or indirectly.

[0030] The method provided by each of following embodiments, which can reduce power consumption, may be applied to a driving structure of an external compensation organic light-emitting sub-pixel circuit, and the driving structure may refer to FIG. 1A. FIG. 1A takes a sub-pixel in row m and column n as an example to describe, each of the sub-pixels comprises a driving transistor T1, a scan switch transistor T2, a sense switch transistor T3, a capacitor C1, a data line Y(n), a sense line S(n), a first scan line G(m)_1, a second scan line G(m)_2, a power line ELVDD and an OLED device. However, those skilled in the art should be understood that the present disclosure is not limited to the specific sub-pixel circuit illustrated in FIG. 1A, and the sub-pixel circuit of an embodiment of present disclosure may also have other structures, provided that the sub-pixel circuit can sense the related characteristics of the driving transistor and/or the OLED device.

[0031] Referring to FIG. 1A, the exemplary OLED pixel circuit 100 comprises an OLED pixel driving circuit and an organic light emitting diode (OLED). The organic light emitting diode emits light according to an electrical current flowing through the driving transistor T1. The anode of the organic light emitting diode may be connected to a source electrode of the driving transistor T1, and the cathode of the OLED may be grounded.

[0032] The organic light emitting diode may comprise the anode, a hole transport layer, an organic light-emitting layer, an electron transport layer, and the cathode. If a voltage is applied across the anode and the cathode of the organic light emitting diode, holes and electrons are injected and moved to the organic light-emitting layer through the hole transport layer and the electron transport layer respectively, and are recombined with each other in the organic light-emitting layer so as to excite to emit light.

[0033] The driving transistor T1 is disposed between a first power line ELVDD and the organic light emitting diode. The driving transistor T1 controls the electrical current, which flows from the first power line ELVDD to the OLED, according to a voltage difference applied between the gate electrode and the source electrode of the driving transistor T1. The gate electrode of the driving transistor T1 may be

connected to a first electrode of the scan switch transistor T2, the source electrode of the driving transistor T1 may be connected to the anode of the organic light emitting diode, and the drain electrode of the driving transistor T1 may be connected to the first power line ELVDD which is applied with a first supply voltage.

[0034] The gate electrode of the scan switch transistor T2 is connected to the M^{th} first scan line G(m)_1, and thus the scan switch transistor T2 can be switched on or off by a scan pulse over the first scan line G(m)_1, so as to transfer an image data voltage over the N^{th} data line Y(n) to the gate electrode of the driving transistor T1. The first electrode (such as a drain electrode) of the scan switch transistor T2 may be connected to the gate electrode of the driving transistor T1, and a second electrode (such as a source electrode) of the scan switch transistor T2 may be connected to the N^{th} data line Y(n).

[0035] The gate electrode of the sense switch transistor T3 is connected to the M^{th} second scan line G(m)_2, and thus the sense switch transistor T3 can be switched on or off by a sense pulse over the second scan line G(m)_2, so as to connect the N^{th} sense line S(n) to the source electrode of the driving transistor T1. The first electrode (such as a source electrode) of the sense switch transistor T3 may be connected to the N^{th} sense line S(n), and the second electrode (such as a drain electrode) of the sense switch transistor T3 may be connected to the source electrode of the driving transistor T1.

[0036] The capacitor C1 is provided between the gate electrode and the source electrode of the driving transistor T1. The capacitor C1 stores the voltage difference between the gate electrode and the source electrode of the driving transistor T1.

[0037] As illustrated in FIG. 1A, the driving transistor T1, the scan switch transistor T2, the sense switch transistor T3 can be formed by an N type MOSFET (metal oxide semiconductor field effect transistor), but this arrangement is not limitative herein. In another example, the driving transistor T1, the scan switch transistor T2, the sense switch transistor T3 can be formed by a P type MOSFET. In addition, it should be noted that, as for the above mentioned transistor T2 and T3, one of the first electrode and the second electrode may be a source electrode, and correspondingly the other one may be a drain electrode.

