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(54) **DISPLAY DEVICE AND OPERATING METHOD THEREOF**

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(57) **ABSTRACT**

Provided are a display device and an operating method thereof. The display device includes a liquid crystal display panel, a backlight unit including a plurality of light sources for supplying light to the liquid crystal display panel and driven in a state of being divided into a plurality of blocks corresponding to the number of the light sources, and a backlight dimming controller configured to calculate dimming values of the plurality of blocks. The backlight dimming controller is configured to divide each of the plurality of blocks into a plurality of unit blocks and control brightness of an output image differently for each of the unit blocks.

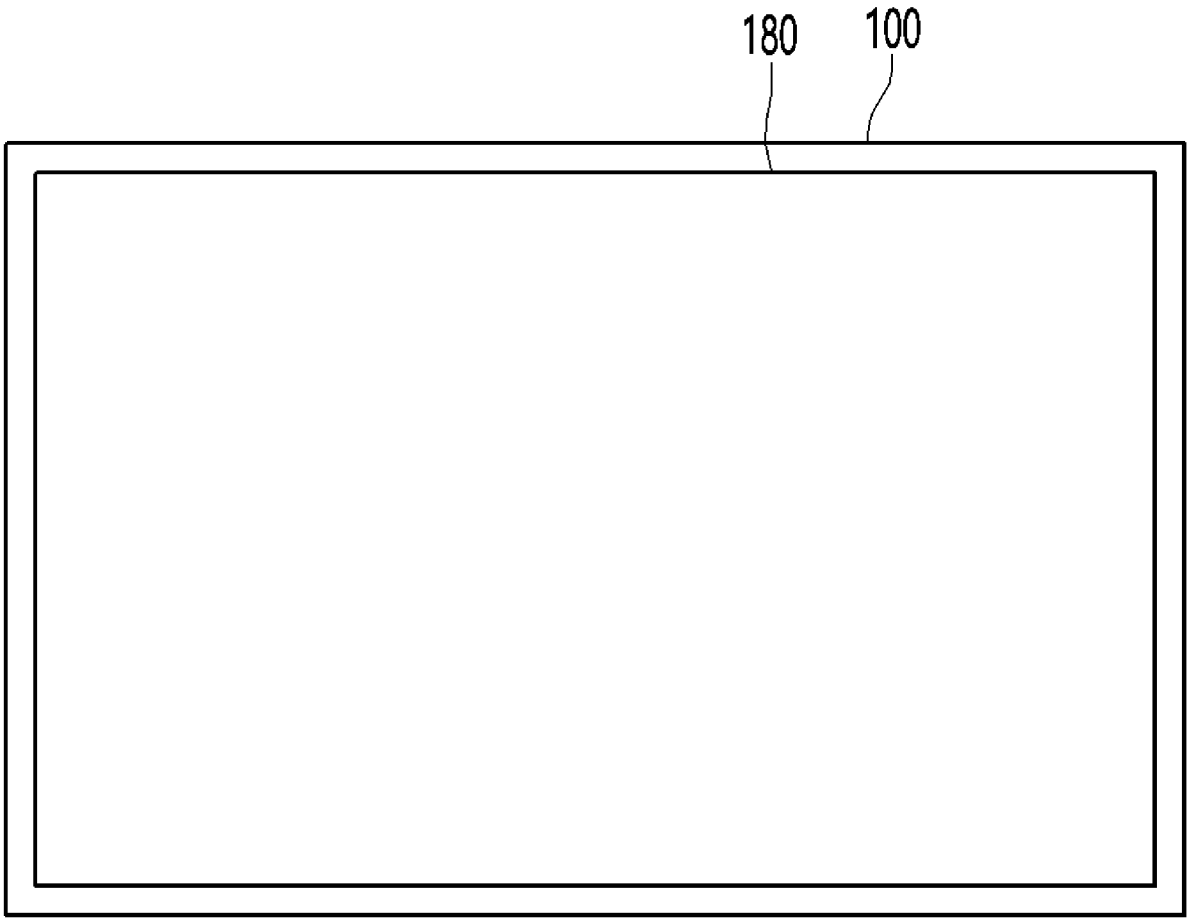


FIG. 1

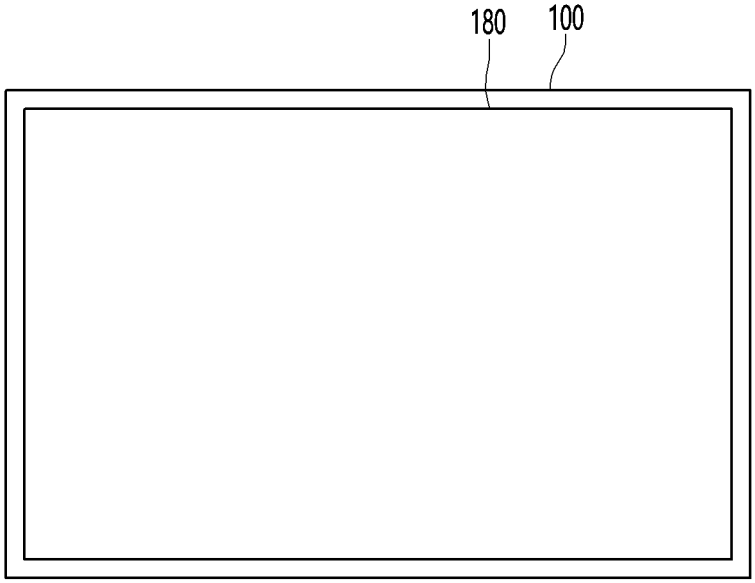


FIG. 2

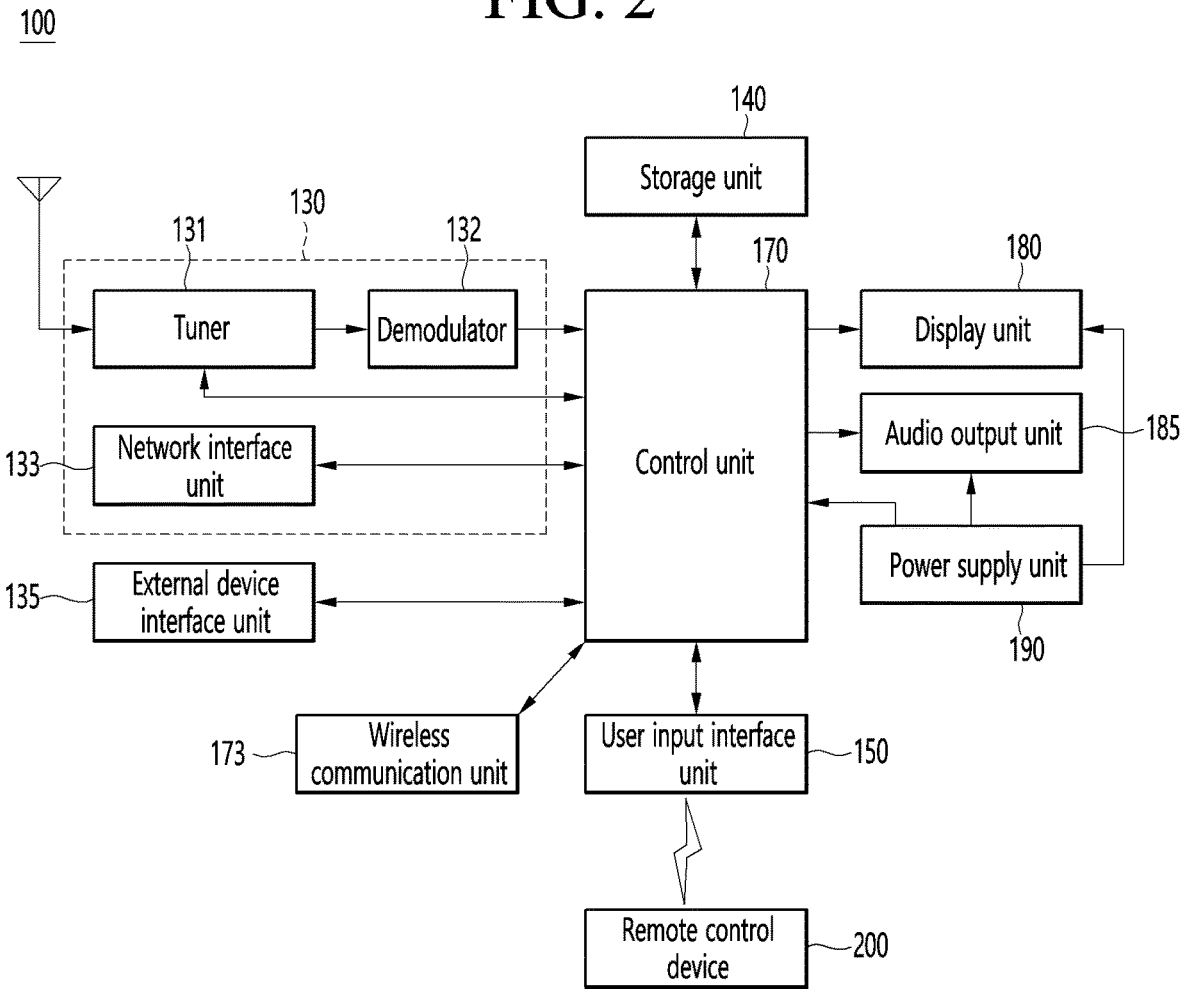

100
140
Storage unit
130
131
132
170
180
Tuner
Demodulator
Display unit
Network interface unit
133
Control unit
Audio output unit
185
Power supply unit
135
External device interface unit
190
173
Wireless communication unit
User input interface unit
150
Remote control device
200

FIG. 3

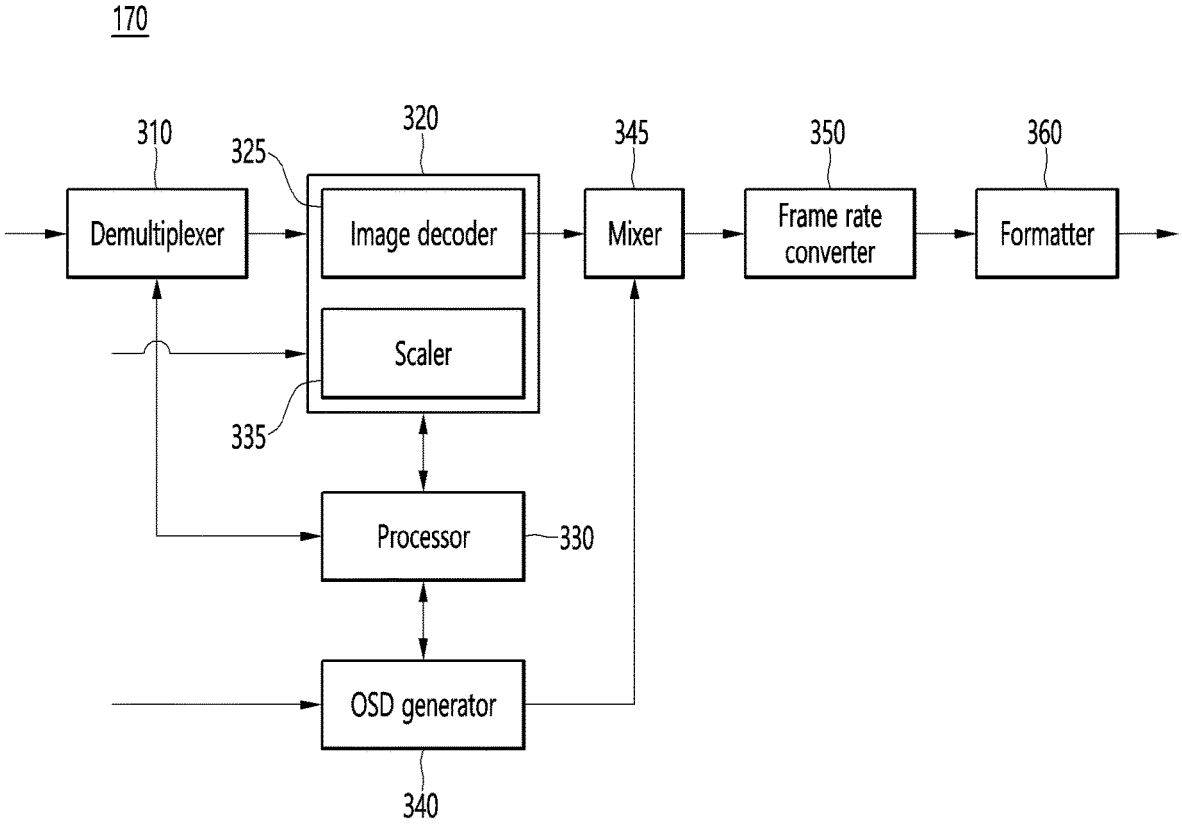

170
310
325
320
345
350
360
Demultiplexer
Image decoder
Mixer
Frame rate converter
Formatter
Scaler
335
Processor
330
OSD generator
340

