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Kim et al.

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(54) **DISPLAY APPARATUS AND METHOD FOR CONTROLLING DISPLAY APPARATUS**

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CPC ***G09G 3/3406*** (2013.01); ***G09G 3/36*** (2013.01); *G09G 2320/0247* (2013.01); *G09G 2320/0626* (2013.01); *G09G 2354/00* (2013.01)

(58) **Field of Classification Search**
CPC G09G 3/3233
See application file for complete search history.

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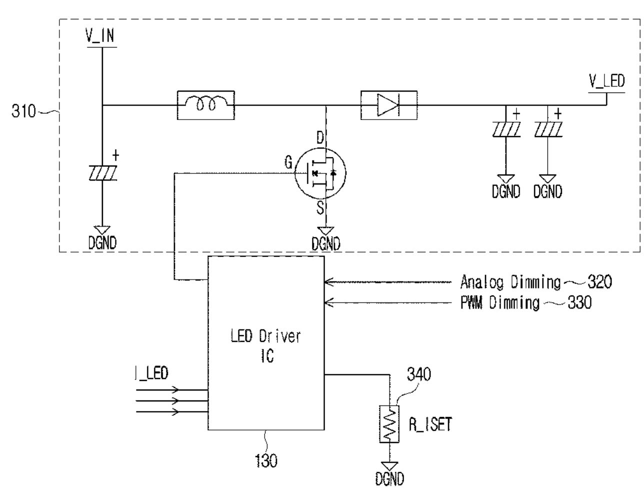
(57) **ABSTRACT**

A display apparatus is disclosed. The present display apparatus comprises: a display panel; a backlight unit configured to provide light to the display panel by using a plurality of light-emitting elements; a driver configured to provide a driving current to the plurality of light-emitting elements on the basis of an amplitude of a driving voltage; a memory storing information on an amplitude of a driving voltage according to a plurality of brightnesses for each resistance value of an output resistor connected to the driver; and a processor configured to set a resistance value of the output resistor on the basis of a brightness value of the display panel, identify an amplitude of the driving voltage corresponding to the brightness value of the display panel from among amplitudes of the driving voltage according to the plurality of brightnesses corresponding to the set resistance value on the basis of the information stored in the memory, and apply the driving voltage of the identified amplitude to the driver, wherein an amplitude of the driving current is
(Continued)



determined on the basis of the amplitude of the driving voltage and the resistance value of the output resistor.

12 Claims, 13 Drawing Sheets

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FIG. 1

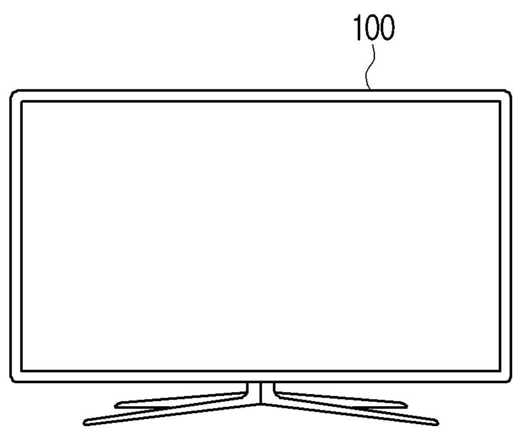


FIG. 2

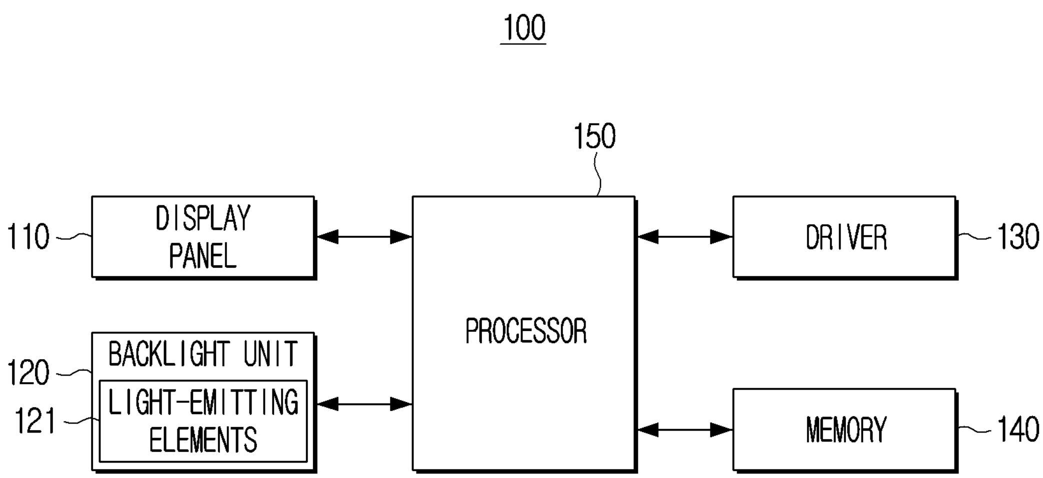

100
150
DISPLAY PANEL
110
BACKLIGHT UNIT
LIGHT-EMITTING ELEMENTS
120
121
PROCESSOR
DRIVER
130
MEMORY
140

FIG. 3

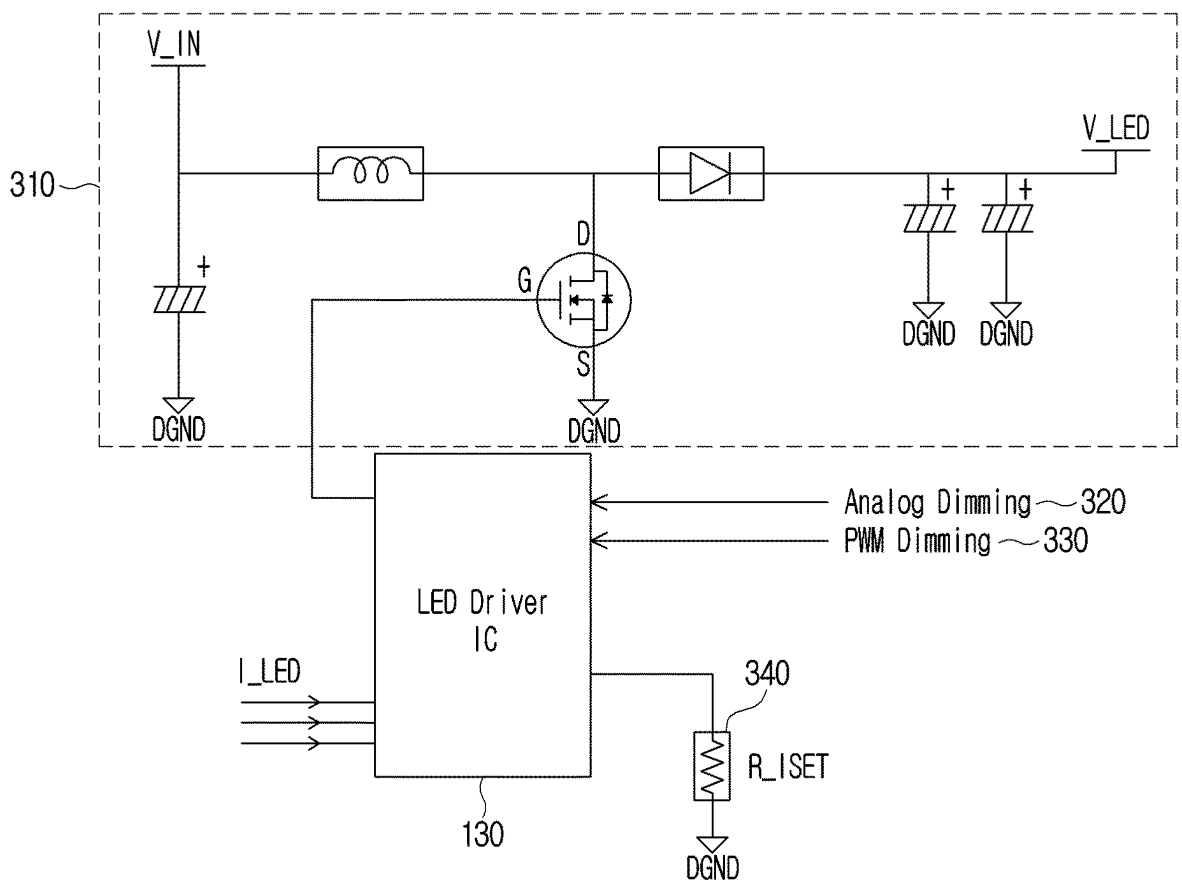

V_IN
V_LED
310
D
G
S
DGND
DGND
DGND
DGND
Analog Dimming 320
PWM Dimming 330
LED Driver IC
I_LED
340
R_ISET
130
DGND