[0038] In an organic light-emitting display device, a cross voltage may be changed due to factors such as the instability of a driving transistor and/or the aging of the organic light-emitting diode (OLED), even for the same light-emitting supply voltage, the currents flowing through the same OLED may be different at different times, so that the display panel has non-uniform brightness or presents ghost.

[0039] FIG. 1B is an enlarged schematic diagram of a driving transistor and an OLED of an exemplary sub-pixel driving circuit provided by the present embodiment. Referring to FIG. 1B, a threshold voltage of the driving transistor T1 of the organic light-emitting sub-pixel driving circuit is V_{th} , a gate voltage of the driving transistor T1 is V_{Data} , a drain voltage of the driving transistor T1 is V_{ELVDD} , and the cross voltage (namely the turn-on voltage) of the OLED is V_{OLED} . In operation of the organic light-emitting display device, the driving transistor T1 is required to work in a saturation region (the saturation region includes a constant

current region and an amplification region), and the condition, that a driving transistor works in the saturation region, is as follows:

$$V_{GS} \geq V_{th}, \text{ and } V_{DS} \geq V_{GS} - V_{th}$$

where $V_{GS} = V_{Data}$, $V_{DS} = V_{ELVDD} - V_{OLED}$.

[0040] From the above formula, it should be understood that if the value of the threshold voltage V_{th} of the driving transistor T1 is changed, the condition that the driving transistor T1 works in the saturation region can be satisfied by changing value of the image data voltage V_{Data} . If the turn-on voltage of the OLED device is changed, the condition that the driving transistor T1 works in the saturation region can be satisfied by changing value of the V_{ELVDD} applied to the anode of the organic light-emitting diode.

[0041] In an organic light-emitting display device, in order to ensure that, for the same image data voltage, the currents flowing through the OLED device are the same at different times, if the threshold voltage V_{th} of the driving transistor T1 positively shifts, then the value of the input image data voltage V_{Data} is increased. If the threshold voltage V_{th} of the driving transistor T1 negatively shifts, then the value of the input image data voltage V_{Data} is reduced. In a source driver chip, the different image data voltage V_{Data} values may be generated according to an analog driving voltage AVDD and image data, and the value of the analog driving voltage AVDD must be greater than the value of the image data voltage $V_{Data_{max}}$, the value of which makes the OLED device produce the required maximum brightness. If the threshold voltage V_{th} of the driving transistor T1 is changed, the value of the $V_{Data_{max}}$ is also changed, so that the value of the analog driving voltage AVDD needs to be changed correspondingly; finally the value of the analog driving voltage AVDD is optimal at all times, so as to achieve the purpose that the OLED display device reduces the power consumption under the initial circumstance.

[0042] In addition, in an OLED display device, the turn-on voltage V_{OLED} of the OLED generally increases due to the aging of the OLED device. In order to ensure that the driving transistor works in the saturation region (namely $V_{DS} \geq V_{GS} - V_{th}$), the voltage V_{ELVDD} applied to the anode of the organic light-emitting diode needs to be improved. Finally, the value of the V_{ELVDD} is optimal at all times, so as to achieve the purpose that the OLED display device reduces the power consumption under the initial circumstance.

[0043] The driving method of the organic light-emitting display device provided by embodiments of the present disclosure is described in detail below in combination with FIG. 2-FIG. 7 and the above mentioned sub-pixel circuit.