FIG. 4A

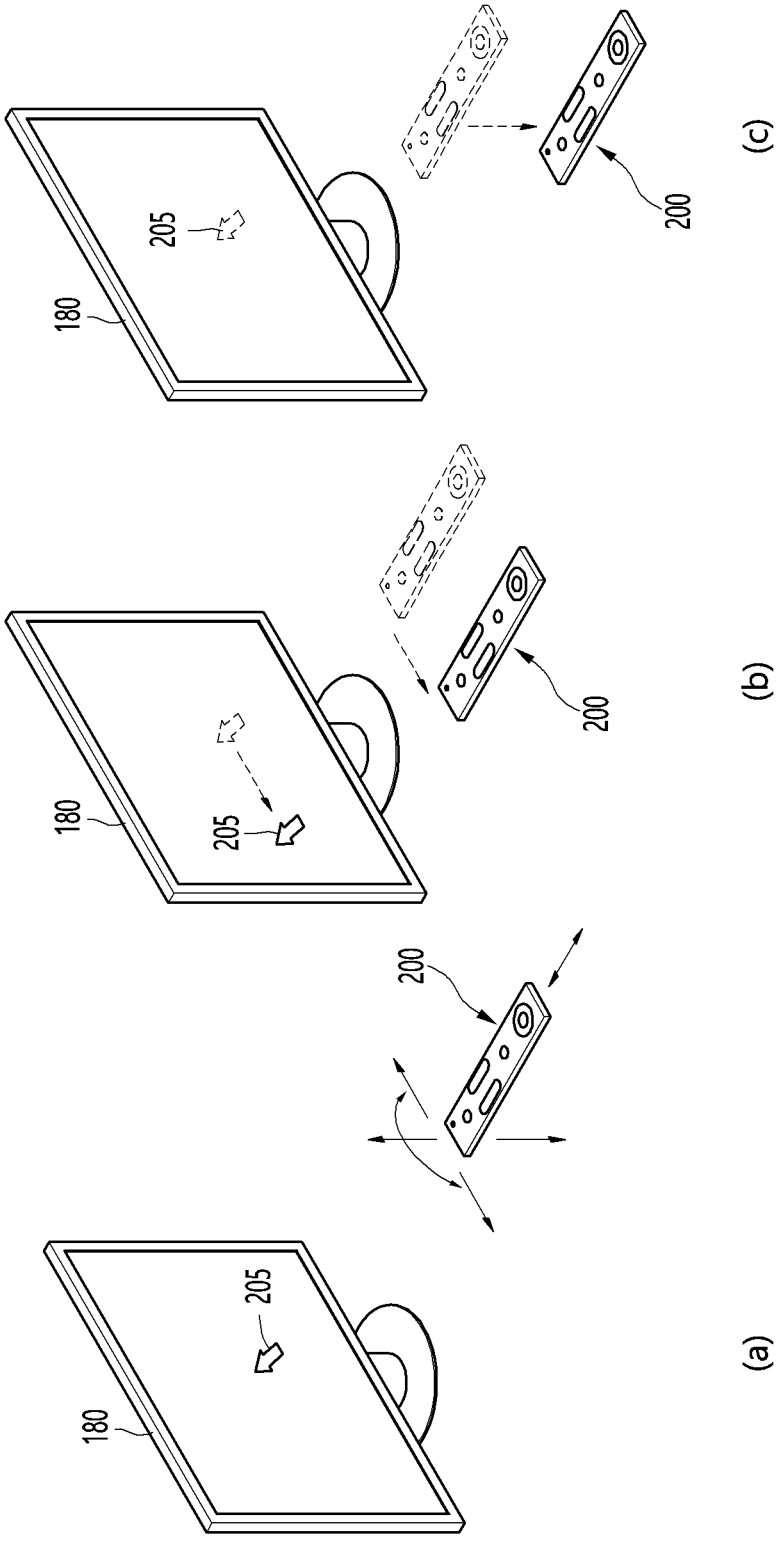


FIG. 4B

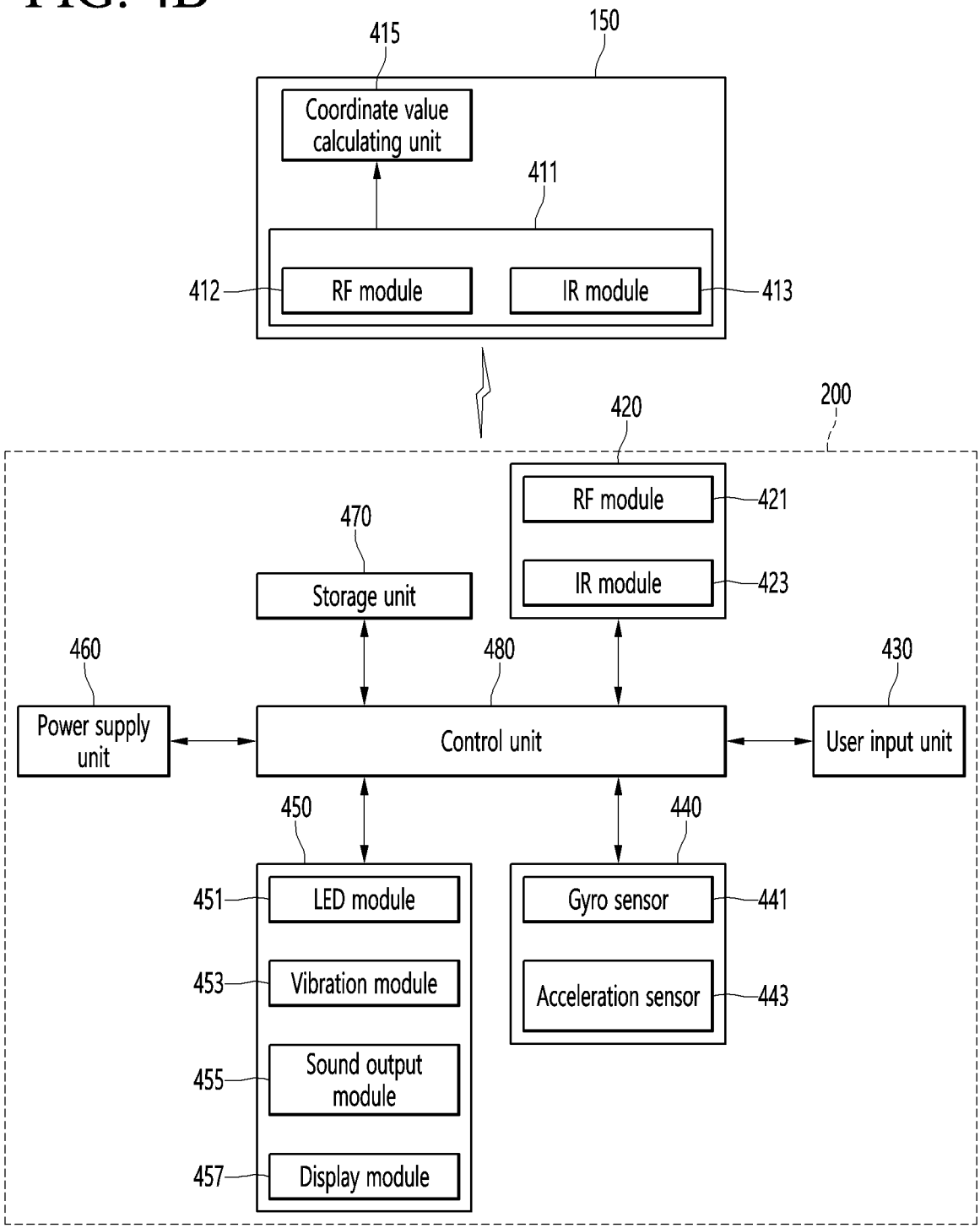

415
150
Coordinate value calculating unit
411
412
RF module
IR module
413
200
420
RF module
421
470
Storage unit
IR module
423
460
480
430
Power supply unit
Control unit
User input unit
450
440
451
LED module
Gyro sensor
441
453
Vibration module
Acceleration sensor
443
455
Sound output module
457
Display module

FIG. 5

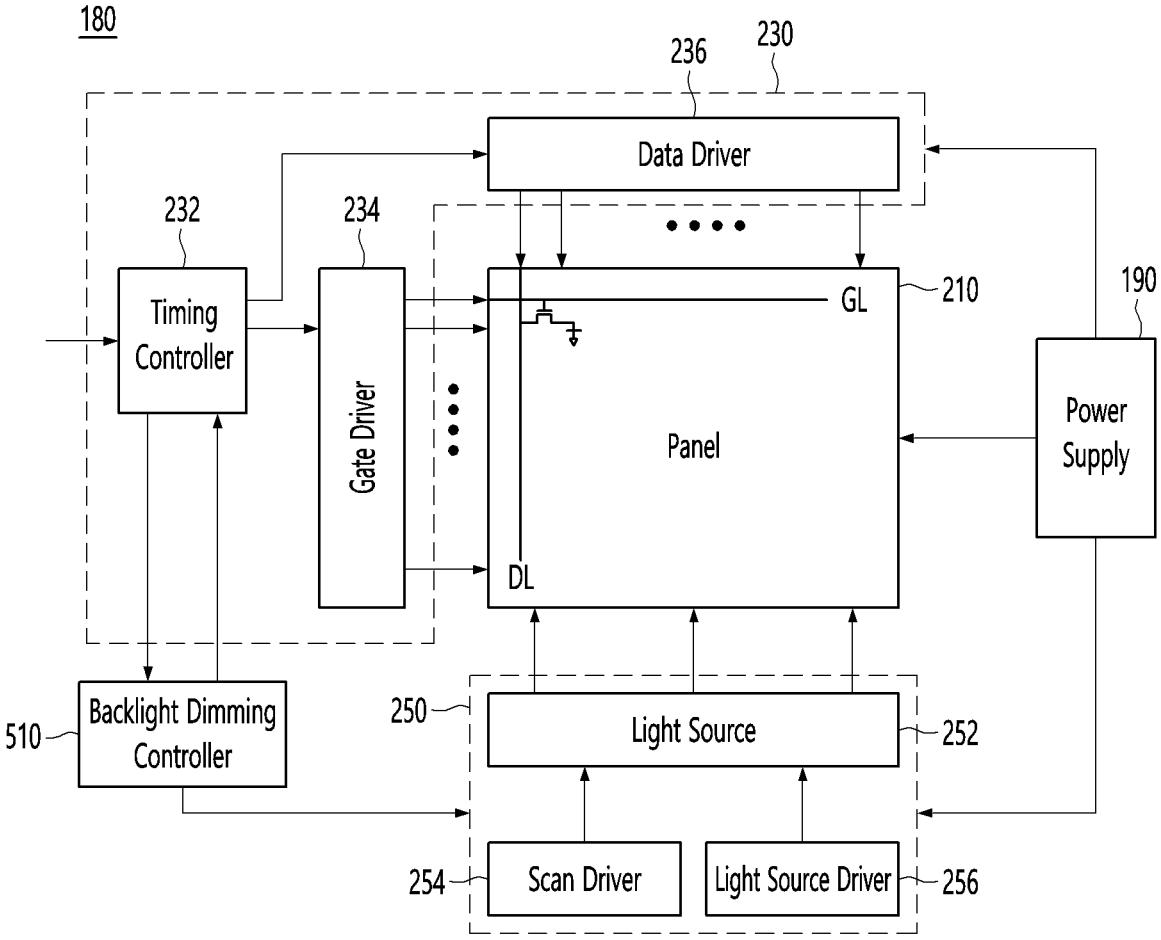

180
236
230
Data Driver
232
234
Timing Controller
Gate Driver
GL
210
190
Panel
Power Supply
DL
510
Backlight Dimming Controller
250
Light Source
252
254
Scan Driver
Light Source Driver
256