FIG. 4

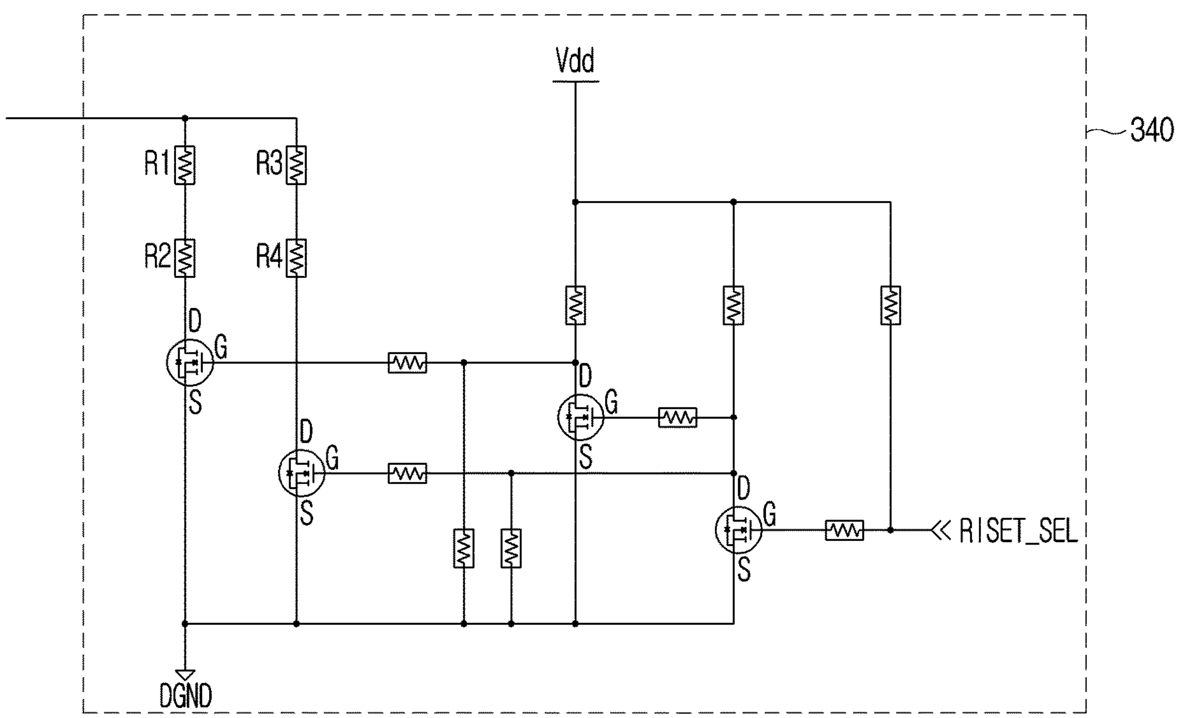
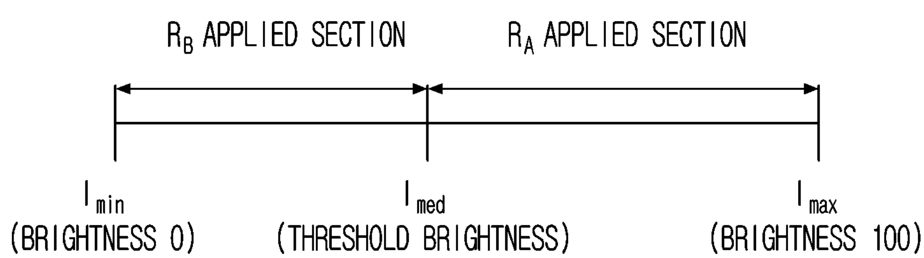


FIG. 5



R_B APPLIED SECTION
R_A APPLIED SECTION
I_{min}
(BRIGHTNESS 0)
I_{med}
(THRESHOLD BRIGHTNESS)
I_{max}
(BRIGHTNESS 100)

FIG. 6

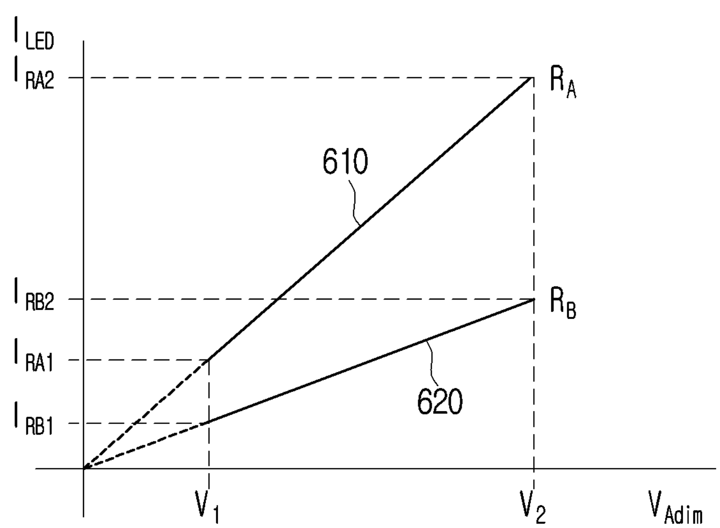


FIG. 7A

710

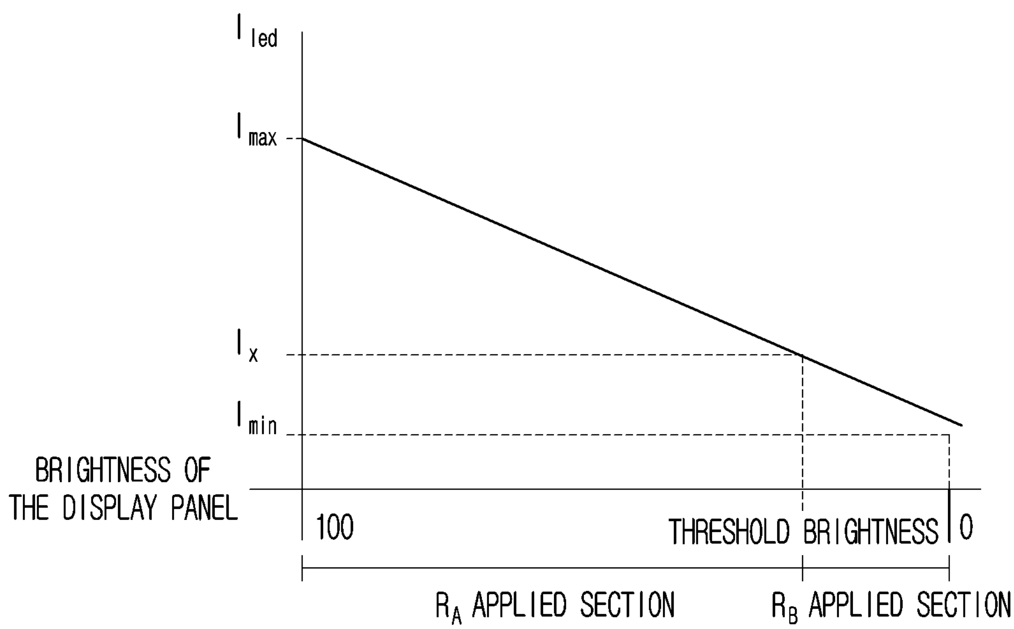

I led
I max
I x
I min
BRIGHTNESS OF
THE DISPLAY PANEL
100
THRESHOLD BRIGHTNESS
0
R A APPLIED SECTION
R B APPLIED SECTION

FIG. 7B

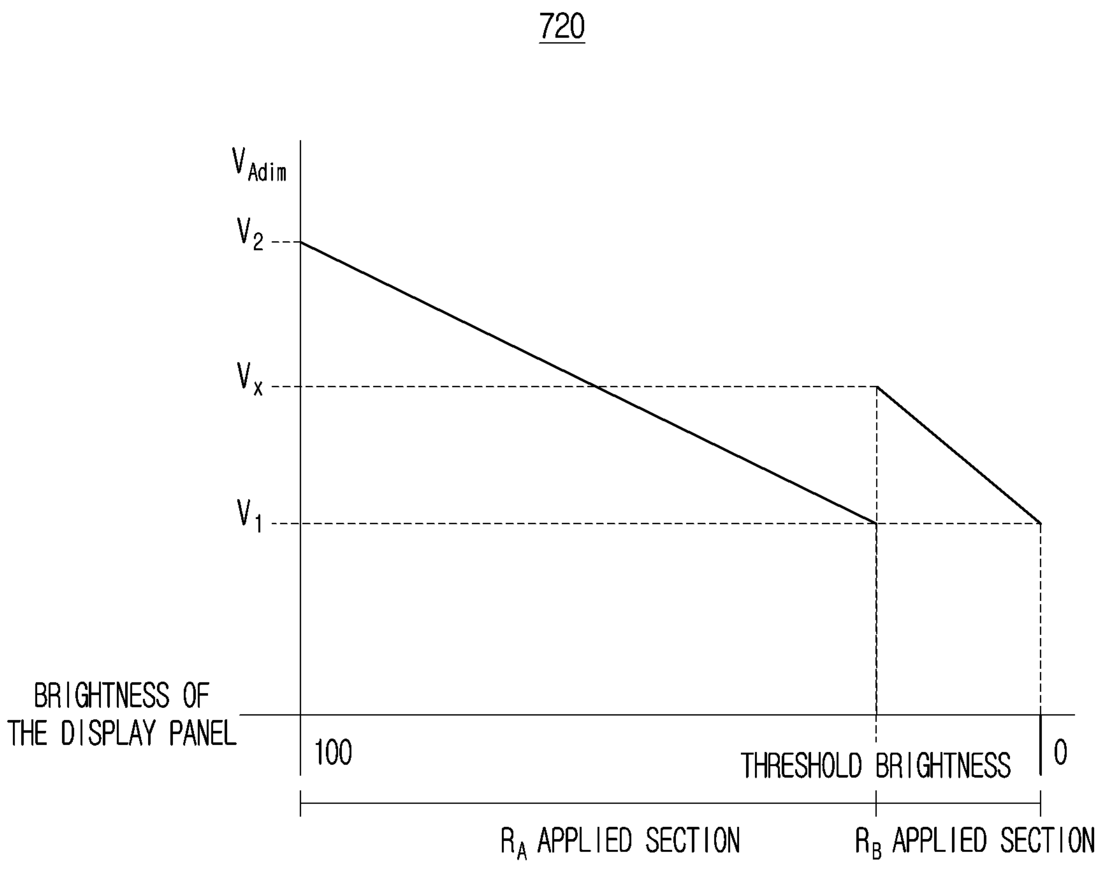

720
V_{Adim}
V_2
V_x
V_1
BRIGHTNESS OF
THE DISPLAY PANEL
100
THRESHOLD BRIGHTNESS
0
R_A APPLIED SECTION
R_B APPLIED SECTION