[0044] FIG. 2 is a flow chart of a driving method of an organic light-emitting display device provided by an embodiment of the present disclosure, for instance, here the organic light-emitting display device comprises a plurality of sub-pixels 100 as illustrated in FIG. 1A, each of the sub-pixels 100 comprises a driving transistor, an organic light-emitting diode, and a sense line connected to the driving transistor and the organic light-emitting diode (the specific structure can be referred to the description in FIG. 1A), the driving method 200 comprises the following steps:

[0045] Step 201, detecting threshold voltages of the driving transistors of the sub-pixels or turn-on voltages of the organic light-emitting diodes of the sub-pixels by the sense lines;

[0046] Step 221, calculating a first driving voltage of a data driving circuit or a second driving voltage applied to anodes of the organic light-emitting diodes according to all the detected threshold voltages or the detected turn-on voltages respectively; and

[0047] Step 241, based on the first driving voltage or the second driving voltage, applying data driving voltages and supply voltages to the sub-pixels.

[0048] In some embodiments, for instance, detecting the threshold voltages of the driving transistors of the sub-pixels may comprise: writing image data voltages to gate electrodes of the driving transistors; and reading stable voltages of the sense lines, calculating the values of the threshold voltages of the driving transistors based on the stable voltages.

[0049] FIG. 3 a flow chart of another driving method of an organic light-emitting display device provided by an embodiment of the present disclosure. The driving method 300 of the organic light-emitting display device is a method for obtaining the first driving voltage, which is involved in the driving method 200 as illustrated in FIG. 2. The driving method 300 comprises the following steps:

[0050] Step 301, obtaining a maximum threshold voltage of all the driving transistors on the display panel based on the detected threshold voltages of all the driving transistors.

[0051] Step 311, calculating a latest first analog driving voltage value based on the maximum threshold voltage, and comparing the latest first analog driving voltage value with a stored first analog driving voltage value, in the case that the latest first analog driving voltage value is different from the stored first analog driving voltage value, taking the latest first analog driving voltage value as the first driving voltage.

[0052] In an example, calculating the latest first analog driving voltage value based on the maximum threshold voltage may comprise: obtaining a corresponding image data voltage when all the organic light-emitting diodes on the display panel produce the maximum brightness; obtaining a first difference; and calculating the sum of the corresponding image data voltage, the first difference and the maximum threshold voltage, taking a calculated result as the first driving voltage.

[0053] In an example, the driving method 300 of the organic light-emitting display device further comprises (not shown in figure): in the case that the latest first analog driving voltage value is the same as the stored first analog driving voltage value, continuing to detect the threshold voltages of the driving transistors on the display panel.

[0054] For instance, according to the circuit and signal design of the specific organic light-emitting display device, the first driving voltage is transmitted to a voltage generating circuit of the data driving circuit in a form such as TTL signal, I2C signal or differential signal, and etc.

[0055] In an example, the driving method of the organic light-emitting display device further comprises (not shown in figure): detecting whether a command of closing a detecting process is received or not, and if the command is received, closing the detecting process; otherwise, continuing to detect the threshold voltages of the driving transistors on the display panel.

[0056] In an example, steps of detecting the turn-on voltages of the organic light-emitting diodes of the sub-pixels by the sense lines may comprise: applying a preset voltage to the organic light-emitting diodes to make the organic light-emitting diodes turn on; and reading the stable voltages over

the sense lines, and calculating the turn-on voltages of the organic light-emitting diodes based on the stable voltages.

[0057] FIG. 4 is a flow chart of another driving method of an organic light-emitting display device provided by an embodiment of the present disclosure. The driving method 400 of the organic light-emitting display device is a method for obtaining the second driving voltage, which is involved in the driving method 200 as illustrated in FIG. 2. The driving method 400 comprises the following steps:

[0058] Step 401, obtaining a maximum turn-on voltage of the plurality of organic light-emitting diodes on the display panel; calculating a latest voltage value applied to the anodes of the organic light-emitting diodes based on the obtained maximum turn-on voltage.

[0059] Step 411, determining a difference between the latest voltage value applied to the anodes of the organic light-emitting diodes and a previous voltage value applied to the anodes of the organic light-emitting diodes before, if the latest voltage value is the same as the previous voltage value, continuing to detect the turn-on voltages of the organic light-emitting diodes, and if the latest voltage value is different from the previous voltage value, taking the latest voltage value applied to the anodes of the organic light-emitting diodes as the second driving voltage.