FIG. 6

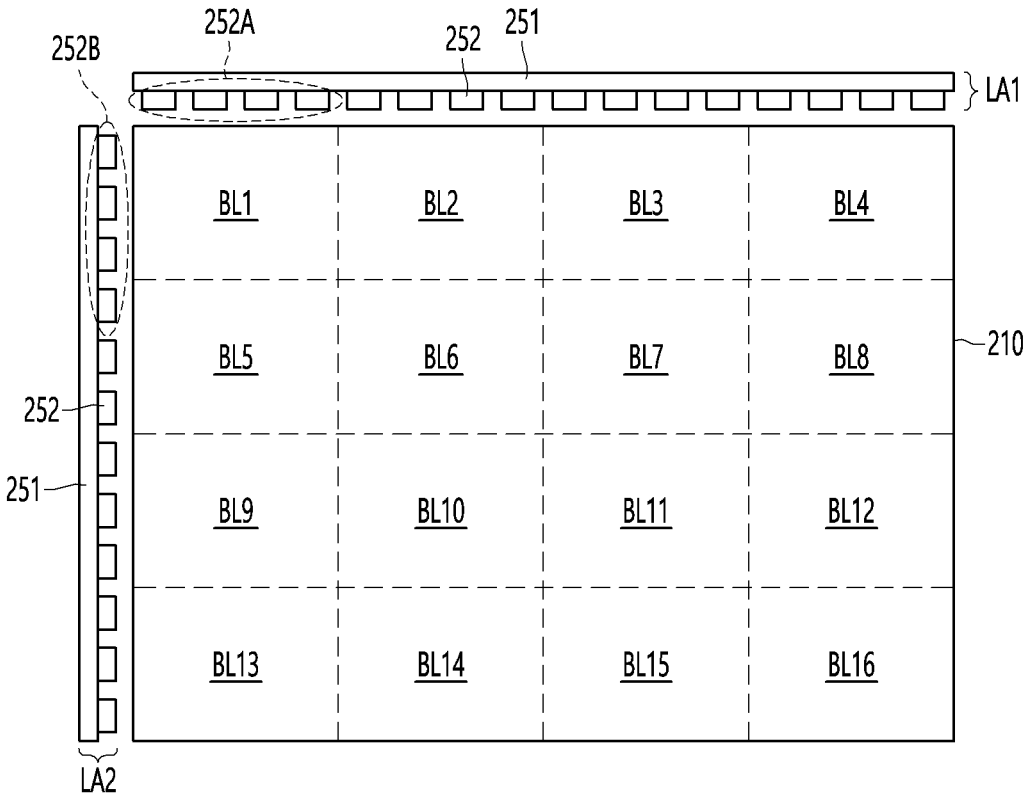

252A
252
251
252B
LA1
BL1
BL2
BL3
BL4
BL5
BL6
BL7
BL8
BL9
BL10
BL11
BL12
BL13
BL14
BL15
BL16
210
252
251
LA2

FIG. 7

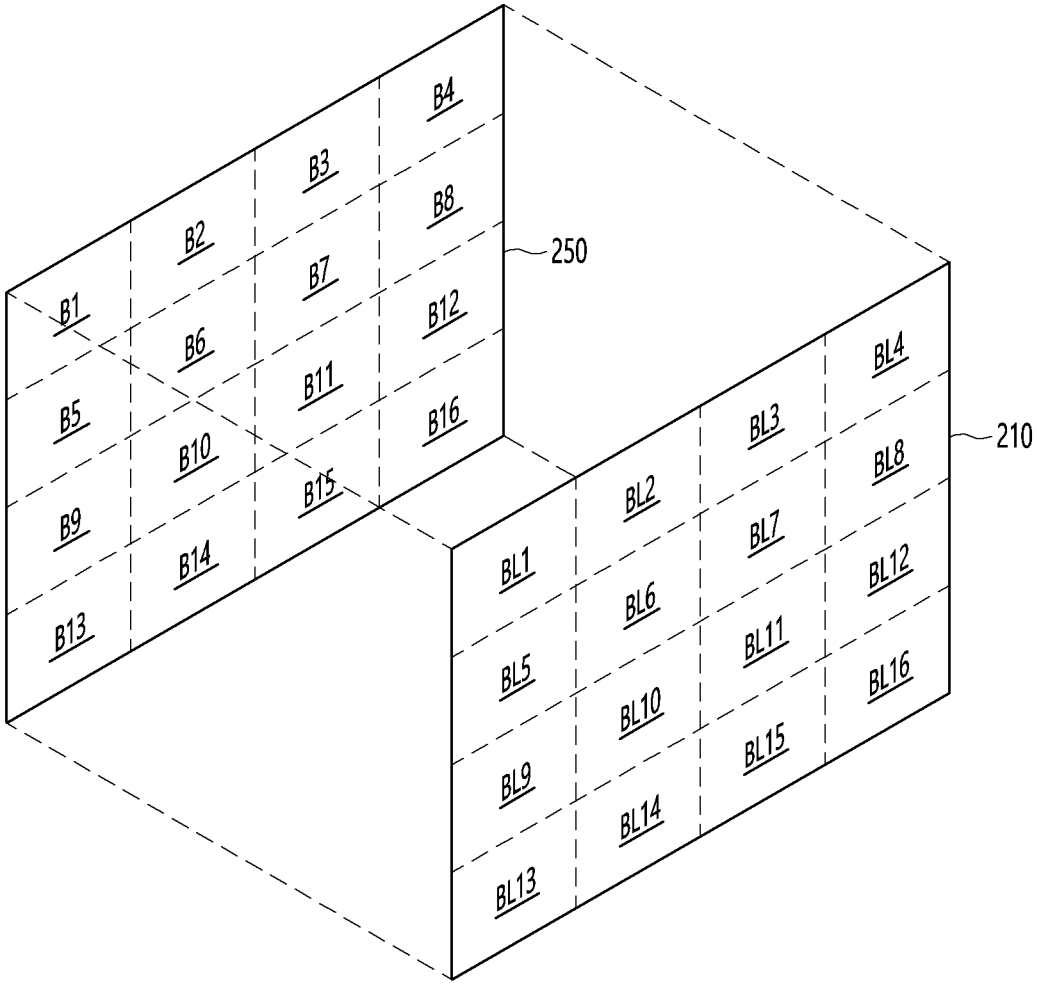

B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
B14
B15
B16
250
BL1
BL2
BL3
BL4
BL5
BL6
BL7
BL8
BL9
BL10
BL11
BL12
BL13
BL14
BL15
BL16
210

FIG. 8

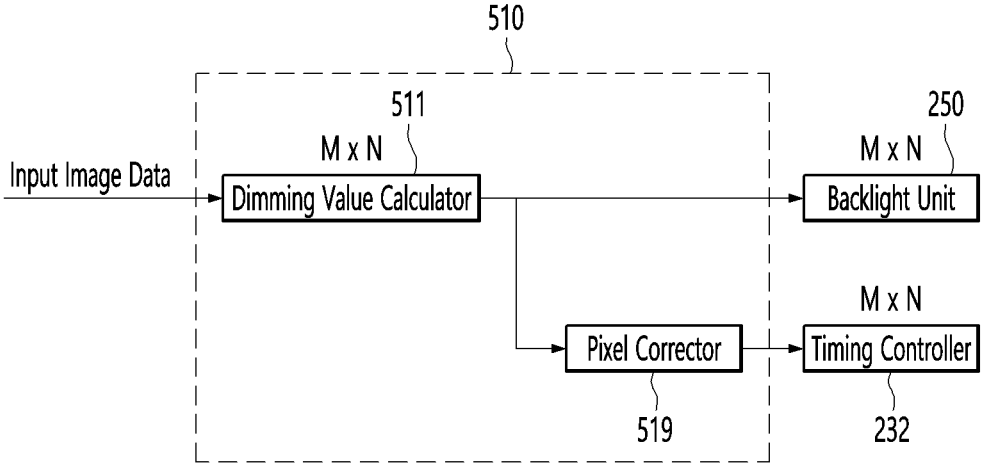

510
511
M x N
Input Image Data
Dimming Value Calculator
250
M x N
Backlight Unit
M x N
Pixel Corrector
Timing Controller
519
232

FIG. 9

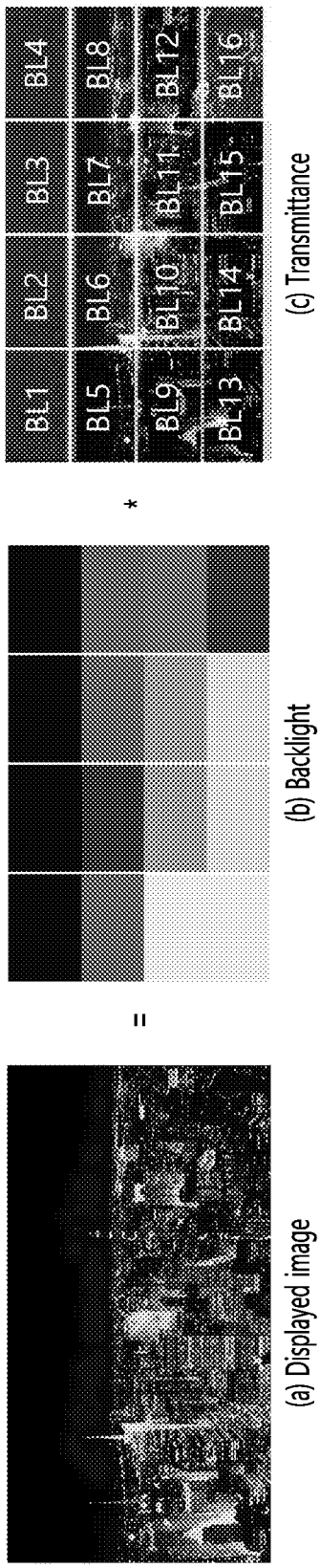

BL1
BL2
BL3
BL4
BL5
BL6
BL7
BL8
BL9
BL10
BL11
BL12
BL13
BL14
BL15
BL16
(c) Transmittance
*
(b) Backlight
=
(a) Displayed image

FIG. 10

FIG. 11

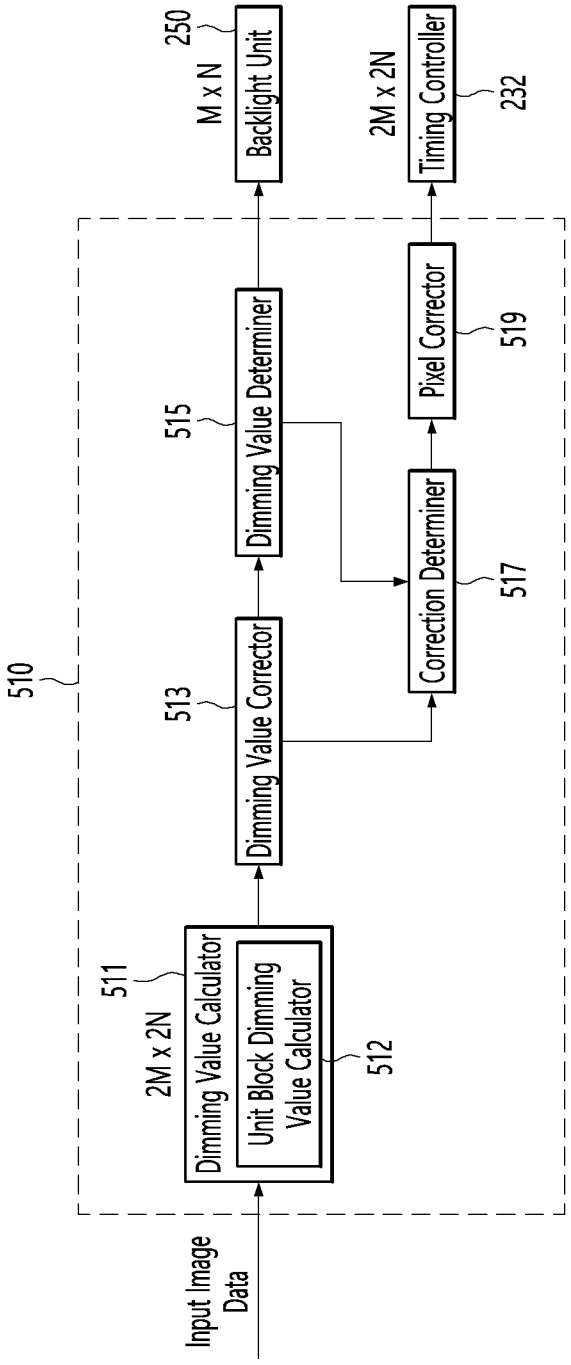

Input Image Data
510
511
2M x 2N
Dimming Value Calculator
Unit Block Dimming Value Calculator
512
513
Dimming Value Corrector
515
Dimming Value Determiner
517
Correction Determiner
519
Pixel Corrector
2M x 2N
232
Timing Controller
M x N
250
Backlight Unit

FIG. 12

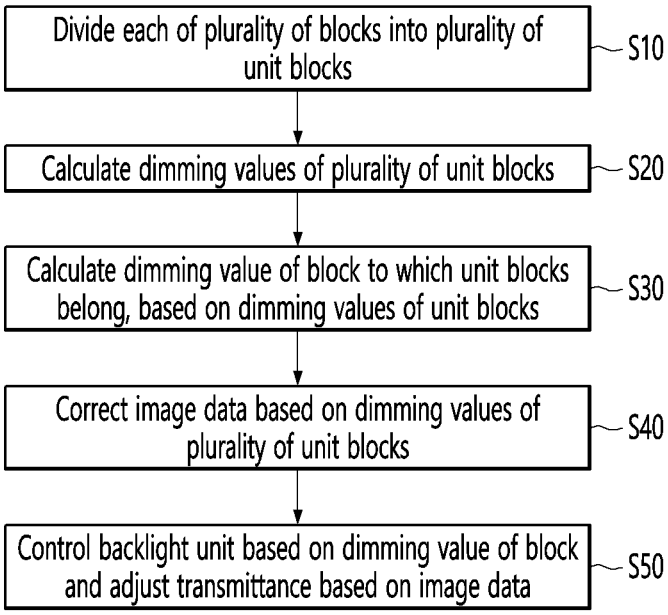

Divide each of plurality of blocks into plurality of unit blocks
S10
Calculate dimming values of plurality of unit blocks
S20
Calculate dimming value of block to which unit blocks belong, based on dimming values of unit blocks
S30
Correct image data based on dimming values of plurality of unit blocks
S40
Control backlight unit based on dimming value of block and adjust transmittance based on image data
S50