FIG. 8A

810

BRIGHTNESS OF THE DISPLAY PANEL	$V_{Adim}(R_A)$
100(MAXIMUM BRIGHTNESS)	3.33V
99	3.30V
98	3.27V
97	3.24V
...	...
34	1.32V
33	1.29V
32	1.26V
31	1.23V
30	1.2V

FIG. 8B

820

BRIGHTNESS OF THE DISPLAY PANEL	$V_{Adim}(R_B)$
30	2.44V
29	2.40V
28	2.36V
27	2.32V
...	...
4	1.36V
3	1.32V
2	1.28V
1	1.24V
0(MINIMUM BRIGHTNESS)	1.2V

FIG. 9

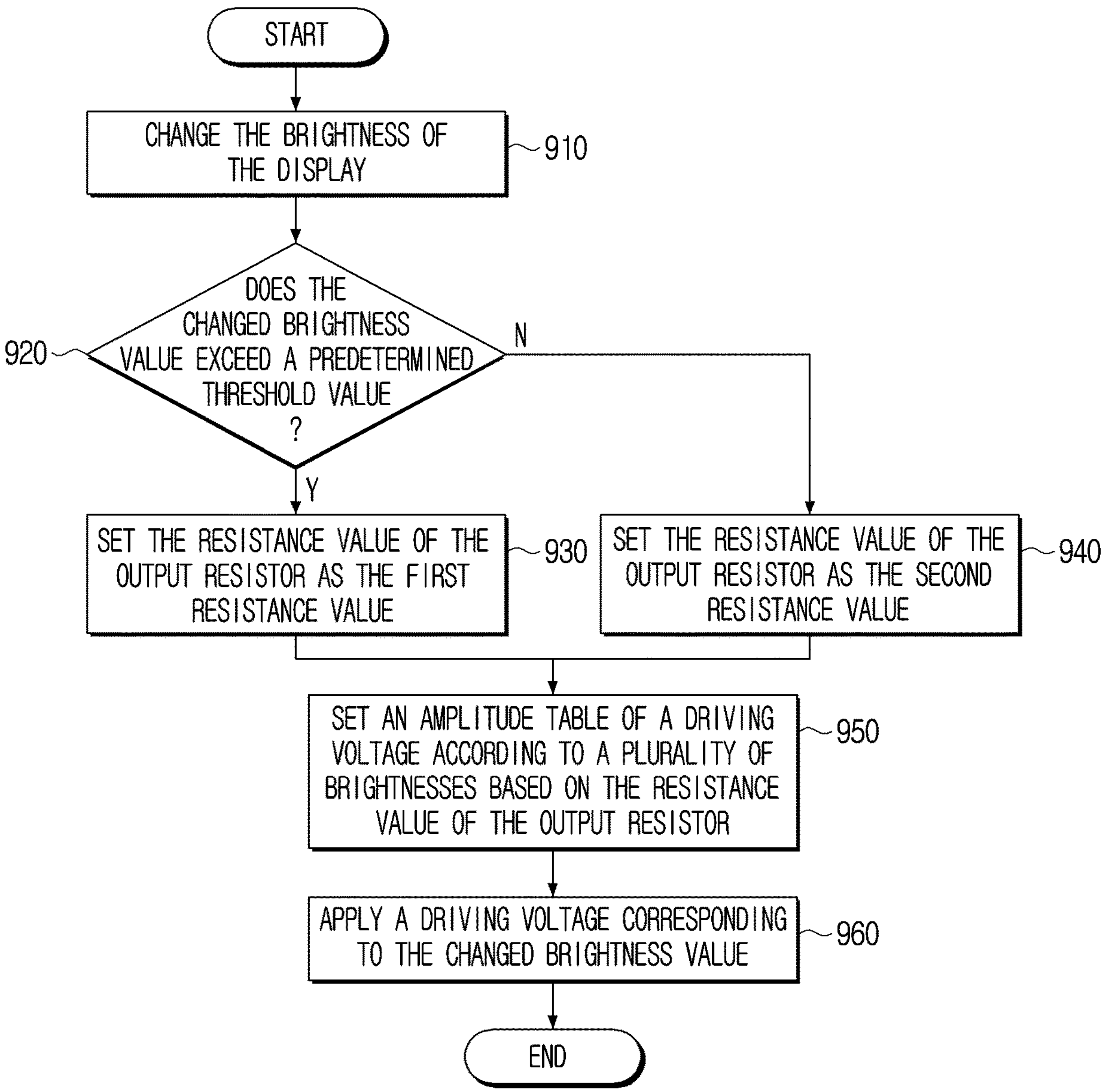

START
CHANGE THE BRIGHTNESS OF THE DISPLAY
910
DOES THE CHANGED BRIGHTNESS VALUE EXCEED A PREDETERMINED THRESHOLD VALUE ?
920
N
Y
SET THE RESISTANCE VALUE OF THE OUTPUT RESISTOR AS THE FIRST RESISTANCE VALUE
930
SET THE RESISTANCE VALUE OF THE OUTPUT RESISTOR AS THE SECOND RESISTANCE VALUE
940
SET AN AMPLITUDE TABLE OF A DRIVING VOLTAGE ACCORDING TO A PLURALITY OF BRIGHTNESSES BASED ON THE RESISTANCE VALUE OF THE OUTPUT RESISTOR
950
APPLY A DRIVING VOLTAGE CORRESPONDING TO THE CHANGED BRIGHTNESS VALUE
960
END

FIG. 10

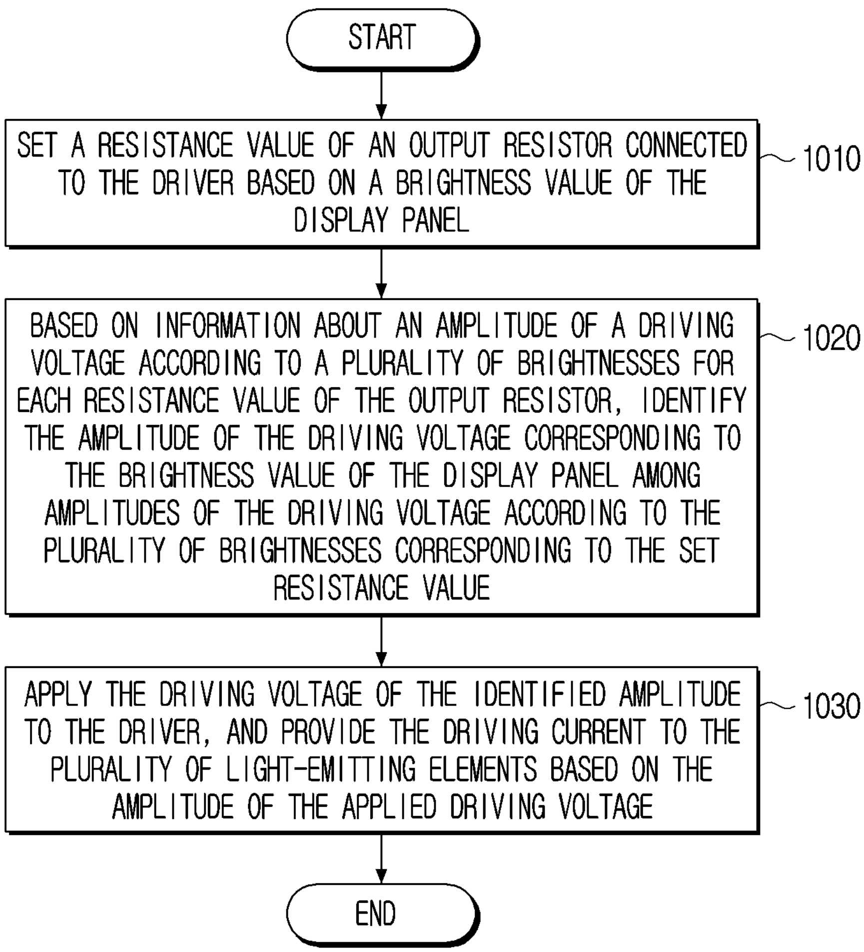
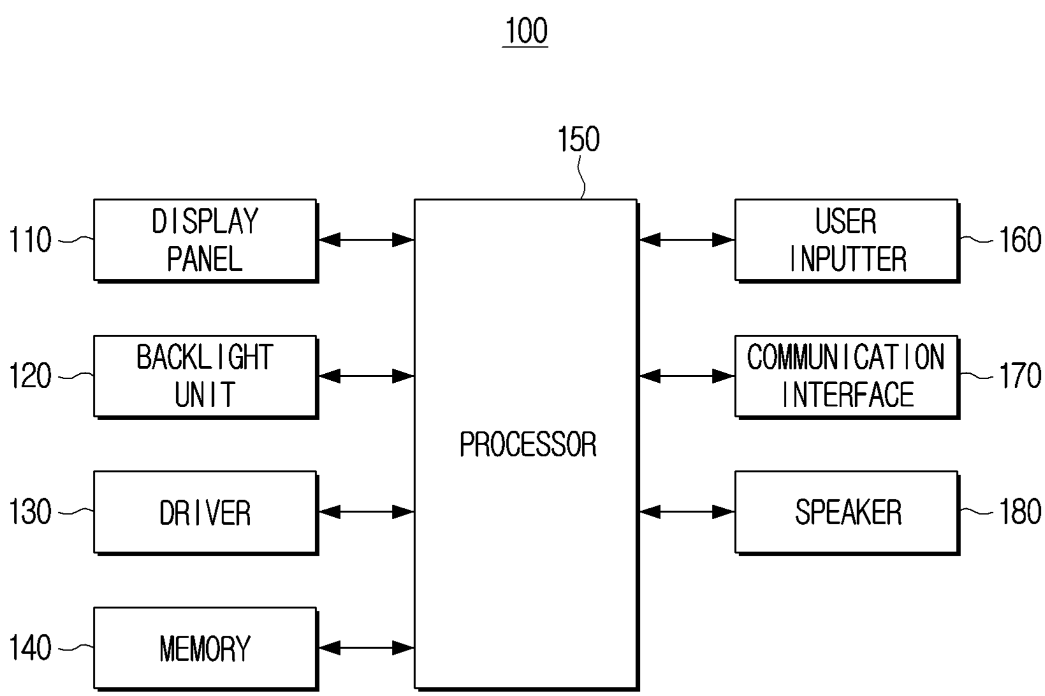