[0060] In an example, step of calculating the latest voltage value applied to the anodes of the organic light-emitting diodes based on the obtained maximum turn-on voltage comprises: obtaining a corresponding light-emitting supply voltage when the plurality of organic light-emitting diodes on the display panel produce the maximum brightness; obtaining a second difference; and calculating the sum of the corresponding light-emitting supply voltage, the second difference and the maximum turn-on voltage, taking a calculated result as a latest ELVDD value.

[0061] For instance, the driving method 400 of the organic light-emitting display device further comprises (not shown in figure): in the case that the latest voltage value applied to the anodes of the organic light-emitting diodes is the same as the previous voltage value applied to the anodes of the organic light-emitting diodes before, continuing to detect the turn-on voltages of the plurality of organic light-emitting diodes.

[0062] For instance, the driving method 400 of the organic light-emitting display device further comprises transmitting the second driving voltage to the voltage generating circuit in a form such as TTL signal, I2C signal or differential signal and etc.

[0063] For instance, the driving method 400 of the organic light-emitting display device further comprises detecting whether a command of closing a detecting process is received or not, and if the command is received, closing the detecting process; otherwise, continuing to detect the turn-on voltages of all the organic light-emitting diodes on the display panel.

[0064] The detail process of the driving methods 200, 300 and 400 of the above mentioned organic light-emitting display device is further described below with two specific embodiments and in combination with the sub-pixel circuits illustrated in FIG. 1A and FIG. 1B

Embodiment 1

[0065] The embodiment 1 is described in detail below in combination with FIG. 1A, FIG. 1B and FIG. 5A. FIG. 5A is an oscillogram when detecting a threshold voltage of a

driving transistor provided by an embodiment of the present disclosure. In combination with FIG. 5A, it should be known that the figure provides sequence diagrams of the first scan line G(m)_1, the second scan line G(m)_2, the sense line S(n) and the data line Y(n) when detecting the threshold voltage of the driving transistor.

[0066] The threshold voltages V_{th} of the driving transistors in the plurality of the sub-pixels are detected. Firstly, the scan switch transistor T2 is switched on (at this time, the first scan line G(m)_1 is provided with a high level), a data voltage is written to the gate electrode of the driving transistor T1 from the N^{th} data line Y(n); then, the first scan line G(m)_1 is closed, the sense switch transistor T3 is switched on (at this time, the second scan line G(m)_2 is provided with a high level); subsequently, the voltage on the sense line S(n) rises, and after a certain period of time, the voltage on the sense line S(n) reaches a stable potential. The threshold voltage V_{th} of the driving transistor T1 is calculated based on the stable potential, and the threshold voltage V_{th} is recorded as $V_{th_{mn}}$. In this way, the threshold voltages V_{th} of all the driving transistors (for instance, $m \times n$ driving transistors) of the OLED display device are detected, the maximum threshold voltage V_{th} value ($V_{th_{max}}$) over the whole OLED display device is selected, and may be represented as:

$$V_{th_{max}} = \text{Max}(V_{th_{01}}, V_{th_{02}}, \dots, V_{th_{mn}})$$

[0067] The latest first analog driving voltage is calculated based on the maximum threshold voltage, namely the latest AVDD value is calculated. If $V_{Data_{max}}$ represents the value of the voltage V_{Data} which makes the OLED device produce the maximum brightness, then the latest AVDD value $V_{AVDD'}$ is obtained as follows:

$$V_{AVDD'} = V_{Data_{max}} + V_{th_{max}} + \Delta V1$$

where $\Delta V1$ is the obtained first difference, and the value of $\Delta V1$ is generally about 0.2 V.