FIG. 13

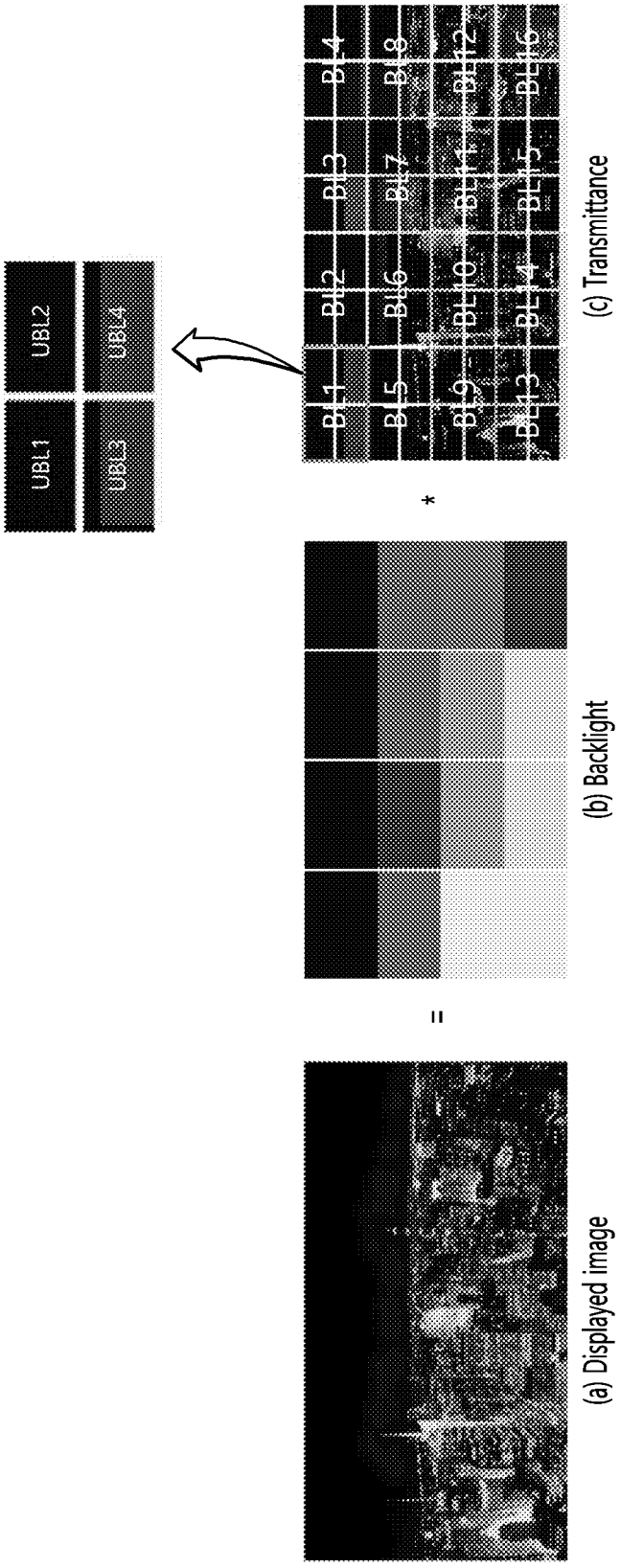

UBL1
UBL2
UBL3
UBL4
(a) Displayed image
=
(b) Backlight
*
(c) Transmittance

FIG. 14

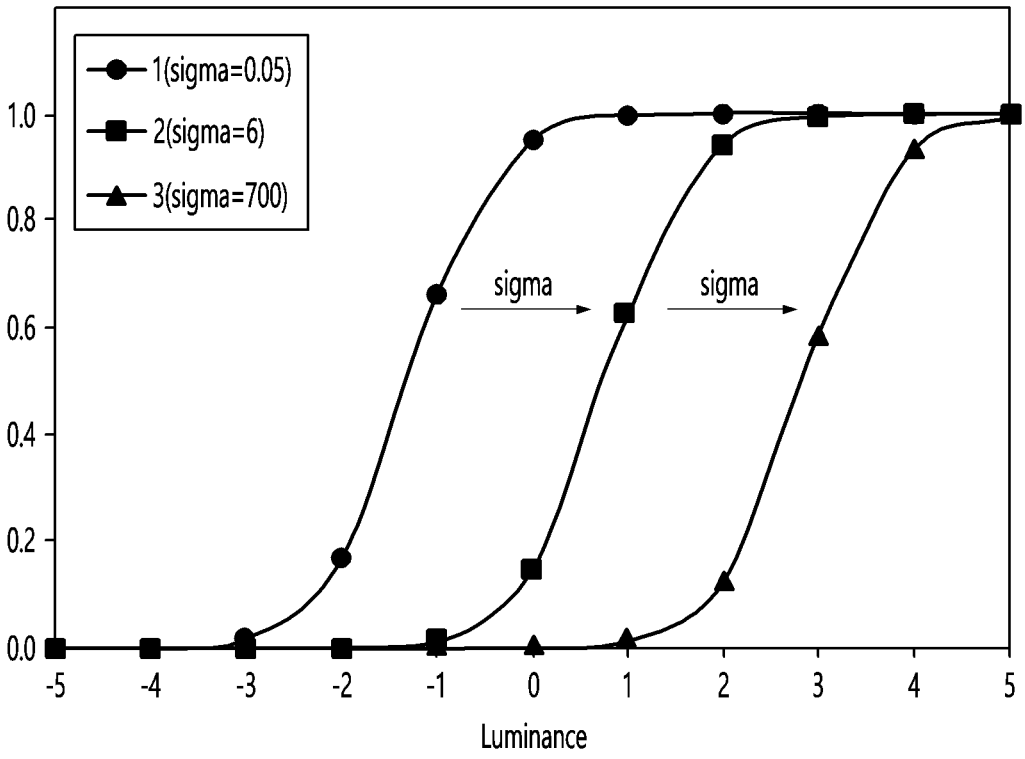

1(sigma=0.05)
2(sigma=6)
3(sigma=700)
sigma
sigma
1.0
0.8
0.6
0.4
0.2
0.0
-5
-4
-3
-2
-1
0
1
2
3
4
5
Luminance

FIG. 15

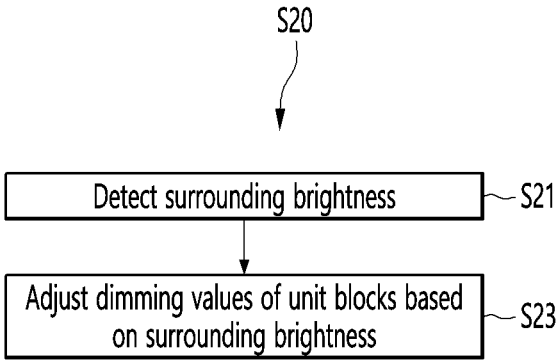

S20
Detect surrounding brightness
S21
Adjust dimming values of unit blocks based on surrounding brightness
S23

FIG. 16

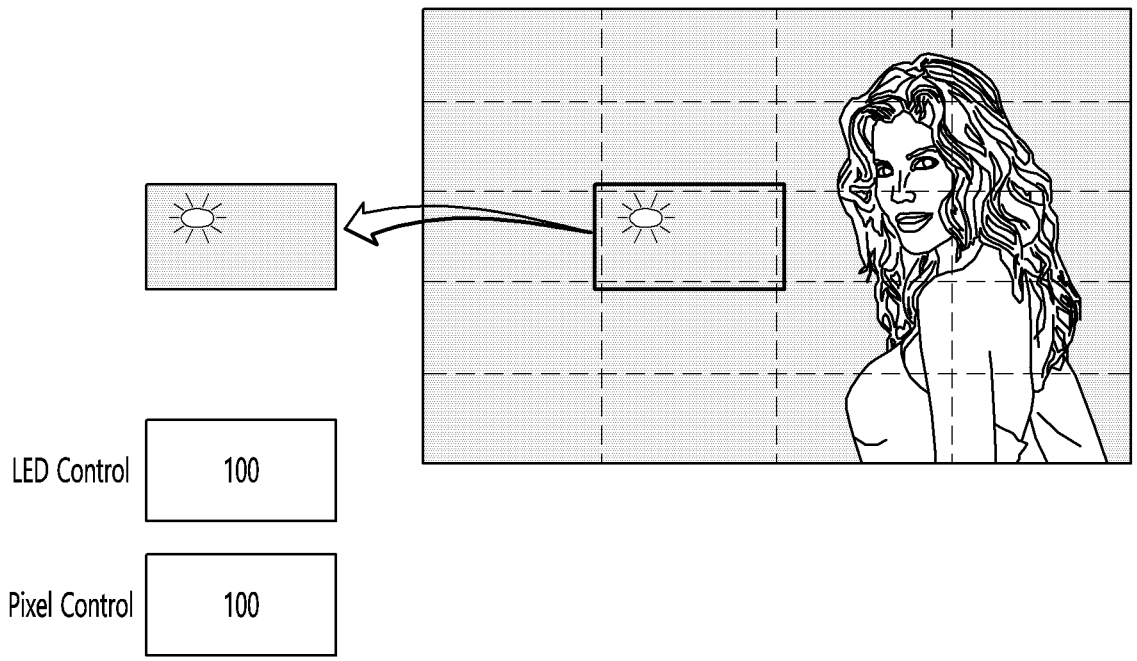
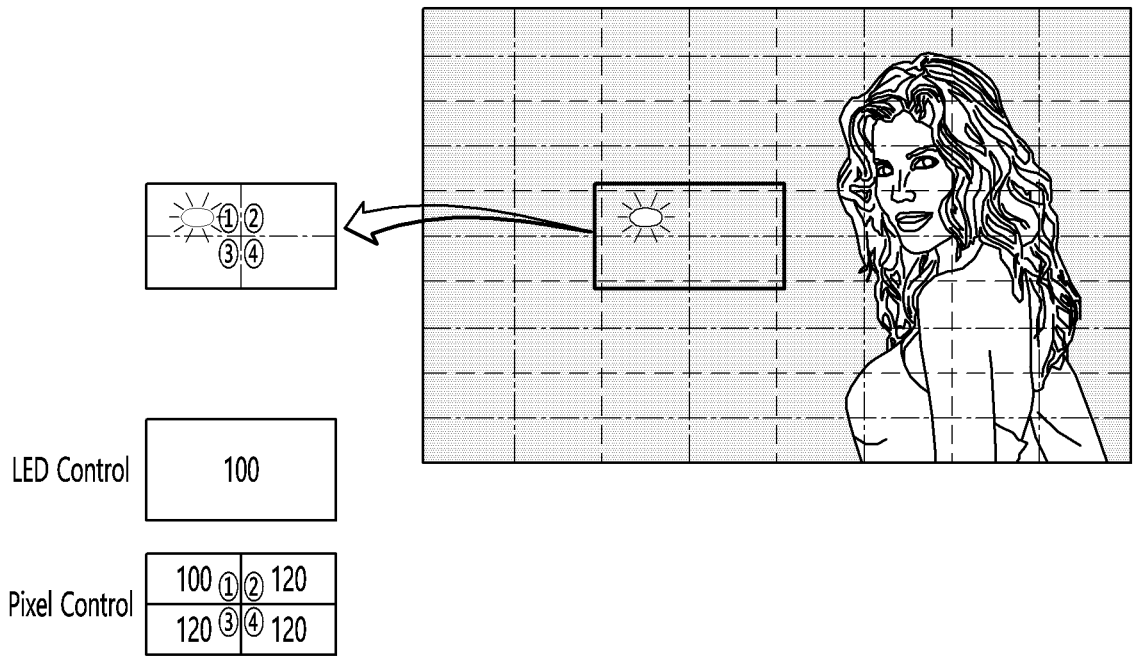


FIG. 17



DISPLAY DEVICE AND OPERATING METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Pursuant to 35 U.S.C. § 119(a), this application claims the benefit of earlier filing date and right of priority to Korean Patent Application No. 10-2020-0039008, filed on Mar. 31, 2020, the contents of which are all hereby incorporated by reference herein in its entirety.

BACKGROUND

[0002] The present disclosure relates to a display device and an operating method thereof, and more particularly, to a display device, which performs local dimming, and an operating method thereof.

[0003] An active matrix liquid crystal display device displays moving images using a thin film transistor (hereafter, referred to as a "TFT") that is a switching element. A liquid crystal display device can be manufactured in a small size, as compared with a Cathode Ray Tube (CRT), so it is used for not only a portable information device, an office device, and a display device such as a computer, but also a television. Accordingly, the liquid crystal display device has rapidly replaced the CRT.

[0004] A transmissive liquid crystal display device that occupies most of liquid crystal display devices displays an image by modulating light from a backlight unit by controlling an electric field that is applied to a liquid crystal layer.

[0005] Meanwhile, backlight dimming methods have been proposed to reduce power consumption of a backlight unit. Local dimming, which is one of the backlight dimming methods, may improve contrast by locally controlling luminance of a display surface within one frame period.

[0006] The local dimming method may be a method for separating input image data according to virtual blocks divided in a matrix form on a display screen of a liquid crystal display panel, deriving a representative value of the input image data for each block, and adjusting a dimming value for each block according to the representative value for each block so as to control the brightness of light sources of a backlight unit for each block.

[0007] Meanwhile, there may occur a blooming phenomenon in which an image become somewhat bright and becomes unclear because strong light is supplied from a light source corresponding to a dark portion during local dimming but corresponding to an adjacent bright portion.

SUMMARY

[0008] The present disclosure provides a display device that minimizes the above-described blooming phenomenon.

[0009] The present disclosure provides a display device that minimizes a reduction in brightness of an image during local dimming and improves a blooming problem.

[0010] The display device includes a liquid crystal display panel, a backlight unit including a plurality of light sources for supplying light to the liquid crystal display panel and driven in a state of being divided into a plurality of blocks corresponding to the number of the light sources, and a backlight dimming controller configured to calculate dimming values of the plurality of blocks. The backlight dimming controller is configured to divide each of the plurality of blocks into a plurality of unit blocks and control brightness of an output image differently for each of the unit blocks.

[0011] wherein brightness of images output through the liquid crystal display panel is differently detected for each of the unit blocks.

[0012] wherein the backlight dimming controller is configured to correct dimming values of the plurality of unit blocks based on input image data.

[0013] wherein the backlight dimming controller is configured to calculate dimming values of the plurality of blocks based on the input image data and divide each of the plurality of blocks into a plurality of unit blocks so that the plurality of unit blocks have calculated dimming values, respectively.

[0014] wherein the backlight dimming controller is configured to correct a dimming value of a unit block corresponding to a boundary region between a bright portion and a dark portion among the plurality of unit blocks divided to have the calculated dimming values, respectively, to be smaller than the calculated dimming value.

[0015] wherein the backlight dimming controller is configured to determine an average of the dimming values of the plurality of unit blocks as a representative dimming value of a block to which the unit blocks belong.

[0016] wherein the backlight dimming controller is configured to correct the input image data based on dimming values of the plurality of unit blocks.

[0017] wherein the backlight dimming controller is configured to determine a correction degree of the image data based on the dimming values of the unit blocks and a representative dimming value of a block to which the unit blocks belong.

[0018] wherein the backlight dimming controller is configured to determine a correction degree of a unit block having a dimming value smaller than the representative dimming value to be smaller than a correction degree of a unit block having a dimming value larger than the representative dimming value.

[0019] wherein the backlight dimming controller is configured to differently adjust dimming values corrected in the plurality of unit blocks based on surrounding brightness.

[0020] wherein the backlight dimming controller is configured to correct the dimming values of the plurality of unit blocks more strongly as the surrounding brightness is darker.

[0021] wherein if the backlight dimming controller corrects a dimming value of a first unit block to a first dimming value when the surrounding brightness is a first brightness, the backlight dimming controller is configured to correct the dimming value of the first unit block to a second dimming value smaller than the first dimming value when the surrounding brightness is a second brightness that is darker than the first brightness.

[0022] The display device further comprises an illuminance sensor configured to detect the surrounding brightness.

[0023] The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] FIG. **1** is a diagram illustrating a display device according to an embodiment of the present invention.

[0025] FIG. **2** is an example of a block diagram of the inside of the display device in FIG. **1**.

[0026] FIG. **3** is an example of a block diagram of the inside of a controller in FIG. **2**.

[0027] FIG. **4**A is a diagram illustrating a method in which the remote controller in FIG. **2** performs control.

[0028] FIG. **4**B is a block diagram of the inside of the remote controller in FIG. **2**.

[0029] FIG. **5** is a block diagram of the inside of the power supply and the display of FIG. **2**.

