(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 318 457 A1**

(12) # EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
07.02.2024 Bulletin 2024/06

(21) Application number: **22791947.9**

(22) Date of filing: **13.04.2022**

(51) International Patent Classification (IPC):
G09G 5/10 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
G09G 5/10

(86) International application number:
PCT/KR2022/005316

(87) International publication number:
WO 2022/225247 (27.10.2022 Gazette 2022/43)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **23.04.2021 KR 20210053205**

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(54) **ELECTRONIC DEVICE COMPRISING FLEXIBLE DISPLAY, AND OPERATION METHOD THEREFOR**

(57) An electronic device comprises: a flexible display capable of extending in a first edge direction; a housing; a display driving circuit; and a processor, wherein the display driving circuit applies dimming on the basis of a first dimming depth in the first edge direction from a first starting point separated by a first width from a first edge, forms a dimming layer, to which the dimming is applied, on the basis of a second dimming depth in a second edge direction from a second starting point separated by a second width from the second edge that is opposite to the first edge, and sets the first and second widths and the first and second dimming depths to be each equal to each other according to the identification of the first state, and sets the first and second widths and the first and second dimming depths to be each different from each other according to the identification of the second state.

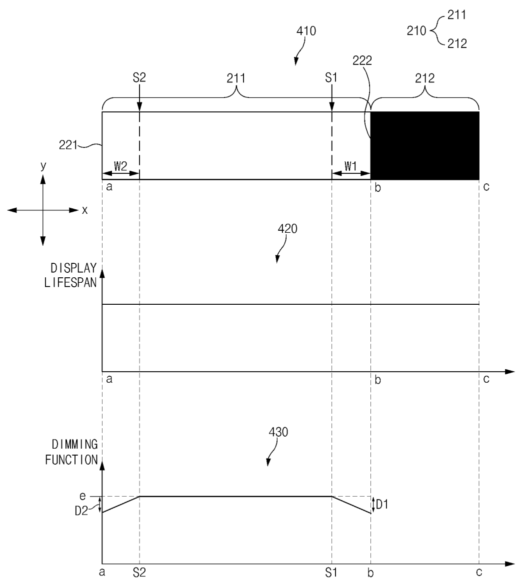

FIG.4

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Description

[Technical Field]

[0001] Embodiments of the disclosure relate to an electronic device including a flexible display variable in type, such as a slide type, a rollable type, or a foldable type, and a method for operating the same.

[Background Art]

[0002] Recently, various types of electronic devices have been developed to ensure a more expanded display region without exerting an influence on portability. For example, the electronic device including the flexible display may correspond to any one of a slide type of an electronic device changed in state of a display while at least one side surface of a housing is sliding, a rollable type of an electronic device having a display region, which is exposed out of the electronic device, and expanded as a display wound inside or outside the housing is spread, or a foldable type of an electronic device having a display region expanded/reduced, as the folded housing is unfolded.

[Disclosure]

[Technical Problem]

[0003] A plurality of pixels included in a display may be gradually reduced in light emitting efficiency or light emitting performance due to an aging effect over time. As the use extent of the display is increased, pixels included in the display have use extents different from each other depending on the positions of the pixels. Accordingly, the pixels experience mutually different aging effects, so the pixels may have light emitting efficiencies or the light emitting performances independent from each other. Accordingly, even if the same voltage or the same current is applied to the plurality of pixels to express an uniform image on the display, a real output screen of the display may show a deterioration phenomenon or a burn-in phenomenon without the uniform image.

[0004] As electronic devices having various flexible displays have been developed, there has been suggested a technology of preventing the burn-in phenomenon and of compensating for the difference in visibility, in consideration of the use aspect, which is different from the use aspect of a conventional display having a fixed display region. In the flexible display, even if the main region is mainly used, a sub-region is used as a display region when the sub-region is expanded. Accordingly, the sub-region may have a difference in the use extent from the main region.

[0005] Accordingly, the difference in visibility or the burn-in phenomenon may be caused at a boundary region between the main region and the sub-region. When the display of the sub-region, which is not exposed to the user, is driven at ordinary times even in the basic state that only the main region is used without the use of the sub-region, to prevent the difference in visibility or the burn-in phenomenon from being caused, current consumption may be increased and heat may be emitted.

[0006] Various embodiments of the disclosure provide an electronic device, capable of preventing the difference in visibility between the main region and the sub-region and the burn-in phenomenon in the main region and the sub-region, and of compensating for the difference in visibility between the main region and the sub-region, when the difference in visibility between the main region and the sub-region and the burn-in phenomenon the main region and the sub-region are caused.