[0068] The calculated $V_{AVDD'}$ value is compared with the previous stored V_{AVDD} value, if the calculated $V_{AVDD'}$ value is the same as the previous stored V_{AVDD} value, continuing to detect the threshold voltage V_{th} , if the calculated $V_{AVDD'}$ value is different from the previous stored V_{AVDD} value, storing the latest calculated AVDD value (namely the $V_{AVDD'}$), taking the latest first analog driving voltage value as the first driving voltage, and sending the obtained latest first driving voltage value to the voltage generating circuit. If no V_{AVDD} value has been stored before, namely at the initialization phase, then the current obtained V_{AVDD} value is stored and is sent to the voltage generating circuit for carrying out subsequent operations.

[0069] The driving voltage is changed according to the obtained latest first driving voltage value. The voltage generating circuit receives the data related to the first driving voltage value, so as to change the previous voltage output value and output the obtained latest first driving voltage. The command data for transmitting the first driving voltage may be transmitted in a form such as TTL signal, I2C signal or differential signal.

Embodiment 2

[0070] The embodiment 2 is described in detail below in combination with FIG. 1A, FIG. 1B and FIG. 5B. FIG. 5B is an oscillogram when detecting a turn-on voltage of an organic light-emitting diode provided by an embodiment of

the present disclosure. In combination with FIG. 5B, it should be known that the figure provides sequence diagrams of the first scan line G(m)_1, the second scan line G(m)_2, the sense line S(n) and the data line Y(n) when detecting the turn-on voltage of the organic light-emitting diode.

[0071] The turn-on voltages of the organic light-emitting diodes in the plurality of the sub-pixels are detected. Firstly, the scan switch transistor T2 is switched off (at this time, the first scan line G(m)_1 is provided with a low level); then, the voltage on the sense line S(n) is preset to V_{Sense} , where $V_{Sense} > V_{OLED}$ and V_{OLED} is the turn-on voltage of the organic light-emitting diode; next, the sense switch transistor T3 is switched on (at this time, the second scan line G(m)_2 is provided with a high level), the OLED device is turned on at this time, and then the voltage on the sense line S(n) drops. After a certain period of time, the voltage on the sense line S(n) reaches a stable potential, V_{OLED} of the OLED device is calculated based on the stable potential and is recorded as $V_{OLED_{mn}}$. Similarly, the V_{OLED} values of all the OLED devices (for instance, $m \times n$ OLED devices) of the organic light-emitting display device are detected, the maximum V_{OLED} value in the whole organic light-emitting display device is selected, and may be represented as:

$$V_{OLED_{max}} = \text{Max}(V_{OLED_{01}}, V_{OLED_{02}}, \dots, V_{OLED_{mn}})$$

[0072] The ELVDD value is calculated, so as to obtain the latest ELVDD value $V_{ELVDD'}$, the $V_{ELVDD'}$ is as follows:

$$V_{ELVDD'} = V_{Data_{max}} + V_{OLED_{max}} + \Delta V2$$

where $\Delta V2$ is the obtained second difference, and the value of $\Delta V2$ is generally about 0.2 V. $V_{Data_{max}}$ corresponds to the light-emitting supply voltage when the organic light-emitting diodes on the display panel produce the maximum brightness.

[0073] The calculated $V_{ELVDD'}$ value is compared with the previous stored V_{ELVDD} value, if the calculated $V_{ELVDD'}$ value is the same as the previous stored V_{ELVDD} value, continuing to detect the turn-on voltage of the organic light-emitting diode, if the calculated $V_{ELVDD'}$ value is different from the previous stored V_{ELVDD} value, storing the latest calculated ELVDD value (namely the $V_{ELVDD'}$), taking the latest calculated $V_{ELVDD'}$ as the second driving voltage, and sending the second driving voltage value to the voltage generating circuit. If no V_{ELVDD} value has been stored before, namely at the initialization phase, then the current obtained V_{ELVDD} value is stored and is sent to the voltage generating circuit for carrying out subsequent operations.