START
SET A RESISTANCE VALUE OF AN OUTPUT RESISTOR CONNECTED TO THE DRIVER BASED ON A BRIGHTNESS VALUE OF THE DISPLAY PANEL
1010
BASED ON INFORMATION ABOUT AN AMPLITUDE OF A DRIVING VOLTAGE ACCORDING TO A PLURALITY OF BRIGHTNESSES FOR EACH RESISTANCE VALUE OF THE OUTPUT RESISTOR, IDENTIFY THE AMPLITUDE OF THE DRIVING VOLTAGE CORRESPONDING TO THE BRIGHTNESS VALUE OF THE DISPLAY PANEL AMONG AMPLITUDES OF THE DRIVING VOLTAGE ACCORDING TO THE PLURALITY OF BRIGHTNESSES CORRESPONDING TO THE SET RESISTANCE VALUE
1020
APPLY THE DRIVING VOLTAGE OF THE IDENTIFIED AMPLITUDE TO THE DRIVER, AND PROVIDE THE DRIVING CURRENT TO THE PLURALITY OF LIGHT-EMITTING ELEMENTS BASED ON THE AMPLITUDE OF THE APPLIED DRIVING VOLTAGE
1030
END

FIG. 11


100
150
110
DISPLAY PANEL
120
BACKLIGHT UNIT
130
DRIVER
140
MEMORY
PROCESSOR
USER INPUTTER
160
COMMUNICATION INTERFACE
170
SPEAKER
180

DISPLAY APPARATUS AND METHOD FOR CONTROLLING DISPLAY APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of International Application No. PCT/KR2022/017990, designating the United States, filed on Nov. 15, 2022, in the Korean Intellectual Property Receiving Office and claiming priority to Korean Patent Application No. 10-2021-0157893, filed on Nov. 16, 2021, in the Korean Intellectual Property Office, the disclosures of each of which are incorporated by reference herein in their entireties.

BACKGROUND

Field

The disclosure relates to a display apparatus and a method for controlling the display apparatus, and more particularly, to a display apparatus that adjusts the entire sections of brightness of a display panel by analog dimming control, and a method for controlling the display apparatus.

Description of Related Art

Brightness of a display panel is adjusted based on a driving current provided to light-emitting elements by a driver. Specifically, a driving current may be adjusted by analog dimming control or pulse width modulation dimming control.

Here, analog dimming control is a method of adjusting the brightness of a display panel by varying the amplitude of a driving current provided to light-emitting elements. Also, pulse width modulation dimming control is a method of adjusting the brightness of a display panel by providing a driving current provided to light-emitting elements in a form of a square wave, and varying a duty ratio of the square wave.

Meanwhile, unlike a high-priced driver that adjusts the amplitude of a driving current based on a digital signal received from a processor, a low-priced driver adjusts the amplitude of a driving current based on a DC signal received from a processor.

Here, in the case of a low-priced driver, the size of a DC signal that can be recognized may be limited according to the specifications of components such as an FET and a TR inside. Accordingly, there is a case wherein the entire sections of brightness of a display panel cannot be adjusted by analog dimming control.

In this case, the sections of brightness of a display panel that cannot be adjusted by analog dimming control should be adjusted by pulse width modulation dimming control.

Meanwhile, in the case of adjusting a display panel with pulse width modulation control, a flicker phenomenon may occur in the display panel, and there are research results showing that this makes fatigue accumulated in the eyes of the user of the display apparatus.

Accordingly, making the entire sections of brightness of a display panel adjusted by analog dimming control in a low-priced driver is an important issue.

SUMMARY

The disclosure was devised for resolving the aforementioned problem, and the purpose of the disclosure is in providing a display apparatus wherein the entire sections of brightness of a display panel can be adjusted by analog dimming control by setting an output resistor based on the brightness of the display panel, and a method for controlling thereof.

A display apparatus according to an embodiment of the disclosure for achieving the aforementioned purpose includes a display panel, a backlight unit configured to provide light to the display panel by using a plurality of light-emitting elements, a driver configured to provide a driving current to the plurality of light-emitting elements based on an amplitude of a driving voltage, a memory storing information about an amplitude of a driving voltage according to a plurality of brightnesses for each resistance value of an output resistor connected to the driver, and a processor configured to set a resistance value of the output resistor based on a brightness value of the display panel, identify an amplitude of the driving voltage corresponding to the brightness value of the display panel among amplitudes of the driving voltage according to the plurality of brightnesses corresponding to the set resistance value based on the information stored in the memory, and apply the driving voltage of the identified amplitude to the driver, wherein an amplitude of the driving current is determined based on the amplitude of the driving voltage and the resistance value of the output resistor.

Meanwhile, the brightness value of the display panel may be set within a brightness range until a second brightness value increasing in stages from a first brightness value, and the processor may, based on the brightness value of the display panel being smaller than or equal to a predetermined brightness value, set the resistance value of the output resistor as a first resistance value, and based on the brightness value of the display panel being greater than the predetermined brightness value, set the resistance value of the output resistor as a second resistance value, and the predetermined brightness value may be greater than the first brightness value and smaller than the second brightness value.

In this case, the processor may, based on the brightness value of the display panel changing to a value smaller than or equal to the predetermined brightness value based on a user input, change the resistance value of the output resistor set as the second resistance value to the first resistance value, and based on the brightness value of the display panel changing to a value greater than the predetermined brightness value based on a user input, change the resistance value of the output resistor set as the first resistance value to the second resistance value.

Also, the amplitude of the driving current may be relatively bigger in a case wherein the resistance value of the output resistor is set as the second resistance value than a case wherein the resistance value of the output resistor is set as the first resistance value.

In addition, based on the brightness value of the display panel being set in stages from the first brightness value to the predetermined brightness value, the amplitude of the driving voltage according to a plurality of brightness values corresponding to the first resistance value may be set such that the amplitude of the driving current continuously increases, based on the brightness value of the display panel being set in stages from a third brightness value to the second brightness value, the amplitude of the driving voltage according to a plurality of brightness values corresponding to the second resistance value may be set such that the amplitude of the driving current continuously increases, and the third brightness value may be a brightness value in a next stage of the predetermined brightness value.

Here, based on the brightness value of the display panel being set in stages from the first brightness value to the second brightness value, brightness of the display panel may continuously increase according to the driving current.

Meanwhile, the processor may, based on the display apparatus being turned on, identify a brightness value of the display panel set as a default, and set the resistance value of the output resistor based on the identified brightness value.

Also, a method for controlling a display apparatus including a display panel, a backlight unit configured to provide light to the display panel by using a plurality of light-emitting elements, and a driver configured to provide a driving current to the plurality of light-emitting elements according to an embodiment of the disclosure includes the steps of setting a resistance value of an output resistor connected to the driver based on a brightness value of the display panel, based on information about an amplitude of a driving voltage according to a plurality of brightnesses for each resistance value of the output resistor, identifying an amplitude of the driving voltage corresponding to the brightness value of the display panel among amplitudes of the driving voltage according to the plurality of brightnesses corresponding to the set resistance value, and applying the driving voltage of the identified amplitude to the driver, and providing the driving current to the plurality of light-emitting elements based on the amplitude of the applied driving voltage.

Meanwhile, the brightness value of the display panel may be set within a brightness range until a second brightness value increasing in stages from a first brightness value, and in the setting step, based on the brightness value of the display panel being smaller than or equal to a predetermined brightness value, the resistance value of the output resistor may be set as a first resistance value, and based on the brightness value of the display panel being greater than the predetermined brightness value, the resistance value of the output resistor may be set as a second resistance value, and the predetermined brightness value may be greater than the first brightness value and smaller than the second brightness value.

In this case, in the setting step, based on the brightness value of the display panel changing to a value smaller than or equal to the predetermined brightness value based on a user input, the resistance value of the output resistor set as the second resistance value may be changed to the first resistance value, and based on the brightness value of the display panel changing to a value greater than the predetermined brightness value based on a user input, the resistance value of the output resistor set as the first resistance value may be changed to the second resistance value.

Also, the amplitude of the driving current may be relatively bigger in a case wherein the resistance value of the output resistor is set as the second resistance value than a case wherein the resistance value of the output resistor is set as the first resistance value.

In addition, based on the brightness value of the display panel being set in stages from the first brightness value to the predetermined brightness value, the amplitude of the driving voltage according to the plurality of brightness values corresponding to the first resistance value may be set such that the amplitude of the driving current continuously increases, and based on the brightness value of the display panel being set in stages from a third brightness value to the second brightness value, the amplitude of the driving voltage according to the plurality of brightness values corresponding to the second resistance value may be set such that the amplitude of the driving current continuously increases, and the third brightness value may be a brightness value in a next stage of the predetermined brightness value.