[Technical Solution]

[0007] According to an embodiment of the disclosure, an electronic device may include a flexible display expandable in at least a direction of a first edge, in which the flexible display operates a first region in a first state, and operates the first region and a second region expanded in the direction of the first edge, in a second state, a housing included inside the flexible display and expandable in the direction of the first edge, a display driving circuit to drive the flexible display, and a processor electrically connected to the flexible display and the display driving circuit. The processor or the display driving circuit may form a dimming layer to apply dimming based on a first dimming depth in the direction of the first edge from a first starting point spaced apart from the first edge by a first width, and to apply the dimming based on a second dimming depth in a direction of a second edge from a second starting point spaced apart from the second edge, which is opposite to the first edge, by a second width, set the first width and the second width to be equal to each other, as the first state is identified, and set the first dimming depth and the second dimming depth to be equal to each other, and set the first width and the second width to be different from each other, as the second state is identified, and set the first dimming depth and the second dimming depth to be different from each other.

[0008] According to an embodiment of the disclosure, a method for operating an electronic device including a flexible display expandable in at least a direction of a first edge, in which the flexible display operates a first region in a first state, and operates the first region and a second region expanded in the direction of the first edge in the second state, the method may include forming a dimming layer to apply dimming based on a first dimming depth in the direction of the first edge from a first starting point spaced apart from the first edge by a first width, and to apply the dimming based on a second dimming depth in a direction of the second edge from a second starting point spaced apart from a second edge, which is opposite to the first edge, by a second width, setting the first width and the second width to be equal to each other and setting the first dimming depth and the second dimming depth to be equal to each other, as the first state is identified, and setting the first width and the second width to be different from each other, and setting the first dimming depth and the second dimming depth to be different from each other, as the second state is identified.

[Advantageous Effects]

[0009] According to various embodiments of the disclosure, the electronic device and the method for operating the same may be provided to prevent the difference in visibility between the main region and the sub-region and the burn-in phenomenon in the main region and the sub-region, and to compensate for the difference in visibility between the main region and the sub-region, when the difference in visibility between the main region and the sub-region and the burn-in phenomenon in the main region and the sub-region are caused.

[0010] Besides, a variety of effects directly or indirectly understood through the disclosure may be provided.

[Description of Drawings]

[0011]

FIG. 1 is a block diagram illustrating an electronic device in a network environment, according to various embodiments;
FIG. 2 is a block diagram of a display module, according to various embodiments;
FIG. 3 is a view illustrating an electronic device, according to an embodiment;
FIG. 4 is a view illustrating the operation of an electronic device, according to an embodiment;
FIG. 5 is a view illustrating a result of an electronic device having a display applied with dimming, according to an embodiment;
FIG. 6 is a view illustrating the operation of an electronic device, according to an embodiment;
FIG. 7 is a view illustrating a result of an electronic device having a display applied with dimming, according to an embodiment;
FIG. 8 is a view illustrating various dimming layers formed by an electronic device, according to an embodiment;
FIG. 9 is a view illustrating the operation of an electronic device, according to an embodiment; and
FIG. 10 is a view illustrating a result of an electronic device having a display applied with dimming, according to an embodiment.

[0012] In the following description made with respect to the accompanying drawings, similar components will be assigned with similar reference numerals.

[Mode for Invention]

[0013] Hereinafter, various embodiments of the disclosure may be described with reference to accompanying drawings. Accordingly, those of ordinary skill in the art will recognize that modification, equivalent, and/or alternative on the various embodiments described herein can be variously made without departing from the scope and spirit of the disclosure.

[0014] FIG. 1 is a block diagram illustrating an electronic device 101 in a network environment 100 according to various embodiments. Referring to FIG. 1, the electronic device 101 in the network environment 100 may communicate with an electronic device 102 via a first network 198 (e.g., a short-range wireless communication network), or an electronic device 104 or a server 108 via a second network 199 (e.g., a long-range wireless communication network). According to an embodiment, the electronic device 101 may communicate with the electronic device 104 via the server 108. According to an embodiment, the electronic device 101 may include a processor 120, a memory 130, an input module 150, a sound output module 155, a display module 160, an audio module 170, a sensor module 176, an interface 177, a connecting terminal 178, a haptic module 179, a camera module 180, a power management module 188, a battery 189, a communication module 190, a subscriber identification module (SIM) 196, or an antenna module 197. In some embodiments, at least one (e.g., the connecting terminal 178) of the components may be omitted from the electronic device 101, or one or more other components may be added in the electronic device 101. In some embodiments, some of the components may be implemented as single integrated circuitry. For example, some (e.g., the sensor module 176, the camera module 180, or the antenna module 197) of the components may be implemented as embedded in the display module 160 (e.g., a display).