[0030] FIG. **6** is an example showing arrangement of a liquid crystal display panel and light sources in an edge type backlight unit.

[0031] FIG. **7** is an example showing arrangement of a liquid crystal display panel and light sources in a direct-type backlight unit.

[0032] FIG. **8** is a block diagram illustrating the internal configuration of the backlight dimming controller, the backlight unit, and the timing controller for explaining local dimming according to comparative example.

[0033] FIG. **9** is an exemplary diagram illustrating a method for displaying an image by local dimming according to comparative example.

[0034] FIG. **10** is an exemplary diagram in which blooming occurring in an image is expressed.

[0035] FIG. **11** is a block diagram illustrating an internal configuration of the backlight dimming controller, the backlight unit, and the timing controller for explaining local dimming according to an embodiment of the present disclosure.

[0036] FIG. **12** is a flowchart illustrating an operation method of a display device according to an embodiment of the present disclosure.

[0037] FIG. **13** is an exemplary diagram illustrating a method for displaying an image by local dimming, according to an embodiment of the present disclosure.

[0038] FIG. **14** illustrates an example of a response graph showing brightness perceived by a user according to brightness of a surrounding environment.

[0039] FIG. **15** is a flowchart illustrating a method for adjusting dimming values of a plurality of unit blocks by a display device according to another embodiment of the present disclosure.

[0040] FIG. **16** is an exemplary diagram for explaining brightness of an output image detected by a display device according to comparative example.

[0041] FIG. **17** is an exemplary diagram for explaining brightness of an output image detected by a display device according to an embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0042] Hereinafter, the present invention will be described in detail with reference to the drawings.

[0043] The suffixes "module" and "unit" for components used in the description below are assigned or mixed in consideration of easiness in writing the specification and do not have distinctive meanings or roles by themselves.

[0044] It will be understood that, although the terms first, second, etc. may be used herein to describe various elements of the present invention, these terms are only used to distinguish one element from another element and essential, order, or sequence of corresponding elements are not limited by these terms.

[0045] A singular representation may include a plural representation unless context clearly indicates otherwise.

[0046] It will be understood that the terms "comprise", "include", etc., when used in this specification, specify the presence of several components or several steps and part of the components or steps may not be included or additional components or steps may further be included.

[0047] FIG. **1** is a diagram illustrating a display device according to an embodiment of the present invention.

[0048] With reference to the drawings, a display device **100** includes a display **180**.

[0049] On the other hand, the display **180** is realized by one among various panels. For example, the display **180** is one of the following panels: a liquid crystal display panel (LCD panel), an organic light-emitting diode (OLED) panel (OLED panel), and an inorganic light-emitting diode (ILED) panel (ILED panel).

[0050] According to the present invention, the display **180** is assumed to include a liquid crystal display panel (LCD panel).

[0051] On the other hand, examples of the display device **100** in FIG. **1** include a monitor, a TV, a tablet PC, a mobile terminal, and so on.

[0052] FIG. **2** is an example of a block diagram of the inside of the display device in FIG. **1**.

[0053] Referring to FIG. **2**, a display device **100** can include a broadcast receiver **130**, an external device interface **135**, a storage **140**, a user input interface **150**, a controller **170**, a wireless communication interface **173**, a display **180**, an audio output interface **185**, and a power supply **190**.

[0054] The broadcast receiver **130** can include a tuner **131**, a demodulator **132**, and a network interface **133**.

[0055] The tuner **131** can select a specific broadcast channel according to a channel selection command. The tuner **131** can receive broadcast signals for the selected specific broadcast channel.

[0056] The demodulator **132** can divide the received broadcast signals into video signals, audio signals, and broadcast program related data signals and restore the divided video signals, audio signals, and data signals to an output available form.

[0057] The network interface **133** can provide an interface for connecting the display device **100** to a wired/wireless network including internet network. The network interface **133** can transmit or receive data to or from another user or another electronic device through an accessed network or another network linked to the accessed network.

[0058] The network interface **133** can access a predetermined webpage through an accessed network or another network linked to the accessed network. That is, it can transmit or receive data to or from a corresponding server by accessing a predetermined webpage through network.

[0059] Then, the network interface **133** can receive contents or data provided from a content provider or a network operator. That is, the network interface **133** can receive contents such as movies, advertisements, games, VODs, and broadcast signals, which are provided from a content provider or a network provider, through network and information relating thereto.

[0060] Additionally, the network interface **133** can receive firmware update information and update files provided from a network operator and transmit data to an internet or content provider or a network operator.

[0061] The network interface **133** can select and receive a desired application among applications open to the air, through network.

[0062] The external device interface **135** can receive an application or an application list in an adjacent external device and deliver it to the controller **170** or the storage **140**.

[0063] The external device interface **135** can provide a connection path between the display device **100** and an external device. The external device interface **135** can receive at least one of image and audio outputted from an external device that is wirelessly or wiredly connected to the display device **100** and deliver it to the controller. The external device interface **135** can include a plurality of external input terminals. The plurality of external input terminals can include an RGB terminal, at least one High Definition Multimedia Interface (HDMI) terminal, and a component terminal.

[0064] An image signal of an external device inputted through the external device interface **135** can be outputted through the display **180**. A sound signal of an external device inputted through the external device interface **135** can be outputted through the audio output interface **185**.

[0065] An external device connectable to the external device interface **135** can be one of a set-top box, a Blu-ray player, a DVD player, a game console, a sound bar, a smartphone, a PC, a USB Memory, and a home theater system but this is just exemplary.

[0066] Additionally, some content data stored in the display device **100** can be transmitted to a user or an electronic device, which is selected from other users or other electronic devices pre-registered in the display device **100**.

[0067] The storage **140** can store signal-processed image, voice, or data signals stored by a program in order for each signal processing and control in the controller **170**.

[0068] Additionally, the storage **140** can perform a function for temporarily store image, voice, or data signals outputted from the external device interface **135** or the network interface **133** and can store information on a predetermined image through a channel memory function.

[0069] The storage **140** can store an application or an application list inputted from the external device interface **135** or the network interface **133**.

[0070] The display device **100** can play content files (for example, video files, still image files, music files, document files, application files, and so on) stored in the storage **140** and provide them to a user.

[0071] The user input interface **150** can deliver signals inputted from a user to the controller **170** or deliver signals from the controller **170** to a user. For example, the user input interface **150** can receive or process control signals such as power on/off, channel selection, and screen setting from the remote controller **200** or transmit control signals from the controller **170** to the remote controller **200** according to various communication methods such as Bluetooth, Ultra Wideband (WB), ZigBee, Radio Frequency (RF), and IR.

[0072] Additionally, the user input interface **150** can deliver, to the controller **170**, control signals inputted from local keys (not shown) such as a power key, a channel key, a volume key, and a setting key.

[0073] Image signals that are image-processed in the controller **170** can be inputted to the display **180** and displayed as an image corresponding to corresponding image signals. Additionally, image signals that are image-processed in the controller **170** can be inputted to an external output device through the external device interface **135**.

[0074] Voice signals processed in the controller **170** can be outputted to the audio output interface **185**. Additionally, voice signals processed in the controller **170** can be inputted to an external output device through the external device interface **135**.

[0075] Besides that, the controller **170** can control overall operations in the display device **100**.

[0076] Additionally, the controller **170** can control the display device **100** by a user command or internal program inputted through the user input interface **150** and download a desired application or application list into the display device **100** in access to network.

[0077] The controller **170** can output channel information selected by a user together with processed image or voice signals through the display **180** or the audio output interface **185**.

[0078] Additionally, according to an external device image playback command received through the user input interface **150**, the controller **170** can output image signals or voice signals of an external device such as a camera or a camcorder, which are inputted through the external device interface **135**, through the display **180** or the audio output interface **185**.

[0079] Moreover, the controller **170** can control the display **180** to display images and control broadcast images inputted through the tuner **131**, external input images inputted through the external device interface **135**, images inputted through the network interface, or images stored in the storage **140** to be displayed on the display **180**. In this case, an image displayed on the display **180** can be a still image or video and also can be a 2D image or a 3D image.

[0080] Additionally, the controller **170** can play content stored in the display device **100**, received broadcast content, and external input content inputted from the outside, and the content can be in various formats such as broadcast images, external input images, audio files, still images, accessed web screens, and document files.

[0081] Moreover, the wireless communication interface **173** can perform a wired or wireless communication with an external electronic device. The wireless communication interface **173** can perform short-range communication with an external device. For this, the wireless communication interface **173** can support short-range communication by using at least one of Bluetooth™, Radio Frequency Identification (RFID), Infrared Data Association (IrDA), Ultra Wideband (UWB), ZigBee, Near Field Communication (NFC), Wireless-Fidelity (Wi-Fi), Wi-Fi Direct, and Wireless Universal Serial Bus (USB) technologies. The wireless communication interface **173** can support wireless communication between the display device **100** and a wireless communication system, between the display device **100** and another display device **100**, or between networks including the display device **100** and another display device **100** (or an external server) through wireless area networks. The wireless area networks can be wireless personal area networks.

[0082] Herein, the other display device **100** can be a mobile terminal such as a wearable device (for example, a smart watch, a smart glass, and a head mounted display (HMD)) or a smartphone, which is capable of exchanging data (or inter-working) with the display device **100**. The wireless communication interface **173** can detect (or recognize) a communicable wearable device around the display

device **100**. Furthermore, if the detected wearable device is a device authenticated to communicate with the display device **100**, the controller **170** can transmit at least part of data processed in the display device **100** to the wearable device through the wireless communication interface **173**. Accordingly, a user of the wearable device can use the data processed in the display device **100** through the wearable device.

[0083] The display **180** can convert image signals, data signals, or OSD signals, which are processed in the controller **170**, or images signals or data signals, which are received in the external device interface **135**, into R, G, and B signals to generate driving signals.

[0084] Furthermore, the display device **100** shown in FIG. **2** is just one embodiment of the present invention and thus, some of the components shown can be integrated, added, or omitted according to the specification of the actually implemented display device **100**.

[0085] That is, if necessary, two or more components can be integrated into one component or one component can be divided into two or more components and configured. Additionally, a function performed by each block is to describe an embodiment of the present invention and its specific operation or device does not limit the scope of the present invention.

[0086] According to another embodiment of the present invention, unlike FIG. **2**, the display device **100** can receive images through the network interface **133** or the external device interface **135** and play them without including the tuner **131** and the demodulator **132**.

[0087] For example, the display device **100** can be divided into an image processing device such as a set-top box for receiving broadcast signals or contents according to various network services and a content playback device for playing contents inputted from the image processing device.

[0088] In this case, an operating method of a display device according to an embodiment of the present invention described below can be performed by one of the display device described with reference to FIG. **2**, an image processing device such as the separated set-top box, and a content playback device including the display **180** and the audio output interface **185**.

[0089] The audio output interface **185** receives the audio processed signal from the controller **170** and outputs the sound.

[0090] The power supply **190** supplies the corresponding power throughout the display device **100**. In particular, the power supply **190** supplies power to the controller **170** that can be implemented in the form of a System On Chip (SOC), a display **180** for displaying an image, and the audio output interface **185** for outputting audio or the like.

[0091] Specifically, the power supply **190** may include a converter for converting an AC power source into a DC power source, and a dc/dc converter for converting a level of the DC source power.

[0092] The remote controller **200** transmits a user input to the user input interface **150**. To this end, the remote controller **200** may use Bluetooth, radio frequency (RF) communication, infrared (IR) communication, ultra wideband (UWB), ZigBee, or the like. In addition, the remote controller **200** may receive video, audio, or data signal output from the user input interface **150** and display the video, audio, or data signal or output sound.

[0093] FIG. **3** is an example of a block diagram of the inside of a controller in FIG. **2**.

[0094] For description with reference to the drawings, the controller **170** according to an embodiment of the present invention includes a demultiplexer **310**, an image processor **320**, a processor **330**, an OSD generator **340**, a mixer **345**, a frame rate converter **350**, and a formatter **360**. In addition, an audio processor (not illustrated) and a data processor (not illustrated) are further included.

[0095] The demultiplexer **310** demultiplexes a stream input. For example, in a case where an MPEG-2 TS is input, the MPEG-2 TS is demultiplexed into an image signal, an audio signal, and a data signal. At this point, a stream signal input into the demultiplexer **310** is a stream signal output from the tuner **110**, the demodulator **120**, or the external device interface **135**.

[0096] The image processor **320** performs image processing of the image signal that results from the demultiplexing. To do this, the image processor **320** includes an image decoder **325** or a scaler **335**.

[0097] The image decoder **325** decodes the image signal that results from the demultiplexing. The scaler **335** performs scaling in such a manner that a resolution of an image signal which results from the decoding is such that the image signal is possibly output to the display **180**.

[0098] Examples of the image decoder **325** possibly include decoders in compliance with various specifications. For example, the examples of the image decoder **325** include a decoder for MPEG-2, a decoder for H.264, a 3D image decoder for a color image and a depth image, a decoder for a multi-point image, and so on.

[0099] The processor **330** controls an overall operation within the display device **100** or within the controller **170**. For example, the processor **330** controls the tuner **110** in such a manner that the tuner **110** performs the selection of (tuning to) the RF broadcast that corresponds to the channel selected by the user or the channel already stored.

[0100] In addition, the processor **330** controls the display device **100** using the user command input through the user input interface **150**, or the internal program.

[0101] In addition, the processor **330** performs control of transfer of data to and from the network interface **133** or the external device interface **135**.

[0102] In addition, the processor **330** controls operation of each of the demultiplexer **310**, the image processor **320**, the OSD generator **340**, and so on within the controller **170**.

[0103] The OSD generator **340** generates an OSD signal, according to the user input or by itself. For example, based on the user input signal, a signal is generated for displaying various pieces of information in a graphic or text format on a screen of the display **180**. The OSD signal generated includes various pieces of data for a user interface screen of the display device **100**, various menu screens, a widget, an icon, and so on. In addition, the OSD generated signal includes a 2D object or a 3D object.