Here, based on the brightness value of the display panel being set in stages from the first brightness value to the second brightness value, the brightness of the display panel may continuously increase according to the driving current.

Meanwhile, in the setting step, based on the display apparatus being turned on, a brightness value of the display panel set as a default may be identified, and the resistance value of the output resistor may be set based on the identified brightness value.

According to the various embodiments of the disclosure, the entire range of the brightness of a display panel can be adjusted just by analog dimming control, and thus increase of fatigue of the eyes of a user by flickers generated by pulse width modulation control can be prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram for illustrating a display apparatus according to an embodiment of the disclosure;

FIG. **2** is a block diagram for illustrating a configuration of a display apparatus according to an embodiment of the disclosure;

FIG. **3** is a diagram for illustrating a driver **130** according to an embodiment of the disclosure;

FIG. **4** is a diagram for illustrating an output resistor according to an embodiment of the disclosure;

FIG. **5** is a diagram for illustrating an amplitude of a driving current for each brightness of a display panel according to an embodiment of the disclosure;

FIG. **6** is a diagram for illustrating an amplitude of a driving current for each resistance value of an output resistor according to an embodiment of the disclosure;

FIG. **7**A is a diagram for illustrating a driving current according to brightnesses of a plurality of display panels according to an embodiment of the disclosure;

FIG. **7**B is a diagram for illustrating an amplitude of a driving voltage according to brightnesses of a plurality of display panels according to an embodiment of the disclosure;

FIG. **8**A and FIG. **8**B are diagrams for illustrating information about an amplitude of a driving voltage according to a plurality of brightnesses for each resistance value of an output resistor according to an embodiment of the disclosure;

FIG. **9** is a flow chart for illustrating an operation of a display apparatus according to an embodiment of the disclosure;

FIG. **10** is a flow chart for illustrating a method for controlling a display apparatus according to an embodiment of the disclosure; and

FIG. **11** is a block diagram for illustrating a detailed configuration of a display apparatus according to an embodiment of the disclosure.

DETAILED DESCRIPTION

Various modifications may be made to the embodiments of the disclosure, and there may be various types of embodiments. Accordingly, specific embodiments will be illustrated in drawings, and the embodiments will be described in detail in the detailed description. However, it should be noted that the various embodiments are not for limiting the scope of the disclosure to a specific embodiment, but they should be interpreted to include all modifications, equivalents, and/or alternatives of the embodiments of the disclosure. Meanwhile, with respect to the detailed description of the drawings, similar components may be designated by similar reference numerals.

Also, in describing the disclosure, in case it is determined that detailed explanation of related known functions or components may unnecessarily confuse the gist of the disclosure, the detailed explanation will be omitted.

In addition, the embodiments below may be modified in various different forms, and the scope of the technical idea of the disclosure is not limited to the embodiments below. Rather, these embodiments are provided to make the disclosure more sufficient and complete, and to fully convey the technical idea of the disclosure to those skilled in the art.

Further, terms used in the disclosure are used just to explain specific embodiments, and are not intended to limit the scope of the disclosure. Also, singular expressions include plural expressions, unless defined obviously differently in the context.

In addition, in the disclosure, expressions such as "have," "may have," "include," and "may include" denote the existence of such characteristics (e.g.: elements such as numbers, functions, operations, and components), and do not exclude the existence of additional characteristics.

Also, in the disclosure, the expressions "A or B," "at least one of A and/or B," or "one or more of A and/or B," and the like may include all possible combinations of the listed items. For example, "A or B," "at least one of A and B," or "at least one of A or B" may refer to all of the following cases: (1) including at least one A, (2) including at least one B, or (3) including at least one A and at least one B.

In addition, the expressions "first," "second," and the like used in the disclosure may describe various elements regardless of any order and/or degree of importance. Also, such expressions are used only to distinguish one element from another element, and are not intended to limit the elements.

Meanwhile, the description in the disclosure that one element (e.g.: a first element) is "(operatively or communicatively) coupled with/to" or "connected to" another element (e.g.: a second element) should be interpreted to include both the case where the one element is directly coupled to the another element, and the case where the one element is coupled to the another element through still another element (e.g.: a third element).

In contrast, the description that one element (e.g.: a first element) is "directly coupled" or "directly connected" to another element (e.g.: a second element) can be interpreted to mean that still another element (e.g.: a third element) does not exist between the one element and the another element.

Also, the expression "configured to" used in the disclosure may be interchangeably used with other expressions such as "suitable for," "having the capacity to," "designed to," "adapted to," "made to," and "capable of," depending on cases. Meanwhile, the term "configured to" may not necessarily mean that an apparatus is "specifically designed to" in terms of hardware.

Instead, under some circumstances, the expression "an apparatus configured to" may mean that the apparatus "is capable of" performing an operation together with another apparatus or component. For example, the phrase "a processor configured to perform A, B, and C" may mean a dedicated processor (e.g.: an embedded processor) for performing the corresponding operations, or a generic-purpose processor (e.g.: a CPU or an application processor) that can perform the corresponding operations by executing one or more software programs stored in a memory device.

Also, in the embodiments of the disclosure, 'a module' or 'a part' may perform at least one function or operation, and may be implemented as hardware or software, or as a combination of hardware and software. In addition, a plurality of 'modules' or 'parts' may be integrated into at least one module and implemented as at least one processor, excluding 'a module' or 'a part' that needs to be implemented as specific hardware.

Meanwhile, various elements and areas in the drawings were illustrated schematically. Accordingly, the technical idea of the disclosure is not limited by the relative sizes or intervals illustrated in the accompanying drawings.

Hereinafter, embodiments according to the disclosure will be described in detail with reference to the accompanying drawings, such that a person having ordinary knowledge in the technical field to which the disclosure belongs can easily carry out the embodiments.

FIG. **1** is a diagram for illustrating a display apparatus according to an embodiment of the disclosure.

A display apparatus **100** may be implemented as a TV, a smartphone, a tablet, etc. Also, the display apparatus **100** may display a screen through a display panel.

Also, the display apparatus **100** may include a backlight unit that provides light to the display panel by using a plurality of light-emitting elements. In this case, the plurality of light-emitting elements of the backlight unit may emit light by a driving current provided to the plurality of light-emitting elements.

Meanwhile, the brightness of the display panel of the display apparatus **100** may be adjusted by analog dimming control. In this case, the brightness of the display panel may be determined in proportion to the amplitude of a driving current. Also, the amplitude of a driving current may be determined based on the amplitude of a driving voltage applied to a driver and a resistance value of an output resistor connected to the driver.

Meanwhile, according to the specifications of components such as an FET and a TR inside the driver, the amplitude of an applied driving voltage that can be recognized by the driver may be restricted. Also, if a value of the output resistor is fixed to a specific value, the range of the amplitude of a driving current determined based on a driving voltage and the output resistor may also be restrictive.

Accordingly, the range of the brightness of the display panel determined according to the amplitude of a driving current in a restricted range may fall under a partial range in a brightness range of the display panel that can be set.

For example, in case the range of brightness values of the display panel that can be set is from 0 to 100, the range of brightness values of the display panel determined according to a driving current having an amplitude of a restricted range may be from 31 to 100.

Accordingly, the display apparatus **100** according to an embodiment of the disclosure may set a resistance value of the output resistor based on a brightness value of the display panel, and identify the amplitude of a driving voltage corresponding to the brightness value of the display panel among amplitudes of the driving voltage according to a plurality of brightnesses corresponding to the set resistance value, and apply the driving voltage in the identified amplitude to the driver.

As described above, according to an embodiment of the disclosure, the range of the amplitude of a driving current provided to the plurality of light-emitting elements can be extended, and thus the display apparatus **100** can adjust the entire range of brightnesses of the display panel just by analog dimming control. That is, according to an embodiment of the disclosure, increase of fatigue of the eyes of a user by flickers generated by pulse width modulation control can be prevented.

FIG. **2** is a block diagram for illustrating a configuration of a display apparatus according to an embodiment of the disclosure.

The display panel **110** may display a screen. For this, the display panel **110** may be implemented as display panels **110** in various types such as a liquid crystal display (LCD).

The backlight unit **120** may provide light to the display panel **110** by using the plurality of light-emitting elements. For this, the backlight unit **120** may include light-emitting elements in various types such as solid light-emitting diodes (LEDs).

The driver **130** may provide a driving current to the plurality of light-emitting elements of the backlight unit **120**. For this, the driver **130** may be connected with a DC to DC converter for generating a driving current.

For example, referring to FIG. **3**, the driver **130** may be connected with a buck-boost converter **310** through one terminal among a plurality of terminals. Also, the buck-boost converter **310** may apply a voltage (V_LED) to the plurality of light-emitting elements of the backlight unit based on a gate voltage received from the driver **130**. Accordingly, a driving current may flow in the plurality of light-emitting elements.

Meanwhile, the amplitude of a driving current may be determined based on the amplitude of a driving voltage applied to the driver **130** and a resistance value of the output resistor **340**. Specifically, the amplitude of a driving current may be calculated by the formula as follows.

$$I_{LED} = k\frac{V_{Admin}}{R_{ISET}} \times \mathrm{duty}_{pdim} \quad \text{[Formula 1]}$$

Here, I_{LED} means a driving current flowing in the plurality of light-emitting elements.

K is a coefficient according to the characteristic of the driver **130**, and may have an intrinsic value.

A_{dim} means a driving voltage which is a signal **320** applied to an analog dimming terminal.