[0074] The ELVDD voltage is changed according to the second driving voltage value. The voltage generating circuit receives the command data related to the second driving voltage, so as to change the ELVDD voltage value. The present embodiment may transmit the command data used for changing the ELVDD voltage to the voltage generating circuit in the form such as TTL signal, I2C signal or differential signal.

[0075] FIG. 6 is a flow chart of a driving method of an organic light-emitting display device provided by an embodiment of the present disclosure. The difference between the driving method 600 as illustrated in FIG. 6 and the driving method 200 as illustrated in FIG. 2 is that: the driving method 200 illustrated in FIG. 2 may only detect one of the threshold voltage and the turn-on voltage to obtain one of the first driving voltage and the second driving voltage, so as to realize the purpose of saving power consumption. However, the driving method 600 as illustrated in FIG. 6 is

used for detecting both the threshold voltage and the turn-on voltage at the same time, and obtains both the first driving voltage and the second driving voltage, so that the purpose of saving power consumption is achieved. Therefore, compared with the driving method 200 provided by FIG. 2, the technical effect of the driving method 600 illustrated in FIG. 6 can be better.

[0076] The display device, to which the driving method 600 as illustrated in FIG. 6 relates, comprises a plurality of sub-pixels 100 as illustrated in FIG. 1A and FIG. 1B. Each of the sub-pixels 100 comprises a driving transistor, an organic light-emitting diode, and a sense line connected to the driving transistor and the organic light-emitting diode (for instance, referring to the descriptions of the FIG. 1A and FIG. 1B). The driving method 600 of the organic light-emitting display device in FIG. 6 may comprise the following steps:

[0077] Step 601: detecting the threshold voltages of the driving transistors of the plurality of sub-pixels on the display panel and the turn-on voltages of the organic light-emitting diodes of the plurality of sub-pixels on the display panel by the sense lines.

[0078] Step 621: calculating the first driving voltage of the data driving circuit and the second driving voltage applied to anodes of the organic light-emitting diodes according to all the detected threshold voltages and the detected turn-on voltages respectively.

[0079] Step 641: based on the first driving voltage and the second driving voltage, applying the data driving voltages and the supply voltages to the sub-pixels.

[0080] The implementation of the steps of the driving method 600 provided by FIG. 6 may be the same as the implementation of the similar steps of the driving method 200 as illustrated in FIG. 2, which will not be elaborated here.

[0081] In summary, the above mention embodiments of the present disclosure provide a method for reducing the power consumption of the organic display device, the method comprises detecting the threshold voltages V_{th} of the driving transistors and/or the turn-on voltages of the organic light-emitting diodes on the display panel, and then calculating the optimal AVDD voltage value and/or the optimal ELVDD voltage value which can satisfy the performance of the display panel, so that the power consumption of the AVDD and/or the ELVDD is optimized at any time, and then the purpose of reducing power consumption is achieved. In this way, the logic power consumption of the driving module and the power supply consumption of the organic light-emitting device can be reduced, and the power consumption of the organic light-emitting device can be maintained within an optimized range, so that the obtained display product is more competitive in the market.

[0082] The embodiments of the present disclosure only relate to the structure which the embodiments of the present disclosure relate to, the other structures may be referred to the customary design. Under the circumstance without conflict, the embodiments of the present disclosure or different features of each embodiment can be combined with each other.

[0083] What are described above is related to the specific embodiments of the present disclosure only and not limitative to the scope of the disclosure, within the disclosed technical scope of the disclosure, the change and replacement, which any skilled who is familiar with the technical

field in the art may easily think of, should be covered within the scope of the protection of the disclosure. Therefore, the scopes of the disclosure are defined by the accompanying claims.

[0084] The application claims priority to the Chinese patent application No. 201610628525.9, filed Aug. 3, 2016, the entire disclosure of which is incorporated herein by reference as part of the present application.