[0104] In addition, based on a pointing signal input from the remote controller **200**, the OSD generator **340** generates a pointer possibly displayed on the display. Particularly, the pointer is generated in a pointing signal processor, and an OSD generator **340** includes the pointing signal processor (not illustrated). Of course, it is also possible that instead of being providing within the OSD generator **340**, the pointing signal processor (not illustrated) is provided separately.

[0105] The mixer **345** mixes the OSD signal generated in the OSD generator **340**, and the image signal that results from the image processing and the decoding in the image processor **320**. An image signal that results from the mixing is provided to the frame rate converter **350**.

[0106] The frame rate converter (FRC) **350** converts a frame rate of an image input. On the other hand, it is also possible that the frame rate converter **350** outputs the image, as is, without separately converting the frame rate thereof.

[0107] On the other hand, the formatter **360** converts a format of the image signal input, into a format for an image signal to be displayed on the display, and outputs an image that results from the conversion of the format thereof.

[0108] The formatter **360** changes the format of the image signal. For example, a format of a 3D image signal is changed to any one of the following various 3D formats: a side-by-side format, a top and down format, a frame sequential format, an interlaced format, and a checker box format.

[0109] On the other hand, the audio processor (not illustrated) within the controller **170** performs audio processing of an audio signal that results from the demultiplexing. To do this, the audio processor (not illustrated) includes various decoders.

[0110] In addition, the audio processor (not illustrated) within the controller **170** performs processing for base, treble, volume adjustment and so on.

[0111] The data processor (not illustrated) within the controller **170** performs data processing of a data signal that results from the demultiplexing. For example, in a case where a data signal that results from the demultiplexing is a data signal the results from coding, the data signal is decoded. The data signal that results from the coding is an electronic program guide that includes pieces of broadcast information, such as a starting time and an ending time for a broadcast program that will be telecast in each channel.

[0112] On the other hand, a block diagram of the controller **170** illustrated in FIG. **3** is a block diagram for an embodiment of the present invention. Each constituent element in the block diagram is subject to integration, addition, or omission according to specifications of the image display controller **170** actually realized.

[0113] Particularly, the frame rate converter **350** and the formatter **360** may be provided separately independently of each other or may be separately provided as one module, without being provided within the controller **170**.

[0114] FIG. **4**A is a diagram illustrating a method in which the remote controller in FIG. **2** performs control.

[0115] In FIG. **4**A(a), it is illustrated that a pointer **205** which corresponds to the remote controller **200** is displayed on the display **180**.

[0116] The user moves or rotates the remote controller **200** upward and downward, leftward and rightward (FIG. **4**A(b)), and forward and backward (FIG. **4**A(c)). The pointer **205** displayed on the display **180** of the display device corresponds to movement of the remote controller **200**. As in the drawings, movement of the pointer **205**, which depends on the movement of the remote controller **200** in a 3D space, is displayed and thus, the remote controller **200** is named a spatial remote controller or a 3D pointing device.

[0117] FIG. **4**A(b) illustrates that, when the user moves the remote controller **200** leftward, the pointer **205** displayed on the display **180** of the display device correspondingly moves leftward.

[0118] Information on the movement of the remote controller **200**, which is detected through a sensor of the remote controller **200**, is transferred to the display device. The display device calculates the information on the movement of the remote controller **200** from coordinates of the pointer **205**. The display device displays the pointer **205** in such a manner that the pointer **25** corresponds to the calculated coordinates.

[0119] FIG. **4**A(c) illustrates a case where the user moves the remote controller **200** away from the display **180** in a state where a specific button within the remote controller **200** is held down. Accordingly, a selection area within the display **180**, which corresponds to the pointer **205**, is zoomed in so that the selection area is displayed in an enlarged manner. Conversely, in a case where the user causes the remote controller **200** to approach the display **180**, the selection area within the display **180**, which corresponds to the pointer **205**, is zoomed out so that the selection is displayed in a reduced manner. On the other hand, in a case where the remote controller **200** moves away from the display **180**, the selection area may be zoomed out, and in a case where the remote controller **200** approaches the display **180**, the selection area may be zoomed in.

[0120] On the other hand, an upward or downward movement, or a leftward or rightward movement is not recognized in a state where a specific button within the remote controller **200** is held down. That is, in a case where the remote controller **200** moves away from or approaches the display **180**, only a forward or backward movement is set to be recognized without the upward or downward movement, or the leftward or rightward movement being recognized. Only the pointer **205** moves as the remote controller **200** moves upward, downward, leftward, or rightward, in a state where a specific button within the remote controller **200** is not held down.

[0121] On the other hand, a moving speed or a moving direction of the pointer **205** corresponds to a moving speed or a moving direction of the remote controller **200**, respectively.

[0122] FIG. **4**B is a block diagram of the inside of the remote controller in FIG. **2**.

[0123] For description with reference to the drawings, the remote controller **200** includes a wireless communication interface **420**, a user input interface **430**, a sensor **440**, an output interface **450**, a power supply **460**, a memory **470**, and a controller **480**.

[0124] The wireless communication interface **420** transmits and receives a signal to and from an arbitrary one of the display devices according to the embodiments of the present invention, which are described above. Of the display devices according to the embodiments of the present invention, one display device is taken as an example for description.

[0125] According to the present embodiment, the remote controller **200** includes an RF module **421** that transmits and receives a signal to and from the display device **100** in compliance with RF communication standards. In addition, the remote controller **200** includes an IR module **423** that possibly transmits and receives a signal to and from the display device **100** in compliance with IR communication standards.

[0126] According to the present embodiment, the remote controller **200** transfers a signal containing information on the movement of the remote controller **200** to the display device **100** through the RF module **421**.

[0127] In addition, the remote controller **200** receives a signal transferred by the display device **100**, through the RF module **421**. In addition, the remote controller **200** transfers a command relating to power-on, power-off, a channel change, or a volume change, to the display device **100**, through the IR module **423**, whenever needed.

[0128] The user input interface **430** is configured with a keypad, buttons, a touch pad, a touch screen, or so on. The user inputs a command associated with the display device **100** into the remote controller **200** by operating the user input interface **430**. In a case where the user input interface **430** is equipped with a physical button, the user inputs the command associated with the display device **100** into the remote controller **200** by performing an operation of pushing down the physical button. In a case where the user input interface **430** is equipped with a touch screen, the user inputs the command associated with the display device **100** into the remote controller **200** by touching on a virtual key of the touch screen. In addition, the user input interface **430** may be equipped with various types of input means operated by the user, such as a scroll key or a jog key, and the present embodiment does not impose any limitation on the scope of the present invention.

[0129] The sensor **440** includes a gyro sensor **441** or an acceleration sensor **443**. The gyro sensor **441** senses information on the movement of the remote controller **200**.

[0130] As an example, the gyro sensor **441** senses the information on operation of the remote controller **200** on the x-, y-, and z-axis basis. The acceleration sensor **443** senses information on the moving speed and so on of the remote controller **200**. On the other hand, a distance measurement sensor is further included. Accordingly, a distance to the display **180** is sensed.

[0131] The output interface **450** outputs an image or an audio signal that corresponds to the operating of the user input interface **430** or corresponds to a signal transferred by the display device **100**. Through the output interface **450**, the user recognizes whether or not the user input interface **430** is operated or whether or not the display device **100** is controlled.

[0132] As an example, the output interface **450** includes an LED module **451**, a vibration module **453**, an audio output module **455**, or a display module **457**. The LED module **451**, the vibration module **453**, the audio output module **455**, and the display module **457** emits light, generates vibration, outputs audio, or outputs an image, respectively, when the input interface **435** is operated, or a signal is transmitted and received to and from the display device **100** through a wireless communication interface **420**.

[0133] The power supply **460** supplies a power to the remote controller **200**. In a case where the remote controller **200** does not move for a predetermined time, the power supply **460** reduces power consumption by interrupting power supply. In a case where a predetermined key provided on the remote controller **200** is operated, the power supply **460** resumes the power supply.

[0134] Various types of programs, pieces of application data, and so on that are necessary for control or operation of the remote controller **200** are stored in the memory **470**. In a case where the remote controller **200** transmits and receives a signal to and from the display device **100** in a wireless manner through the RF module **421**, the signal is transmitted and received in a predetermined frequency band between the remote controller **200** and the display device **100**. The controller **480** of the remote controller **200** stores information on, for example, a frequency band in which data is transmitted and received in a wireless manner to and from the display device **100** paired with the remote controller **200**, in the memory **470**, and makes a reference to the stored information.

[0135] The controller **480** controls all operations associated with the control by the remote controller **200**. The controller **480** transfers a signal that corresponds to operating of a predetermined key of the user input interface **430**, or a signal that corresponds to the movement of the remote controller **200**, which is sensed in the sensor **440**, to the display device **100** through the wireless communication interface **420**.

[0136] A user input interface **150** of the display device **100** includes a wireless communication interface **411** that transmits and receives a signal in a wireless manner to and from the remote controller **200**, and a coordinate value calculator **415** that calculates a coordinate value of the pointer, which corresponds to the operation of the remote controller **200**.

[0137] The user input interface **150** transmits and receives the signal in a wireless manner to and from the remote controller **200** through the RF module **412**. In addition, a signal transferred in compliance with the IR communication standards by the remote controller **200** through the IR module **413** is received.

[0138] The coordinate value calculator **415** calculates a coordinate value (x, y) of the pointer **205** to be displayed on the display **180**, which results from compensating for a hand movement or an error, from a signal that corresponds to the operation of the remote controller **200**, which is received through the wireless communication interface **411**.

[0139] A transfer signal of the remote controller **200**, which is input into the display device **100** through the user input interface **150** is transferred to the controller **170** of the display device **100**. The controller **170** determines information on the operation of the remote controller **200** and information on operating of a key, from the signal transferred by the remote controller **200**, and correspondingly controls the display device **100**.

[0140] As another example, the remote controller **200** calculates a coordinate value of a pointer, which corresponds to the operation of the remote controller **200**, and outputs the calculated value to the user input interface **150** of the display device **100**. In this case, the user input interface **150** of the display device **100** transfers information on the received coordinate values of the pointer, to the controller **170**, without performing a process of compensating for the hand movement and the error.

[0141] In addition, as another example, unlike in the drawings, it is also possible that the coordinate value calculator **415** is included within the controller **170** instead of the user input interface **150**.

[0142] FIG. **5** is a block diagram of the inside of the power supply and the display of FIG. **2**.

[0143] Referring to the figure, the display **180** based on a liquid crystal panel (LCD panel) may include a liquid crystal display panel **210**, a driving circuit **230**, a backlight unit **250**, and a backlight dimming controller **510**.

[0144] The liquid crystal display panel **210**, in order to display an image, includes: a first substrate in which a plurality of gate lines GL and data lines DL are disposed across each other in a matrix shape, thin film transistors and pixel electrodes connected with the thin film transistors are

formed at the intersections; a second substrate having common electrodes; and a liquid crystal layer formed between the first substrate and the second substrate.

[0145] The driving circuit **230** drives the liquid crystal display panel **210** in response to a control signal and a data signal that are supplied from the controller **170** of FIG. **1**. To this end, the driving circuit **230** includes a timing controller **232**, a gate driver **234**, and a data driver **236**.

[0146] The timing controller **232** receives a control signal, R, G, B data signal, a vertical synchronization signal Vsync etc. from the controller **170**, controls the gate driver **234** and the data driver **236** in response to the control signal, and rearranges and provides the R, G, B data signal to the data driver **236**.

[0147] By control of the gate driver **234**, the data driver **236**, and the timing controller **232**, a scan signal and an image signal are supplied to the liquid crystal display panel **210** through a gate line GL and a data line DL.

[0148] The backlight unit **250** supplies light to the liquid crystal display panel **210**. To this end, the backlight unit **250** may include a plurality of light sources **252**, a scan driver **254** that controlling scanning driving of the light sources **252**, and a light source driver **256** that turns on/off the light sources **252**.

[0149] A predetermined image is displayed using light emitted from the backlight unit **250** with the light transmittance of the liquid crystal layer adjusted by an electric field generated between the pixel electrode and the common electrode of the liquid crystal display panel **210**.

[0150] The power supply **190** can supply a common electrode voltage Vcom to the liquid crystal display panel **210** and a gamma voltage to the data driver **236**. Further, the power supply **190** can supply driving power for driving the light sources **252** to the backlight unit **250**.

[0151] Meanwhile, the backlight unit **250** can be divided and driven into a plurality of blocks. The controller **170** can control the display **180** to perform local dimming by setting a dimming value for each block. In detail, the timing controller **232** can output input image data RGB to the backlight dimming controller **510** and the backlight dimming controller **510** can calculate a dimming value for each of a plurality of blocks on the basis of the input image data RGB received from the timing controller **232**.

[0152] FIG. **6** is an example showing arrangement of a liquid crystal display panel and light sources in an edge type backlight unit and FIG. **7** is an example showing arrangement of a liquid crystal display panel and light sources in a direct-type backlight unit.

[0153] The liquid crystal display panel **210** may be divided into a plurality of virtual blocks, as shown in FIGS. **6** and **7**. Although the liquid crystal display panel **210** is equally divided into sixteen blocks BL**1** to BL**16** in FIGS. **6** and **7**, it should be noted that the liquid crystal display panel **210** is not limited thereto. Each of the blocks may include a plurality of pixels.

[0154] The backlight unit **250** may be implemented into any one of an edge type and direct type.

[0155] The edge-type backlight unit **250** has a structure in which a plurality of optical sheets and a light guide plate are stacked under the liquid crystal display panel **210** and a plurality of light sources is disposed on the sides of the light guide plate. When the backlight unit **250** is an edge-type backlight unit, the light sources are disposed on at least any one of the top and the bottom and at least any one of the left and right sides of the liquid crystal display panel **210**. It is exemplified in FIG. **6** that a first light source array LA**1** is disposed on the top of the liquid crystal display panel **210** and a second light source array LA**2** is disposed on the left side of the liquid crystal display panel **210**. The first and second light source arrays LA**1** and LA**2** each include a plurality of light sources **252** and a light source circuit board **251** on which the light sources **252** are mounted. In this case, the brightness of the light traveling into the first block BL**2** of the light source array can be adjusted using the light sources **252**A of the first light source array LA**1** disposed at a position corresponding to the first block BL**2** and the light sources **252**B of the second light source array LA**2**.