R_{ISET} means a resistance value of the output resistor **340** connected to the driver **130**.

duty_{pdim} means a duty ratio which is a signal **330** applied to a pulse width modulation dimming terminal, and in case the brightness of the display panel **110** is adjusted by analog dimming control, duty_{pdim} may have a value of 1.

In the memory **140**, data for operations of the display apparatus **100** may be stored. In particular, in the memory **140**, information about the amplitudes of a driving voltage according to a plurality of brightnesses for each resistance value of the output resistor **340** connected to the driver **130** may be stored, and detailed explanation in this regard will be described later.

Also, in the memory **140**, at least one instruction regarding the display apparatus **100** may be stored. In addition, in the memory **140**, an operating system (O/S) for driving the display apparatus **100** may be stored. Further, in the memory **140**, various kinds of software programs or applications for the display apparatus **100** to operate according to the various embodiments of the disclosure may be stored. For this, the memory **140** may store a semiconductor memory such as a volatile memory, a flash memory, etc., or a magnetic storage medium such as a hard disk, etc.

The processor **150** may be electrically connected with the display panel **110**, the backlight unit **120**, the driver **130**, and the memory **140**, and control the overall operations and functions of the display apparatus **100**.

For this, the processor **150** may include a central processing unit (CPU) or an application processor (AP), and may execute one or more software programs stored in the memory **140** according to the at least one instruction stored in the memory **140** of the display apparatus **100**.

First, the processor **150** may set a resistance value of the output resistor based on a brightness value of the display panel **110**.

Here, the brightness value of the display panel **110** may be set within a brightness range until a second brightness value increasing in stages from a first brightness value. Here, the first brightness value may be a minimum brightness value that can be set in the display panel **110**, and the second brightness value may be maximum brightness value that can be set in the display panel **110**.

For example, in case the minimum brightness value that can be set in the display panel **110** is 0, and the maximum brightness value that can be set is 100, the brightness value of the display panel **110** may be set as a value from 0 to 100.

Also, the brightness value of the display panel **110** may be set based on a user instruction. Specifically, the processor **150** may receive a user's instruction input through a user inputter (not shown), and set a brightness value corresponding to the received instruction as the brightness value of the display panel **110**.

Also, when the display apparatus **100** is turned on, the processor **150** may identify the brightness value of the display panel **110** set as a default, and set a resistance value of the output resistor **340** based on the identified brightness value.

For this, the memory **140** may include information about the brightness value of the display panel **110** set as the default. Here, the brightness value of the display panel **110** set as the default may be the brightness value of the display panel **110** before the display apparatus **100** was turned off.

For this, the processor **150** may store the information about the brightness of the display panel **110** currently set in the memory **140** when the display apparatus **100** is in a turned-on state.

Then, the processor **150** may set the resistance value of the output resistor **340** based on the identified brightness of the display panel **110**.

Specifically, in case the set brightness value of the display panel **110** is smaller than or equal to a predetermined brightness value, the processor **150** may set the resistance value of the output resistor **340** as a first resistance value, and in case the brightness value of the display panel **110** is greater than the predetermined brightness value, the processor **150** may set the resistance value of the output resistor **340** as a second resistance value.

Also, if the brightness value of the display panel **110** is changed to a value smaller than or equal to the predetermined brightness value based on a user input, the processor **150** may change the resistance value of the output resistor **340** set as the second resistance value to the first resistance value, and if the brightness value of the display panel **110** is changed to a value greater than the predetermined brightness value based on a user input, the processor **150** may change the resistance value of the output resistor **340** set as the first resistance value to the second resistance value.

For this, the output resistor **340** may be constituted as a variable resistance circuit of which resistance value may change. Specifically, a resistance value of the output resistor **340** may be set based on a signal received from the processor **150**.

For example, as in FIG. **4**, the output resistor **340** may be constituted as a variable resistance circuit that may have a resistance value of R1+R2 or a resistance value of R3+R4. In this case, the processor **150** may set the resistance value of the output resistor **340** as R1+R2 or set it as R3+R4 by applying an RISET_SEL signal to the variable resistance circuit.

As an example, if an RISET_SEL signal is applied to the variable resistance circuit as a high signal (e.g., 3.3V), the resistance value of the output resistor **340** may be set as R1+R2. As another example, if an RISET_SEL signal is applied to the variable resistance circuit as a low signal (e.g., 0V), the resistance value of the output resistor **340** may be set as R3+R4.

Here, the variable resistance circuit in FIG. **4** is merely an example for setting a resistance value of the output resistor **340**, and is not necessarily limited thereto. That is, the output resistor **340** may be constituted as various circuits of which resistance values may change based on a signal received from the processor **150**.

Meanwhile, the amplitude of a driving current may be relatively bigger in a case wherein the resistance value of the output resistor is set as the second resistance value than a case wherein the resistance value of the output resistor is set as the first resistance value. In this case, the first resistance value may have a bigger value than the second resistance value.

For example, as in FIG. **5**, in case the brightness of the display panel **110** is greater than a predetermined brightness (a threshold brightness), the resistance value of the variable resistor **340** may be set as R_A, and in case the brightness of the display panel **110** is smaller than or equal to the predetermined brightness (the threshold brightness), the resistance value of the variable resistor **340** may be set as R_B. Also, the amplitude of a driving current may be bigger than I_{med} in a case wherein the variable resistor **340** is set as R_A, and smaller than or equal to I_{med} in a case wherein the variable resistor **340** is set as R_B.

For this, the predetermined brightness value may be one of brightness values of the display panel **110** that are determined according to amplitudes of a driving current in an overlapping range between a range of amplitudes of a driving current that can be provided to the plurality of light-emitting elements by the driver **130** when the resistance value of the output resistor is the first resistance value and a range of amplitudes of a driving current that can be provided to the plurality of light-emitting elements by the driver **130** when the resistance value of the output resistor is the second resistance value.

For example, as in FIG. **6**, when a driving voltage is applied to the driver **130** from V**1** to V**2**, if the resistance value of the output resistor **340** is R_A, the amplitude of a driving current may have a size from I_{RA1} to I_{RB2} as in the graph **610**. Also, when a driving voltage is applied to the driver **130** from V**1** to V**2**, if the resistance value of the output resistor **340** is R_B, the amplitude of a driving current may have a size from I_{RA1} to I_{RB2} as in the graph **620**.

In this case, the amplitude of the driving current in the range from I_{RA1} to I_{RB2} is a range wherein the range of the amplitude of the driving current in case the resistance value of the output resistor **340** is R_A and the range of the amplitude of the driving current in case the resistance value of the output resistor **340** is R_B overlap. Accordingly, the predetermined brightness value may be the brightness value of the display panel **110** that is determined according to a driving current when the amplitude of the driving current has any value within the range from I_{RA1} to I_{RB2}.

In this case, the predetermined brightness value may be the minimum brightness among the brightness values of the display panel **110** that are determined according to the amplitudes of a driving current in an overlapping range.

Specifically, if the resistance value of the output resistor is the second resistance value, and the minimum voltage among the ranges of voltages that can be applied to the driver **130** is applied to the driver **130**, the brightness value of the display panel **110** that is determined according to a driving current may be the predetermined brightness value.

For example, as in FIG. **6**, a case wherein the amplitudes of a driving current in an overlapping range are from I_{RA1} to I_{RB2} is assumed. In this case, the predetermined brightness value may be the brightness value of the display panel **110** that is determined according to I_{RA1} that has the lowest amplitude within the range from I_{RA1} to I_{RB2}.

In this case, I_{RA1} may be the amplitude of a driving current when the resistance value of the output resistor **340** is R_A, and V**1** which is the minimum voltage in the range of a driving voltage (from V**1** to V**2**) that can be applied to the driver **130** is applied to the driver **130**.

Also, the predetermined brightness value may be the brightness value of the display panel **110** that is determined according to a driving current having an amplitude of I_{RA1}.

Here, when the resistance value of the output resistor is R_B, V_x which is the amplitude of a voltage applied to the driver for providing a driving current having an amplitude of I_{RA1} to the light-emitting elements may be determined based on the following formula 2.

$$I_{RA1} = \frac{kV_1}{R_A} = \frac{kV_x}{R_B} \qquad \text{[Formula 2]}$$

$$V_x = \frac{R_B V_1}{R_A}$$

As described above, according to an embodiment of the disclosure, the display apparatus **100** can extend the range of amplitudes of a driving current by changing resistance values of the output resistor, and thus the range of the brightness of the display panel **110** wherein the brightness can be controlled by analog dimming control can be increased.

Meanwhile, the processor **150** may identify the amplitude of a driving voltage corresponding to the brightness value of the display panel **110** among the amplitudes of the driving voltage according to a plurality of brightnesses corresponding to resistance values set based on the information stored in the memory **140**.

For this, the memory **140** may store information about the amplitudes of a driving voltage according to a plurality of brightnesses for each of the first resistance value and the second resistance value.

In this case, if the brightness value of the display panel **110** is set in stages from the first brightness value to the predetermined brightness value, the amplitude of a driving voltage according to a plurality of brightness values corresponding to the first resistance value may be set such that the amplitude of a driving current continuously increases.

Also, in case the brightness value of the display panel **110** is set in stages from a third brightness value to the second brightness value, the amplitude of a driving voltage according to a plurality of brightness values corresponding to the second resistance value may be set such that the amplitude of a driving current continuously increases.

Here, the third brightness value may be a brightness value in a next stage of the predetermined brightness value.

Also, in case the brightness value of the display panel **110** is set in stages from the first brightness value to the second brightness value, the brightness of the display panel **110** may continuously increase according to a driving current.