1. A driving method of an organic light-emitting display device, the display device comprising a plurality of sub-pixels, each of the sub-pixels comprising a driving transistor, an organic light-emitting diode, and a sense line connected to the driving transistor and the organic light-emitting diode, the method comprising:

detecting threshold voltages of driving transistors of the sub-pixels or turn-on voltages of organic light-emitting diodes of the sub-pixels by sense lines;

calculating a first driving voltage of a data driving circuit or a second driving voltage applied to anodes of the organic light-emitting diodes according to all detected threshold voltages or detected turn-on voltages respectively; and

based on the first driving voltage or the second driving voltage, applying data driving voltages and supply voltages to the sub-pixels.

2. The driving method of the organic light-emitting display device according to claim 1, wherein,

detecting the threshold voltages of the driving transistors of the sub-pixels by the sense lines comprises:

writing an image data voltage to gate electrodes of the driving transistors; and

reading stable voltages of the sense lines, calculating values of the threshold voltages of the driving transistors based on the stable voltages.

3. The driving method of the organic light-emitting display device according to claim 1, wherein,

calculating the first driving voltage of the data driving circuit according to all the detected threshold voltages comprises:

obtaining a maximum threshold voltage of all the driving transistors on the display device based on the detected threshold voltages of all the driving transistors.

4. The driving method of the organic light-emitting display device according to claim 3,

wherein a latest first analog driving voltage value is calculated based on the maximum threshold voltage, the latest first analog driving voltage value is compared with a stored first analog driving voltage value, and in a case that the latest first analog driving voltage value is different from the stored first analog driving voltage value, the latest first analog driving voltage value is taken as the first driving voltage.

5. The driving method of the organic light-emitting display device according to claim 4, wherein,

calculating of the latest first analog driving voltage value based on the maximum threshold voltage comprises:

obtaining a corresponding image data voltage when all the organic light-emitting diodes on the display device produce a maximum brightness;