[0015] The processor 120 may execute, for example, software (e.g., a program 140) to control at least one other component (e.g., a hardware or software component) of the electronic device 101 coupled with the processor 120, and may perform various data processing or computation. According to one embodiment, as at least part of the data processing or computation, the processor 120 may load a command or data received from another component (e.g., the sensor module 176 or the communication module 190) in a volatile memory 132, process the command or the data stored in the volatile memory 132, and store resulting data in a non-volatile memory 134. According to an embodiment, the processor 120 may include a main processor 121 (e.g., a central processing unit (CPU) or an application processor (AP)), and an auxiliary processor 123 (e.g., a graphics processing unit (GPU), a neural processing unit (NPU), an image signal processor (ISP), a sensor hub processor, or a communication processor (CP)) that is operable independently from, or in conjunction with, the main processor 121. When the electronic device 101 includes the main processor 121 and the auxiliary processor, the auxiliary processor 123 may be adapted to consume less power than the main processor 121, or to be specific to a specified function. The auxiliary processor 123 may be implemented as separate from, or as part of the main processor 121.

[0016] The auxiliary processor 123 may control at least some of functions or states related to at least one component (e.g., the display module 160, the sensor module 176, or the communication module 190) among the components of the electronic device 101, instead of the main processor 121 while the main processor 121 is in an inactive (e.g., sleep) state, or together with the main processor 121 while the main processor 121 is in an active state (e.g., executing an application). According to an embodiment, the auxiliary processor 123 (e.g., an image signal processor or a communication processor) may be implemented as part of another component (e.g., the camera module 180 or the communication module 190) functionally related to the auxiliary processor 123. According to an embodiment, the auxiliary processor 123 (e.g., a neural network processing device) may include a hardware structure specified for processing an artificial intelligence (AI) model. The AI model may be generated through machine learning. The learning may be performed by the electronic device 101 performing the AI, and may be performed through an additional server (e.g., the server 108). A learning algorithm may include, for example, a supervised learning algorithm, an unsupervised learning algorithm, a semi-supervised learning algorithm, or a reinforcement learning algorithm, but the disclosure is not limited thereto. The AI model may include a plurality of artificial neural network (ANN) layers. The ANN may include a deep neural network (DNN), a convolutional neural network (CNN), a recurrent neural network (RNN), a restricted boltzman machine (RBM), a deep belief network (DBN), a bidirectional recurrent deep neural network (BRDNN), a deep Q-networks or the combination of the above networks, but the disclosure is not limited thereto. The AI model may additionally or alternatively include a software structure, in addition to a hardware structure.

[0017] The memory 130 may store various data used by at least one component (e.g., the processor 120 or the sensor module 176) of the electronic device 101. The various data may include, for example, software (e.g., the program 140) and input data or output data for a command related thereto. The memory 130 may include the volatile memory 132 or the non-volatile memory 134.

[0018] The program 140 may be stored in the memory 130 as software, and may include, for example, an operating system (OS) 142, middleware 144, or an application 146.

[0019] The input module 150 may receive a command or data to be used by other component (e.g., the processor 120) of the electronic device 101, from the outside (e.g., a user) of the electronic device 101. The input module 150 may include, for example, a microphone, a mouse, a keyboard, a key (e.g., a button), or a digital pen (e.g., a stylus pen).

[0020] The sound output module 155 may output sound signals to the outside of the electronic device 101. The sound output module 155 may include, for example, a speaker or a receiver. The speaker may be used for general purposes, such as playing multimedia or playing record, and the receiver may be used for an incoming calls. According to an embodiment, the receiver may be implemented as separate from, or as part of the speaker.

[0021] The display module 160 may visually provide information to the outside (e.g., a user) of the electronic device 101. The display module 160 may include, for example, a display, a hologram device, or a projector and control circuitry to control a corresponding one of the display, hologram device, and projector. According to an embodiment, the display module 160 may include touch sensor adapted to detect a touch, or a pressure sensor adapted to measure the intensity of force incurred by the touch.

[0022] The audio module 170 may convert a sound into an electrical signal and vice versa. According to an embodiment, the audio module 170 may obtain the sound via the input module 150, or output the sound via the sound output module 155 or an external electronic device (e.g., the electronic device 102) (e.g., speaker of headphone) directly (e.g., wiredly) or wirelessly coupled with the electronic device 101.