For example, as in the graph **710** in FIG. **7**A, the brightness of the display panel **110** may be determined according to the amplitude of a driving current. Here, if the brightness value of the display panel **110** is smaller than or equal to the threshold brightness, in case the resistance value of the output resistor is set as R_A, and the brightness value of the display panel **110** is greater than the threshold brightness, the resistance value of the output resistor may be set as R_B.

In this case, the amplitude of the driving current may continuously increase as the brightness value of the display panel **110** increases from the threshold brightness to 30, and may continuously increase as the brightness value of the display panel **110** increases from the threshold brightness to 100.

Also, the amplitude of the driving current may continuously increase as the brightness value of the display panel **110** increases from 0 to 100. That is, the amplitude of the driving current may continuously increase as the brightness value increases in the entire sections of the brightnesses that can be set in the display panel **110**.

Meanwhile, for determining a driving current as in the graph **710** in FIG. **7**A, a driving voltage applied to the driver **130** may be determined for each resistance value of the output resistor based on formula 1.

For example, as in the graph **720** in FIG. **7**B, an amplitude of a driving voltage according to the plurality of brightnesses of the display panel **110** in a case wherein the resistance value of the output resistor is RA may be determined, and an amplitude of a driving voltage according to the plurality of brightnesses of the display panel **110** in a case wherein the resistance value of the output resistor is RB may be determined. Here, the value of V_x may be determined based on formula 2, as described above.

Also, information about the amplitudes of a driving voltage according to the plurality of brightnesses of the display panel **110** may be matched for each resistance value of the output resistor and stored in the memory **140**.

In this case, the brightness values of the display panel **110** that are matched with the amplitudes of a driving voltage and stored in the memory **140** may fall under a stage of the brightnesses that can be set in the display panel **110**. For example, if the brightnesses of a stage that can be set in the display panel **110** are from 0 to 100 by an interval of 1, the brightness values of the display panel **110** that are matched with the amplitudes of a driving voltage and stored in the memory **140** may be from 0 to 100 by an interval of 1.

Also, the processor **150** may identify the amplitude of a driving voltage corresponding to the brightness value of the display panel **110** that is currently set among the amplitudes of a driving voltage according to a plurality of brightnesses of a resistance value set based on the information stored in the memory **140**.

For example, as in FIG. **8**A and FIG. **8**B, the memory **140** may include information **810** about the amplitudes of a driving voltage according to the plurality of brightnesses of the display panel **110** in case the resistance value of the output resistor is R_A, and information **820** about the amplitudes of a driving voltage according to the plurality of brightnesses of the display panel **110** in case the resistance value of the output resistor is R_B.

As an example, a case wherein the brightness value of the display panel **110** is set as 97 is assumed. In this case, as in FIG. **8**A, from the information **810** about the amplitudes of a driving voltage according to the plurality of brightnesses of the display panel **110** in case the resistance value of the output resistor is R_A, the processor **150** may identify that the amplitude of a driving voltage 3.24V corresponding to the brightness value of the display panel **110**, i.e., 97 is the amplitude of a driving voltage corresponding to the brightness value of the display panel **110**.

As another example, a case wherein the brightness value of the display panel **110** is set as 4 is assumed. In this case, as in FIG. **8**B, from the information **820** about the amplitudes of a driving voltage according to the plurality of brightnesses of the display panel **110** in case the resistance value of the output resistor is R_B, the processor **150** may identify that the amplitude of a driving voltage 1.36V corresponding to the brightness value of the display panel **110**, i.e., 4 is the amplitude of a driving voltage corresponding to the brightness value of the display panel **110**.

Meanwhile, in FIG. **8**A and FIG. **8**B, the brightness value 30 of the display panel **110** may be the predetermined brightness value. That is, in case the resistance value of the output resistor is R_A, the memory **140** may include information about the amplitudes of a driving voltage according to the brightnesses of the display panel **110** wherein the brightnesses are from 100 which is the maximum brightness value to 30 which is the predetermined brightness value, and in case the resistance value of the output resistor is R_B, the memory **140** may include information about the amplitudes of a driving voltage according to the brightnesses of the display panel **110** wherein the brightnesses are from 30 which is the predetermined brightness value to 0 which is the minimum brightness value.

However, this is merely an example, and the range of the plurality of brightnesses of the display panel **110** stored in the memory **140** does not need to be restricted. As an example, in case the resistance value of the output resistor is R_A, the memory **140** may include information about the amplitudes of a driving voltage according to the brightnesses of the display panel **110** wherein the brightnesses are from 100 which is the maximum brightness value to a value smaller than the predetermined brightness value 30, and in case the resistance value of the output resistor is R_B, the memory **140** may include information about the amplitudes of a driving voltage according to the brightnesses of the display panel **110** wherein the brightnesses are from a value greater than the predetermined brightness value to 0 which is the minimum brightness value.

As described above, regarding a driving voltage according to a plurality of brightnesses of the display panel **110** according to an embodiment of the disclosure, a driving current may continuously increase as the brightness of the display panel **110** increases in stages. Accordingly, the display apparatus **100** may linearly adjust the brightness of the display panel **110** by analog dimming control, and can thus provide a more natural experience of brightness control to the user.

FIG. **9** is a flow chart for illustrating an operation of a display apparatus according to an embodiment of the disclosure.

First, the processor **150** may change a brightness value of the display panel **110** in operation **S910**.

Specifically, the processor **150** may receive a user's instruction input through the user inputter (not shown), and change a brightness value corresponding to the received instruction as the brightness value of the display panel **110**.

Then, the processor **150** may identify whether the changed brightness value exceeds a predetermined brightness value in operation S**920**. Here, as the explanation regarding the predetermined brightness value was described above in FIG. **5**, detailed explanation will be omitted.

Then, if it is identified that the changed brightness value exceeded the predetermined brightness value in operation S**920**-Y, the processor **150** may identify that the resistance value of the output resistor is the second resistance value in operation S**930**. In contrast, if it is identified that the changed brightness value is smaller than or equal to the predetermined brightness value in operation S**920**-N, the processor **150** may identify that the resistance value of the output resistor is the first resistance value in operation S**940**. Here, as the method for setting the resistance value of the output resistor to the first resistance value or the second resistance value was described above in FIG. **4**, detailed explanation will be omitted.

Then, the processor **150** may set an amplitude table of a driving voltage according to a plurality of brightnesses based on the resistance value of the output resistor in operation S**950**. Here, the amplitude table of a driving voltage according to the plurality of brightnesses may be information about the amplitudes of a driving voltage according to the plurality of brightnesses as in FIG. **7**A and FIG. **7**B.

Then, the processor **150** may apply a driving voltage corresponding to the changed brightness value to the driver **130** in operation S**960**.

As described above, the display apparatus **100** according to an embodiment of the disclosure can extend the range of amplitudes of a driving current by changing the resistance value of the output resistor when changing the brightness of the display panel **110** to a brightness value of the display panel **110** corresponding to a user instruction, and thus the display apparatus **100** can adjust the entire sections of the brightness of the display panel **110** by analog dimming control.

FIG. **10** is a flow chart for illustrating a method for controlling a display apparatus according to an embodiment of the disclosure.

First, a resistance value of the output resistor connected to the driver is set based on a brightness value of the display panel in operation S**1010**.

Then, an amplitude of a driving voltage corresponding to the brightness value of the display panel among amplitudes of the driving voltage according to the plurality of brightnesses corresponding to the set resistance value is identified based on information about the amplitudes of the driving voltage according to the plurality of brightnesses for each resistance value of the output resistor in operation S**1020**.

Then, the driving voltage of the identified amplitude is applied to the driver, and a driving current is provided to the plurality of light-emitting elements based on the amplitude of the applied driving voltage in operation S**1030**.

In this case, the brightness value of the display panel may be set within a brightness range until a second brightness value increasing in stages from a first brightness value.

Also, in the operation S**1010**, in case the brightness value of the display panel is smaller than or equal to a predetermined brightness value, the resistance value of the output resistor may be set as a first resistance value, and in case the brightness value of the display panel is greater than the predetermined brightness value, the resistance value of the output resistor may be set as a second resistance value.

In this case, the predetermined brightness value may be greater than the first brightness value and smaller than the second brightness value.

Also, in the operation S**1010**, if the brightness value of the display panel is changed to a value smaller than or equal to the predetermined brightness value based on a user input, the resistance value of the output resistor set as the second resistance value may be changed to the first resistance value.

Further, if the brightness value of the display panel is changed to a value greater than the predetermined brightness value based on a user input, the resistance value of the output resistor set as the first resistance value may be changed to the second resistance value.

In this case, the amplitude of the driving current may be relatively bigger in a case wherein the resistance value of the output resistor is set as the second resistance value than a case wherein the resistance value of the output resistor is set as the first resistance value.

Meanwhile, in case the brightness value of the display panel is set in stages from the first brightness value to the predetermined brightness value, the amplitude of the driving voltage according to the plurality of brightness values corresponding to the first resistance value may be set such that the amplitude of the driving current continuously increases.

Also, in case the brightness value of the display panel is set in stages from a third brightness value to the second brightness value, the amplitude of the driving voltage according to the plurality of brightness values corresponding to the second resistance value may be set such that the amplitude of the driving current continuously increases.

In addition, the third brightness value may be a brightness value in a next stage of the predetermined brightness value.

Further, in case the brightness value of the display panel is set in stages from the first brightness value to the second brightness value, the brightness of the display panel may continuously increase according to the driving current.

Meanwhile, in the operation S**1010**, when the display apparatus is turned on, a brightness value of the display panel set as a default may be identified, and the resistance value of the output resistor may be set based on the identified brightness value.