obtaining a first difference; and

- calculating a sum of the corresponding image data voltage, the first difference and the maximum threshold voltage, and taking a calculated result as the first driving voltage.
6. The driving method of the organic light-emitting display device according to claim 3, further comprising: in the case that the latest first analog driving voltage value is the same as the stored first analog driving voltage value, continuing to detect the threshold voltages of the driving transistors on the display device panel.
7. The driving method of the organic light-emitting display device according to claim 3, wherein, the first driving voltage is transmitted to a voltage generating circuit of the data driving circuit by a TTL signal, an I2C signal or a differential signal.
8. The driving method of the organic light-emitting display device according to claim 3, further comprising: detecting whether a command of closing a detecting process is received or not, and
if the command is received, closing the detecting process; otherwise, continuing to detect the threshold voltages of the driving transistors on the display device.
9. The driving method of the organic light-emitting display device according to claim 1, wherein, detecting the turn-on voltages of the organic light-emitting diodes of the sub-pixels by the sense lines comprises:
applying a preset voltage to the organic light-emitting diodes to make the organic light-emitting diodes turn on; and
reading stable voltages on the sense lines, and calculating the turn-on voltages of the organic light-emitting diodes based on the stable voltages.
10. The driving method of the organic light-emitting display device according to claim 1, wherein, calculating the second driving voltage of the anodes of the organic light-emitting diodes according to all the detected turn-on voltages comprises:
obtaining a maximum turn-on voltage of the organic light-emitting diodes on the display device; and
calculating a latest voltage value applied to the anodes of the organic light-emitting diodes based on the maximum turn-on voltage that is obtained.
11. The driving method of the organic light-emitting display device according to claim 10, further comprising: determining a difference between the latest voltage value applied to the anodes of the organic light-emitting diodes and a previous voltage value applied to the anodes of the organic light-emitting diodes before, and
if the latest voltage value is the same as the previous voltage value, continuing to detect the turn-on voltages of the organic light-emitting diodes, and if the latest voltage value is different from the previous voltage value, taking the latest voltage value applied to the anodes of the organic light-emitting diodes as the second driving voltage.
12. The driving method of the organic light-emitting display device according to claim 10, wherein, calculating the latest voltage value applied to the anodes of the organic light-emitting diodes based on the obtained maximum turn-on voltage comprises:
obtaining a corresponding light-emitting supply voltage when the organic light-emitting diodes on the display device produce a maximum brightness;
obtaining a second difference; and
calculating a sum of the corresponding light-emitting supply voltage, the second difference and the maximum turn-on voltage, taking a calculated result as a latest ELVDD value.
13. The driving method of the organic light-emitting display device according to claim 10, further comprising: in the case that the latest voltage value applied to the anodes of the organic light-emitting diodes is the same as the previous voltage value applied to the anodes of the organic light-emitting diodes before, continuing to detect the turn-on voltages of the organic light-emitting diodes.
14. The driving method of the organic light-emitting display device according to claim 10, wherein, the second driving voltage is transmitted to a voltage generating circuit by a TTL signal, a I2C signal or a differential signal.
15. The driving method of the organic light-emitting display device according to claim 10, further comprising: detecting whether a command of closing a detecting process is received or not, and
if the command is received, closing the detecting process; otherwise, continuing to detect the turn-on voltages of all the organic light-emitting diodes on the display device.
16. The driving method of the organic light-emitting display device according to claim 1, comprising:
detecting the threshold voltages of the driving transistors of the sub-pixels on the display device and the turn-on voltages of the organic light-emitting diodes of the sub-pixels on the display device by the sense lines;
calculating the first driving voltage of the data driving circuit and the second driving voltage applied to anodes of the organic light-emitting diodes according to all the detected threshold voltages and the detected turn-on voltages respectively; and
based on the first driving voltage and the second driving voltage, applying the data driving voltages and the supply voltages to the sub-pixels.
17. The driving method of the organic light-emitting display device according to claim 2, wherein, calculating the first driving voltage of the data driving circuit according to all the detected threshold voltages comprises:
obtaining a maximum threshold voltage of all the driving transistors on the display device based on the detected threshold voltages of all the driving transistors.
18. The driving method of the organic light-emitting display device according to claim 17, wherein a latest first analog driving voltage value is calculated based on the maximum threshold voltage, the latest first analog driving voltage value is compared with a stored first analog driving voltage value, and in a case that the latest first analog driving voltage value is different from the stored first analog driving voltage value, the latest first analog driving voltage value is taken as the first driving voltage.
19. The driving method of the organic light-emitting display device according to claim 9, wherein, calculating the second driving voltage of the anodes of the organic light-emitting diodes according to all the detected turn-on voltages comprises:

obtaining a maximum turn-on voltage of the organic light-emitting diodes on the display device; and calculating a latest voltage value applied to the anodes of the organic light-emitting diodes based on the maximum turn-on voltage that is obtained.

20. The driving method of the organic light-emitting display device according to claim **19**, further comprising:

determining a difference between the latest voltage value applied to the anodes of the organic light-emitting diodes and a previous voltage value applied to the anodes of the organic light-emitting diodes before,

if the latest voltage value is the same as the previous voltage value, continuing to detect the turn-on voltages of the organic light-emitting diodes, and if the latest voltage value is different from the previous voltage value, taking the latest voltage value applied to the anodes of the organic light-emitting diodes as the second driving voltage.

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摘要(译)

一种有机发光显示装置的驱动方法，所述显示装置包括多个子像素，每个所述子像素包括驱动晶体管，有机发光二极管和连接到所述驱动晶体管的感测线。所述有机发光二极管，所述方法包括：通过感测线检测所述子像素的驱动晶体管的阈值电压或所述子像素的有机发光二极管的导通电压；根据所有检测到的阈值电压或检测到的导通电压，分别计算施加到有机发光二极管的阳极的数据驱动电路的第一驱动电压或第二驱动电压；基于第一驱动电压或第二驱动电压，将数据驱动电压和电源电压施加到子像素。