[0156] The direct-type backlight unit **250** has a structure in which a plurality of optical sheets and a diffuser plate are stacked under the liquid crystal display panel **210** and a plurality of light sources is disposed under the diffuser plate. When the backlight unit **250** is a direct-type backlight unit, it is divided to correspond one to one to the blocks BL**1** to BL**16** of the liquid crystal display panel **210**, as shown in FIG. **7**. In this case, the brightness of the light traveling into the first block BL**2** of the light source array can be adjusted using the light sources **252** included in the first block BL**1** of the backlight unit **250** disposed at a position corresponding to the first block BL**1** of the liquid crystal display panel **210**.

[0157] The light sources **252** may be point light sources such as a Light Emitting Diode (LED). The light sources **252** are turned on and off in response to light source driving signals LDS from the light source driver **256**. The light sources **252** can be adjusted in intensity of light in accordance with the amplitudes of the light source driving signals LDS and can be adjusted in turning-on time in accordance with the pulse width. The brightness of light that is outputted from the light sources **252** may be adjusted in accordance with the light source driving signal LDS.

[0158] The light source driver **256** can generate and output light source driving signals LDS to the light sources **252** on the basis of the dimming values of the blocks inputted from the backlight dimming controller **510**. The dimming values of the blocks, which are values for performing local dimming, may be the brightness of the light that is outputted from the light sources **252**.

[0159] FIG. **8** is a block diagram illustrating the internal configuration of the backlight dimming controller, the backlight unit, and the timing controller for explaining local dimming according to comparative example, and FIG. **9** is an exemplary diagram illustrating a method for displaying an image by local dimming according to comparative example.

[0160] The backlight dimming controller **510** may include at least part or all of a dimming value calculator **511** and a pixel corrector **519**.

[0161] The dimming value calculator **511** may receive input image data RGB. The dimming value calculator **511** may receive image data input from the controller **170**. The dimming value calculator **511** may calculate dimming values of a plurality of blocks based on the input image data.

[0162] For example, when the number of light sources **252** is M×N, the dimming value calculator **511** may calculate the dimming values of the M×N blocks.

[0163] The dimming value calculator **511** may calculate the dimming values of the plurality of blocks based on the

average brightness and maximum brightness of pixels of each block and brightness of the adjacent blocks.

[0164] For example, the dimming value calculator **511** may select a smaller value among the set maximum value and the averages considering the weight for each pixel value as the initial dimming value, and may enhance the dimming value through the weighting by recognizing a corresponding region as a dark region when the initial dimming value is greater than the average brightness and the average brightness is less than the threshold value.

[0165] As another example, the dimming value calculator **511** may analyze the input image data RGB in block units of the liquid crystal display panel **210** to calculate a representative value of each of the blocks. The representative value may be the sum of the input image data RGB of each block, the average value of the input image data RGB of each block, or the maximum value of the input image data RGB of each block. The dimming value calculator **511** may calculate dimming values of blocks according to representative values of blocks. The dimming value calculator **511** may calculate the dimming value of the block in proportion to the representative value of any one block. Therefore, as the representative value of the block is larger, the dimming value of the block may be calculated as a larger value.

[0166] In addition, the dimming value calculator **511** may calculate the dimming values of the blocks in various methods based on the input image data RGB. That is, the dimming value calculator **511** may reduce the brightness of light output by the light sources **252** of the block corresponding to the dark portion of the image and may calculate the dimming value so that the brightness of the light output from the light sources **252** of the block corresponding to the bright portion of the image is increased.

[0167] The backlight unit **250** may control the light sources **252** based on the dimming values of the blocks received from the dimming value calculator **511**.

[0168] The pixel corrector **519** may compensate for the input image data RGB of the block as much as the reduction of the dimming value of any one block. For example, when the dimming value of any one block is reduced more than a reference value, light of about half brightness is provided from the light sources **252**, as compared with the case in which the local dimming is not performed. In this case, since the luminance of the corresponding block of the liquid crystal display panel **210** is too low, the pixel corrector **519** may up-regulate the input image data RGB of the corresponding block of the liquid crystal display panel **210**. In this case, when the dimming value of the corresponding block is reduced by a certain ratio, how much the input image data RGB of the block is up-regulated may be preset.

[0169] The pixel corrector **519** may correct the input image data RGB based on the dimming value calculated by the dimming value calculator **511**, and the timing controller **232** may adjust the transmittance based on the corrected input image data RGB'.

[0170] FIG. **9**A is an example of an image output from the display **180**, and the image output from the display **180** may be determined by the brightness of the light output by the backlight unit **250** and the transmittance of the liquid crystal layer adjusted by the timing controller **232**. FIG. **9**B may illustrate the brightness of light of the blocks BL**1** to BL**16** output by the backlight unit **250**, and FIG. **9**C may illustrate the transmittance of the liquid crystal layer.

[0171] As described above, when local dimming in which the brightness and transmittance of light for each of the plurality of blocks are adjusted is performed, the power consumption of the backlight unit **250** may be reduced and the contrast of the output image may be improved.

[0172] Meanwhile, even when local dimming is performed, problems such as blooming may occur.

[0173] FIG. **10** is an exemplary diagram in which blooming occurring in an image is expressed.

[0174] Blooming may refer to a phenomenon in which, when the light is partially brightened, the image portion becomes bright as if it is blurred, and the image becomes unclear.

[0175] As an example, although the brightness of the first block should be dark and the brightness of the second block adjacent to the first block should be bright, blooming may occur because the first block is brightened by a light source that outputs light to the second block.

[0176] As another example, when a dark portion and a bright portion are present in the same block, blooming in which the dark portion is brightly illuminated may occur.

[0177] Referring to the example of FIG. **10**, a region indicated by a dashed line is a boundary region between a dark portion and a bright portion. It can be seen that the dark portion is slightly brightened by the light source that outputs the light to the bright portion.

[0178] Therefore, a method for minimizing blooming occurring during local dimming may be required. To this end, the display device **100** according to the embodiment of the present disclosure minimizes blooming by compensating for the dimming value or image data on the assumption that there are more blocks than the blocks divided so as to correspond to the actual light source **252**.

[0179] In detail, in the local dimming according to comparative example, the dimming value and transmittance are determined by dividing the block into the same number as the number of the light sources **252**, but the display device **100** according to the embodiment of the present disclosure determines the dimming value and transmittance by dividing the block into a number greater than the number of the light sources **252** during local dimming.

[0180] That is, when the backlight unit **250** is divided into a plurality of blocks corresponding to the number of the light sources **252** and then driven, the backlight dimming controller **510** may control the brightness of the output image differently for each unit block by dividing each of the plurality of blocks into a plurality of unit blocks.

[0181] FIG. **11** is a block diagram illustrating an internal configuration of the backlight dimming controller, the backlight unit, and the timing controller for explaining local dimming according to an embodiment of the present disclosure.

[0182] The backlight dimming controller **510** may include at least part or all of a dimming value calculator **511**, a dimming value corrector **513**, a dimming value determiner **515**, a correction determiner **517**, and a pixel corrector **519**. Meanwhile, detailed components of the backlight dimming controller **510** illustrated in FIG. **11** may be only classified so as to describe the role of the backlight dimming controller **510**. Therefore, it is reasonable that the detailed configuration of the backlight dimming controller **510** is not limited to that illustrated in FIG. **11**, and part of the detailed configuration illustrated in FIG. **11** may be omitted or further added.

[0183] The dimming value calculator **511** may calculate the dimming values of the plurality of blocks. In particular, the dimming value calculator **511** may calculate the dimming values of the plurality of blocks divided into a number greater than the number of light sources **252**.

[0184] When the number of light sources **252** is M×N, the dimming value calculator **511** may calculates the dimming value by dividing the block into M×N blocks corresponding to the number of light sources **252**, and may calculate the dimming values of the plurality of unit blocks by dividing each of the plurality of M×N blocks into a plurality of unit blocks. That is, the dimming value calculator **511** may divide the block into (a*M)×(a*N) unit blocks and may calculate the dimming values of the divided unit blocks. "a" may be any integer.

[0185] For example, the dimming value calculator **511** may divide a first block into first to fourth unit blocks and divide a second block into fifth to eighth unit blocks. In this manner, the dimming value calculator **511** may divide a sixteenth block into sixty-first to sixty-fourth unit blocks.

[0186] The dimming value calculator **511** may include a unit block dimming value calculator **512** that divides each of a plurality of pre-divided blocks into a plurality of unit blocks and calculates dimming values of the unit blocks.

[0187] The dimming value calculator **511** may calculate the dimming values of unit blocks belonging to the same block. In detail, the dimming value calculator **511** may calculates the dimming values of the plurality of blocks, divide each of the plurality of blocks into a plurality of unit blocks, and then calculate the dimming values of the unit blocks. For example, when the dimming value of the first block is 0.5, the dimming values of the first to fourth unit blocks belonging to the first block may be calculated as 0.5.

[0188] The dimming value corrector **513** may correct the dimming values of the unit blocks calculated by the dimming value calculator **511**, based on the input image data RGB.

[0189] The dimming value corrector **513** may correct a dimming value of a unit block corresponding to a boundary region between a bright portion and a dark portion to a small value, based on the input image data. In detail, the dimming value corrector **513** may calculate the dimming values of the plurality of blocks based on the input image data, and correct a dimming value of a unit block corresponding to a boundary region between a bright portion and a dark portion to a value smaller than the calculated dimming value, based on the input image data.

[0190] A correction degree of the dimming value may be calculated by a difference in brightness between the bright portion and the dark portion. For example, the dimming value corrector **513** may calculate a higher correction degree of the dimming value as the brightness difference between the bright portion and the dark portion increases, and may calculate a lower correction degree of the dimming value as the brightness difference between the bright portion and the dark portion decreases The dimming value corrector **513** may correct the dimming value of the unit block based on the calculated correction degree of the dimming value. However, this method is merely an example and the present disclosure is not limited thereto.

[0191] The dimming value determiner **515** may reflect the dimming value of the unit block corrected by the dimming value corrector **513** to determine the dimming value of the block to which the unit blocks belong. For example, when one block is divided into a^2 unit blocks by the dimming value calculator **511**, the dimming value determiner **515** may determine the dimming value of the block to which the unit blocks belong, based on the dimming values of the a^2 unit blocks.

[0192] According to an embodiment, the dimming value determiner **515** may filter the dimming values of the a^2 unit blocks into a certain filter (e.g., a low pass filter (LPF)) and may determine the filtered dimming value as the dimming value of the block to which the unit blocks belong. According to another embodiment, the dimming value determiner **515** may determine an average of dimming values of a plurality of unit blocks as the dimming value of the block to which the unit blocks belong. However, the above-described embodiments are merely examples for convenience of description, and the present disclosure is not limited thereto.

[0193] For example, the dimming value determiner **515** may determine the dimming value of the first block based on the dimming values of the corrected first to fourth unit blocks.

[0194] The backlight unit **250** may receives the dimming values of the blocks from the dimming value determiner **515**, and the light sources **252** may be controlled based on the received dimming value.

[0195] Therefore, according to the present disclosure, since the dimming values of the blocks corresponding to the number of light sources **252** are determined through the dimming value calculator **511**, the dimming value corrector **513** and the dimming value determiner **515** on the assumption that there are more blocks than the number of light sources **252**, the contrast of the image may be corrected more precisely and the blooming problem may be improved.

[0196] The correction determiner **517** may determine the correction degree of the transmittance before the pixel corrector **519** adjusts the transmittance based on the dimming value.

[0197] The correction determiner **517** may determine the correction degree of transmittance based on the dimming values of the unit blocks corrected by the dimming value corrector **513** and the dimming values of the blocks determined by the dimming value determiner **515**.

[0198] For example, the correction determiner **517** may determine the correction degree of transmittance of image data corresponding to the first to fourth unit blocks based on the dimming values of the first to fourth unit blocks corrected by the dimming value corrector **513** and the dimming value of the first block determined by the dimming value determiner **515**.

[0199] When the dimming value of the block (e.g., the first block) to which the unit blocks determined based on the dimming values of the unit blocks (e.g., the first to fourth unit blocks) belong is a representative dimming value, the correction determiner **517** may determine the correction degree of transmittance of the unit block having a dimming value smaller than the representative dimming value to be less than the correction degree of transmittance of the unit block having a dimming value larger than the representative dimming value.

[0200] Since the unit block having a dimming value smaller than the representative dimming value is supplied with light that is brighter than the calculated dimming value, the correction degree of transmittance is determined to be low, and since the unit block having a dimming value greater than the representative dimming value is supplied with light

that is darker than the calculated dimming value, the correction degree of transmittance is determined to be high. Therefore, the transmittance may be corrected for the adjusted dimming value, and the contrast may be improved accordingly.

[0201] The pixel corrector **519** may correct the input image data RGB based on the correction degree of transmittance determined by the correction determiner **517**.

[0202] The timing controller **232** may adjust the transmittance based on the input image data RGB 'corrected by the pixel corrector **519**.

[0203] FIG. **12** is a flowchart illustrating an operation method of a display device according to an embodiment of the present disclosure.

[0204] The backlight dimming controller **510** may divide each of a plurality of blocks into a plurality of unit blocks (S**10**).

[0205] In detail, the backlight dimming controller **510** may divide each of the plurality of blocks divided so as to correspond to the number of light sources **252** into a plurality of unit blocks. The number of unit blocks may be larger than the number of light sources **252**.

[0206] The backlight dimming controller **510** may calculate the dimming values of the plurality of blocks divided so as to correspond to the number of light sources **252** based on the input image data RGB, and may divide each of the plurality of blocks into a plurality of unit blocks. At this time, the dimming values of the unit blocks may be the same as the dimming value of the block to which the unit blocks belong before division.