As described above, in a method for controlling a display apparatus according to an embodiment of the disclosure, the output resistor is set based on the brightness of the display panel, and thus the entire sections of the brightness of the display panel may be adjusted by analog dimming control.

FIG. **11** is a block diagram for illustrating a detailed configuration of a display apparatus according to an embodiment of the disclosure.

Referring to FIG. **11**, the display apparatus **100** may include a display panel **110**, a backlight unit **120**, a driver **130**, a memory **140**, a processor **150**, a user inputter **160**, a communication interface **170**, and a speaker **180**. Meanwhile, the components illustrated in FIG. **11** are merely an example, and it is obvious that at least some components can be omitted, or other components can be added depending on embodiments.

Also, as the display panel **110**, the backlight unit **120**, the driver **130**, the memory **140**, and the processor **150** were explained in FIG. **1** to FIG. **10**, detailed explanation regarding overlapping parts will be omitted.

The user inputter **160** is a component for receiving inputs of various user instructions. For example, the user inputter **160** may include a touch panel, etc. Also, the user inputter **160** may include a remote control signal receiver, and may receive various user instructions from a remote control, etc. for controlling the display apparatus **100**.

In this case, the processor **150** may receive a user instruction for setting the brightness of the screen through the user inputter **160**. Then, the processor **150** may set the brightness of the screen corresponding to the received user instruction as the brightness of the display panel **110**.

The communication interface **170** is a component performing communication with an external apparatus. For example, the communication interface **170** may perform communication with various external apparatuses through a wireless communication method such as Bluetooth (BT), Bluetooth Low Energy (BLE), Wireless Fidelity (WI-FI), Zigbee, etc., or an infrared (IR) communication method. Meanwhile, the communication interface **170** may not only be mounted on the processor **150**, but may also be included in the display apparatus **100** as a separate component from the processor **150**.

In this case, the processor **150** may transmit data related to the operations of the display apparatus **100** to an external apparatus through the communication interface **170**, or receive data from an external apparatus. In this case, the data received from the external apparatus may be image data or audio data that can be reproduced in the display apparatus **100**.

The speaker **180** may output an audio signal. For example, the processor **150** may output an audio signal included in the audio data through the speaker **180**.

Meanwhile, according to an embodiment of the disclosure, the various embodiments described above may be implemented as software including instructions stored in a machine-readable storage medium which can be read by machines (e.g.: computers). The machines refer to apparatuses that call instructions stored in a storage medium, and can operate according to the called instructions, and the apparatuses may include an apparatus according to the aforementioned embodiments. In case an instruction is executed by a processor, the processor may perform a function corresponding to the instruction by itself, or by using other components under its control. An instruction may include a code that is generated or executed by a compiler or an interpreter. A storage medium that is readable by a machine may be provided in the form of a non-transitory storage medium. Here, the term 'a non-transitory storage medium' only means that the storage medium is a tangible apparatus, and does not include a signal (e.g.: an electromagnetic wave), and the term does not distinguish a case wherein data is stored semi-permanently in a storage medium and a case wherein data is stored temporarily. For example, 'a non-transitory storage medium' may include a buffer wherein data is temporarily stored.

Also, according to an embodiment, the method according to the various embodiments described in the disclosure may be provided while being included in a computer program product. A computer program product refers to a product, and it can be traded between a seller and a buyer. A computer program product can be distributed in the form of a storage medium that is readable by machines (e.g.: a compact disc read only memory (CD-ROM)), or may be distributed directly between two user apparatuses (e.g.: smartphones), and distributed on-line (e.g.: download or upload) through an application store (e.g.: Play Store™). In the case of on-line distribution, at least a portion of a computer program product may be stored in a storage medium such as the server of the manufacturer, the server of the application store, and the memory of the relay server at least temporarily, or may be generated temporarily.

In addition, while preferred embodiments of the disclosure have been shown and described, the disclosure is not limited to the aforementioned specific embodiments, and it is apparent that various modifications may be made by those having ordinary skill in the technical field to which the disclosure belongs, without departing from the gist of the disclosure as claimed by the appended claims. Further, it is intended that such modifications are not to be interpreted independently from the technical idea or prospect of the disclosure.

What is claimed is:

1. A display apparatus comprising:
- a display panel;
- a backlight unit configured to provide light to the display panel by using a plurality of light-emitting elements;
- a driver configured to provide a driving current to the plurality of light-emitting elements based on an amplitude of a driving voltage;
- a memory storing information on an amplitude of a driving voltage according to a plurality of brightnesses for each resistance value of an output resistor connected to the driver; and
- a processor configured to:
  - set a resistance value of the output resistor based on a brightness value of the display panel,
  - identify an amplitude of the driving voltage corresponding to the brightness value of the display panel among amplitudes of the driving voltage according to the plurality of brightnesses corresponding to the set resistance value based on the information stored in the memory, and
  - apply the driving voltage of the identified amplitude to the driver,
- wherein
  - an amplitude of the driving current is determined based on the amplitude of the driving voltage and the resistance value of the output resistor,
  - the brightness value of the display panel is set within a brightness range until a second brightness value increasing in stages from a first brightness value, and
  - the processor is configured to:
    - based on the brightness value of the display panel being smaller than or equal to a predetermined brightness value, set the resistance value of the output resistor as a first resistance value, and based on the brightness value of the display panel being greater than the predetermined brightness value, set the resistance value of the output resistor as a second resistance value, and
    - the predetermined brightness value is greater than the first brightness value and smaller than the second brightness value.

2. The display apparatus of claim **1**, wherein the processor is configured to:
- based on the brightness value of the display panel changing to a value smaller than or equal to the predetermined brightness value based on a user input, change the resistance value of the output resistor set as the second resistance value to the first resistance value, and
- based on the brightness value of the display panel changing to a value greater than the predetermined brightness value based on a user input, change the resistance value of the output resistor set as the first resistance value to the second resistance value.

3. The display apparatus of claim **1**, wherein the amplitude of the driving current is relatively bigger in a case wherein the resistance value of the output resistor is set as the second resistance value than a case wherein the resistance value of the output resistor is set as the first resistance value.

4. The display apparatus of claim 1, wherein,

based on the brightness value of the display panel being set in stages from the first brightness value to the predetermined brightness value, the amplitude of the driving voltage according to a plurality of brightness values corresponding to the first resistance value is set such that the amplitude of the driving current continuously increases,

based on the brightness value of the display panel being set in stages from a third brightness value to the second brightness value, the amplitude of the driving voltage according to a plurality of brightness values corresponding to the second resistance value is set such that the amplitude of the driving current continuously increases, and

the third brightness value is a brightness value in a next stage of the predetermined brightness value.

5. The display apparatus of claim 4, wherein, based on the brightness value of the display panel being set in stages from the first brightness value to the second brightness value, brightness of the display panel continuously increases according to the driving current.

6. The display apparatus of claim 1, wherein the processor is configured to:

based on the display apparatus being turned on, identify a brightness value of the display panel set as a default, and set the resistance value of the output resistor based on the identified brightness value.

7. A method for controlling a display apparatus that includes a display panel, a backlight unit configured to provide light to the display panel by using a plurality of light-emitting elements, and a driver configured to provide a driving current to the plurality of light-emitting elements, the method comprising:

setting a resistance value of an output resistor connected to the driver based on a brightness value of the display panel;

based on information about an amplitude of a driving voltage according to a plurality of brightnesses for each resistance value of the output resistor, identifying an amplitude of the driving voltage corresponding to the brightness value of the display panel among amplitudes of the driving voltage according to the plurality of brightnesses corresponding to the set resistance value; and

applying the driving voltage of the identified amplitude to the driver, and providing the driving current to the plurality of light-emitting elements based on the amplitude of the applied driving voltage,

wherein

the brightness value of the display panel is set within a brightness range until a second brightness value increasing in stages from a first brightness value, and

the setting comprises:

based on the brightness value of the display panel being smaller than or equal to a predetermined brightness value, setting the resistance value of the output resistor as a first resistance value, and based on the brightness value of the display panel being greater than the predetermined brightness value, setting the resistance value of the output resistor as a second resistance value, and

the predetermined brightness value is greater than the first brightness value and smaller than the second brightness value.

8. The method of claim 7, wherein

the setting comprises:

based on the brightness value of the display panel changing to a value smaller than or equal to the predetermined brightness value based on a user input, changing the resistance value of the output resistor set as the second resistance value to the first resistance value; and

based on the brightness value of the display panel changing to a value greater than the predetermined brightness value based on a user input, changing the resistance value of the output resistor set as the first resistance value to the second resistance value.

9. The method of claim 7, wherein

the amplitude of the driving current is relatively bigger in a case wherein the resistance value of the output resistor is set as the second resistance value than a case wherein the resistance value of the output resistor is set as the first resistance value.

10. The method of claim 7, wherein,

based on the brightness value of the display panel being set in stages from the first brightness value to the predetermined brightness value, the amplitude of the driving voltage according to a plurality of brightness values corresponding to the first resistance value is set such that the amplitude of the driving current continuously increases,

based on the brightness value of the display panel being set in stages from a third brightness value to the second brightness value, the amplitude of the driving voltage according to a plurality of brightness values corresponding to the second resistance value is set such that the amplitude of the driving current continuously increases, and

the third brightness value is a brightness value in a next stage of the predetermined brightness value.

11. The method of claim 10, wherein, based on the brightness value of the display panel being set in stages from the first brightness value to the second brightness value, brightness of the display panel continuously increases according to the driving current.

12. The method of claim 10, wherein

the setting comprises:

based on the display apparatus being turned on, identifying a brightness value of the display panel set as a default, and setting the resistance value of the output resistor based on the identified brightness value.

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