[0207] The backlight dimming controller **510** may calculate the dimming values of the plurality of unit blocks (S**20**).

[0208] The backlight dimming controller **510** may calculate the dimming values of the plurality of unit blocks by correcting the dimming values of the plurality of unit blocks through the dimming value corrector **513**.

[0209] The backlight dimming controller **510** may calculate the dimming value of the block to which the unit blocks belong, based on the dimming values of the unit blocks (S**30**).

[0210] The backlight dimming controller **510** may calculate a representative dimming value of the block, to which the unit blocks belong, through the dimming value determiner **515**.

[0211] The backlight dimming controller **510** may correct image data based on the dimming values of the plurality of unit blocks (S**40**).

[0212] The backlight dimming controller **510** may determine the correction degree of transmittance based on the dimming values of the unit blocks calculated by the dimming value corrector **513** and the representative dimming value determined by the dimming value determiner **515**, and correct image data based on the determined correction degree of transmittance.

[0213] The backlight unit **250** may control the backlight unit **250** based on the dimming value (representative dimming value) of the block determined by the dimming value determiner **515**, and the timing controller **232** may adjust the transmittance based on the image data (S**50**).

[0214] FIG. **13** is an exemplary diagram illustrating a method for displaying an image by local dimming, according to an embodiment of the present disclosure.

[0215] FIG. **13**A is an example of an image output from the display **180**, and the image output from the display **180** may be determined by the brightness of the light output by the backlight unit **250** and the transmittance of the liquid crystal layer adjusted by the timing controller **232**. FIG. **13**B may illustrate the brightness of light of the blocks BL**1** to BL**16** output by the backlight unit **250**, and FIG. **13**C may illustrate the transmittance of the liquid crystal layer.

[0216] The brightness of the light of the blocks (e.g., BL**1** to BL**16**) output from the backlight unit **250** as illustrated in FIG. **13**B may be determined by the dimming values of the blocks through the dimming value determiner **515**.

[0217] The transmittance of the liquid crystal layer as illustrated in FIG. **13**C may be adjusted by the image data of the unit blocks (e.g., the first to sixty-fourth unit blocks UBL**1** to UBL**64**) calculated through the pixel corrector **519**.

[0218] As described above, when the local dimming is performed on the assumption that there are more unit blocks than the number of light sources **252**, the blooming phenomenon is reduced when local dimming is performed according to the block divided by the number of light sources **252**

[0219] Meanwhile, since users are more sensitive to a change in brightness as they are in a dark environment, the blooming phenomenon may be more easily recognized when the environment is dark than when the environment is bright.

[0220] FIG. **14** illustrates an example of a response graph showing brightness perceived by a user according to brightness of a surrounding environment.

[0221] In FIG. **14**, the horizontal axis may represent the brightness applied to the user, and the vertical axis may represent the brightness perceived by the user for each brightness.

[0222] A first graph (sigma=0.05) may be a response graph of a user who is in an environment in which surrounding brightness is the darkest, a second graph (sigma=6) may be a response graph of a user who is in an environment in which surrounding brightness is between the environment of the first graph and the environment of a third graph, and the third graph (sigma=700) may be a response graph of a user who is in an environment in which surrounding brightness is the brightest.

[0223] Referring to FIG. **14**, it can be confirmed that, when the brightness applied to the user is 1, a first user recognizes the brightness as 1, a second user recognizes the brightness as about 0.9, and a third user recognizes the brightness as about zero. That is, it can be confirmed that the user who is in the environment in which the surrounding brightness is darker is more sensitive to the applied brightness.

[0224] From this, it can be confirmed that as the environment is darker, the blooming phenomenon occur more seriously. Therefore, when the surrounding environment is somewhat bright, the dimming value is adjusted to be small through the above-described method although it is difficult for the user to recognize the blooming phenomenon. Therefore, only the total brightness of the image is darkened during the local dimming.

[0225] Therefore, the display device **100** according to another embodiment of the present disclosure may differently adjust the dimming value according to the brightness of the surrounding environment during the local dimming, thereby minimizing the problem that reduces the total brightness of the image while minimizing the blooming phenomenon.

[0226] The display device **100** according to another embodiment of the present disclosure operates as illustrated in FIG. **12**, but in operation S**20**, the display device **100** may calculate the dimming value by adjusting the brightness of the surrounding environment.

[0227] FIG. **15** is a flowchart illustrating a method for adjusting dimming values of a plurality of unit blocks by a display device according to another embodiment of the present disclosure.

[0228] The backlight dimming controller **510** may acquire surrounding brightness (S**21**).

[0229] According to an embodiment, the display device **100** may further include an illuminance sensor (not illustrated). The illuminance sensor (not illustrated) may detect the surrounding brightness of the display device **100**. The backlight dimming controller **510** may acquire the surrounding brightness of the display device **100** by receiving the surrounding brightness detected by the illuminance sensor (not illustrated). However, this method is merely an example, and the backlight dimming controller **510** may acquire surrounding brightness in various ways.

[0230] The backlight dimming controller **510** may adjust the dimming value corrected in each of the plurality of unit blocks based on the surrounding brightness (S**23**).

[0231] The backlight dimming controller **510** may enhance the degree of correcting the dimming values of the plurality of unit blocks in operation S**20** as the surrounding brightness is darker. That is, the dimming value corrector **513** may strongly correct the dimming values of the unit blocks as the surrounding brightness is darker. Enhancing or strongly correcting the correction degree may mean correcting the dimming value to be smaller.

[0232] Therefore, as an example, if the backlight dimming controller **510** corrects the dimming value of the first unit block to the first dimming value when the surrounding brightness is the first brightness, the dimming value of the first unit block may be corrected to the second dimming value smaller than the first dimming value when the surrounding brightness is the second brightness that is darker than the first brightness.

[0233] Therefore, since it is difficult for the user to recognize the blooming phenomenon when the surrounding environment is somewhat bright. the display device **100** may slightly correct the dimming value to minimize a case in which the total brightness of the image becomes dark. Since the user can easily recognize the blooming phenomenon when the surrounding environment is slightly dark, the display device **100** may strongly correct the dimming value to improve the blooming problem.

[0234] FIG. **16** is an exemplary diagram for explaining brightness of an output image detected by a display device according to comparative example, and FIG. **17** is an exemplary diagram for explaining brightness of an output image detected by a display device according to an embodiment of the present disclosure.

[0235] First, referring to FIG. **16**, the display device **100** may divide a screen into a plurality of blocks according to the number of light sources **252** and may output an image according to brightness (LED control) and transmittance (pixel control) determined for each block. Therefore, in this case, the brightness of the output image may be equally detected in the same block.

[0236] Meanwhile, referring to FIG. **17**, the display device **100** may divide a screen into a plurality of blocks according to the number of light sources **252** and may divide each block into a plurality of unit blocks (e.g., four unit blocks). In this case, the display device **100** outputs an image according to brightness (LED Control) and transmittance (pixel Control) determined for each block. The transmittance within the same block may be different for each unit block. For example, the transmittance of the first unit block may be determined as 100 and the transmittance of the second to fourth unit blocks may be determined as 120. In this case, the brightness of the output image in the first unit block may be different from the brightness of the output image in the second to fourth unit blocks.

[0237] As described above, according to the present disclosure, even in the same block, the brightness of the output image may be differently detected for each unit block. As such, since the dimming value and image data are corrected based on unit blocks even in the same block, the dimming value and image data may be adjusted more finely. Therefore, the blooming phenomenon may be improved and the contrast may be improved.

[0238] According to the present disclosure, the dimming value of the image and the image data are finely adjusted by dividing the block as if there are more blocks than the number of light sources, thereby minimizing the blooming phenomenon and improving the contrast.

[0239] According to the present disclosure, since the dimming value and the image data of the image are adjusted through the virtual unit blocks without increasing the number of light sources, the blooming phenomenon may be improved while minimizing the increase in manufacturing costs.

[0240] According to the present disclosure, since the correction degree of the dimming value is adjusted according to the surrounding environment, the brightness of the image may be minimized and the blooming phenomenon may be improved.

[0241] The present disclosure may be embodied as computer-readable codes on a program-recorded medium. The computer-readable recording medium may be any recording medium that stores data which can be thereafter read by a computer system. Examples of the computer-readable medium may include hard disk drive (HDD), solid state disk (SSD), silicon disk drive (SDD), read-only memory (ROM), random-access memory (RAM), CD-ROM, a magnetic tape, a floppy disk, and an optical data storage device. In addition, the computer may include the controller **170** of the display device **100**. Accordingly, the above detailed description should not be construed as being restrictive in all respects and should be considered illustrative. The scope of the present specification should be determined by rational interpretation of the appended claims, and all changes within the equivalent scope of the present specification fall within the scope of the present specification.

[0242] The above description is merely illustrative of the technical idea of the present invention, and various modifications and changes may be made thereto by those skilled in the art without departing from the essential characteristics of the present invention.

[0243] Therefore, the embodiments of the present invention are not intended to limit the technical spirit of the present invention but to illustrate the technical idea of the present invention, and the technical spirit of the present invention is not limited by these embodiments.

[0244] The scope of protection of the present invention should be interpreted by the appending claims, and all technical ideas within the scope of equivalents should be construed as falling within the scope of the present invention.

What is claimed is:

1. A display device comprising:

a liquid crystal display panel;

a backlight unit including a plurality of light sources for supplying light to the liquid crystal display panel and driven in a state of being divided into a plurality of blocks corresponding to the number of the light sources; and

a backlight dimming controller configured to calculate dimming values of the plurality of blocks,

wherein the backlight dimming controller is configured to divide each of the plurality of blocks into a plurality of unit blocks and control brightness of an output image differently for each of the unit blocks.

2. The display device according to claim 1, wherein brightness of images output through the liquid crystal display panel is differently detected for each of the unit blocks.

3. The display device according to claim 1, wherein the backlight dimming controller is configured to correct dimming values of the plurality of unit blocks based on input image data.

4. The display device according to claim 3, wherein the backlight dimming controller is configured to calculate dimming values of the plurality of blocks based on the input image data and divide each of the plurality of blocks into a plurality of unit blocks so that the plurality of unit blocks have calculated dimming values, respectively.

5. The display device according to claim 4, wherein the backlight dimming controller is configured to correct a dimming value of a unit block corresponding to a boundary region between a bright portion and a dark portion among the plurality of unit blocks divided to have the calculated dimming values, respectively, to be smaller than the calculated dimming value.

6. The display device according to claim 5, wherein the backlight dimming controller is configured to determine an average of the dimming values of the plurality of unit blocks as a representative dimming value of a block to which the unit blocks belong.

7. The display device according to claim 1, wherein the backlight dimming controller is configured to correct the input image data based on dimming values of the plurality of unit blocks.

8. The display device according to claim 7, wherein the backlight dimming controller is configured to determine a correction degree of the image data based on the dimming values of the unit blocks and a representative dimming value of a block to which the unit blocks belong.

9. The display device according to claim 8, wherein the backlight dimming controller is configured to determine a correction degree of a unit block having a dimming value smaller than the representative dimming value to be smaller than a correction degree of a unit block having a dimming value larger than the representative dimming value.

10. The display device according to claim 1, wherein the backlight dimming controller is configured to differently adjust dimming values corrected in the plurality of unit blocks based on surrounding brightness.

11. The display device according to claim 10, wherein the backlight dimming controller is configured to correct the dimming values of the plurality of unit blocks more strongly as the surrounding brightness is darker.

12. The display device according to claim 11, wherein if the backlight dimming controller corrects a dimming value of a first unit block to a first dimming value when the surrounding brightness is a first brightness, the backlight dimming controller is configured to correct the dimming value of the first unit block to a second dimming value smaller than the first dimming value when the surrounding brightness is a second brightness that is darker than the first brightness.

13. The display device according to claim 10, further comprising an illuminance sensor configured to detect the surrounding brightness.

14. The display device according to claim 1, wherein the backlight dimming controller comprises a unit block dimming value calculator configured to divide each of a plurality of previously divided blocks into the plurality of unit blocks and calculate dimming values of the unit blocks.

15. The display device according to claim 14, wherein the backlight dimming controller comprises:

a dimming value corrector configured to correct the dimming values of the unit blocks calculated by the unit block dimming value calculator;

a dimming value determiner configured to determine a representative dimming value of a block to which the unit blocks belong, based on the dimming values of the unit blocks;

a correction determiner configured to determine a correction degree of transmittance based on the dimming values of the unit blocks corrected by the dimming value corrector and the representative dimming value determined by the dimming value determiner; and

a pixel corrector configured to correct input image data based on the correction degree of transmittance determined by the correction determiner.

16. A method for operating a display device, the method comprising:

dividing a block into a plurality of blocks corresponding to the number of light sources;

calculating dimming values of the plurality of blocks; and

outputting an image by driving the plurality of light sources based on the dimming value,

wherein the method further comprises controlling output brightness of the image differently for each of the unit blocks by dividing each of the plurality of blocks into a plurality of unit blocks.

17. The method according to claim 16, wherein the controlling of the output brightness of the image differently for each unit block comprises correcting the dimming values of the plurality of unit blocks based on input image data.

18. The method according to claim 17, wherein the correcting of the dimming values of the plurality of blocks comprises:

calculating the dimming values of the plurality of blocks based on the input image data;

dividing each of the plurality of blocks into a plurality of unit blocks so that the plurality of unit blocks have the calculated dimming values, respectively; and

correcting a dimming value of a unit block corresponding to a boundary region between a bright portion and a

dark portion among the plurality of divided unit blocks to be smaller than the calculated dimming value.

19. The method according to claim **17**, wherein the controlling of the output brightness of the image differently for each of the unit blocks further comprises determining an average of the dimming values of the plurality of unit blocks as a representative dimming value of a block to which the unit blocks belong.

20. The method according to claim **17**, wherein the controlling of the output brightness of the image differently for each of the unit blocks further comprises correcting the input image data based on the dimming values of the plurality of unit blocks.

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