[0023] The sensor module 176 may detect an operational state (e.g., power or temperature) of the electronic device 101 or an environmental state (e.g., a state of a user) external to the electronic device 101, and then generate an electrical signal or data value corresponding to the detected state. According to an embodiment, the sensor module 176 may include, for example, a gesture sensor, a gyro sensor, an atmospheric pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a proximity sensor, a color sensor, an infrared (IR) sensor, a biometric sensor, a temperature sensor, a humidity sensor, or an illuminance sensor.

[0024] The interface 177 may support one or more specified protocols to be used for the electronic device 101 to be coupled with the external electronic device (e.g., the electronic device 102) directly (e.g., wiredly) or wirelessly. According to an embodiment, the interface 177 may include, for example, a high definition multimedia interface (HDMI), a universal serial bus (USB) interface, a secure digital (SD) card interface, or an audio interface.

[0025] A connecting terminal 178 may include a connector via which the electronic device 101 may be physically connected with the external electronic device (e.g., the electronic device 102). According to an embodiment, the connecting terminal 178 may include, for example, a HDMI connector, a USB connector, a SD card connector, or an audio connector (e.g., a headphone connector).

[0026] The haptic module 179 may convert an electrical signal into a mechanical stimulus (e.g., a vibration or a movement) or electrical stimulus which may be recognized by a user via his tactile sensation or kinesthetic sensation. According to an embodiment, the haptic module 179 may include, for example, a motor, a piezoelectric element, or an electric stimulator.

[0027] The camera module 180 may capture a still image or moving images. According to an embodiment, the camera module 180 may include one or more lenses, image sensors, image signal processors, or flashes.

[0028] The power management module 188 may manage power supplied to the electronic device 101. According to one embodiment, the power management module 188 may be implemented as at least part of, for example, a power management integrated circuit (PMIC).

[0029] The battery 189 may supply power to at least one component of the electronic device 101. According to an embodiment, the battery 189 may include, for example, a primary cell which is not rechargeable, a secondary cell which is rechargeable, or a fuel cell.

[0030] The communication module 190 may support establishing a direct (e.g., wired) communication channel or a wireless communication channel between the electronic device 101 and the external electronic device (e.g., the electronic device 102, the electronic device 104, or the server 108) and performing communication via the established communication channel. The communication module 190 may include one or more communication processors that are operable independently from the processor 120 (e.g., the application processor (AP)) and supports a direct (e.g., wired) communication or a wireless communication. According to an embodiment, the communication module 190 may include a wireless communication module 192 (e.g., a cellular communication module, a short-range wireless communication module, or a global navigation satellite system (GNSS) communication module) or a wired communication module 194 (e.g., a local area network (LAN) communication module or a power line communication (PLC) module). The corresponding communication module from among the communication modules may communicate with the external electronic device via the first network 198 (e.g., a short-range communication network, such as Bluetooth™, wireless-fidelity (WiFi) direct, or infrared data association (IrDA)) or the second network 199 (e.g., a long-range communication network, such as a legacy cellular network, 5G network, next generation communication network, the Internet, or a computer network (e.g., LAN or wide area network (WAN)). These various types of communication modules may be implemented as a single component (e.g., a single chip), or may be implemented as multi components (e.g., multi chips) separate from each other. The wireless communication module 192 may identify or authenticate the electronic device 101 in a communication network, such as the first network 198 or the second network 199, using subscriber information (e.g., international mobile subscriber identity (IMSI)) stored in the subscriber identification module 196.

[0031] The wireless communication module 192 may support a 5G network and a next-generation communication technology, for example, a new radio (NR) access technology after a 4G network. The NR access technology may support high-speed transmission for high capacity data (enhanced mobile broadband; eMBB), terminal power minimizing and multiple terminal access (massive machine type communication; mMTC), or ultra-reliable and low-latency communications (URLLC). The wireless communication module 192 may support a high-frequency band (e.g., mmWave band) to achieve, for example, a higher data rate. The wireless communication module 192 may support various technologies, for example, beamforming, massive multiple-input and multiple-output (MIMO), Full-dimensional MIMO, an array antenna, analog beamforming, or a large-scale antenna, to secure performance in high frequency bands. The wireless communication module 192 may support various requirements defined in the electronic device 101, the external electronic device (e.g., the electronic device 104) or the network system (e.g., the second network 199). According to one embodiment, the wireless communication module 192 may support a peak data rate (e.g., 20Gbps or more) for eMBB realization, loss coverage (e.g., 164 dB or less) for mMTC realization, or U-plane latency (e.g., 0.5 ms or less, or the round trip of 1 ms or less in each of a downlink (DL) and an uplink (UL)) for URLCC realization.

[0032] The antenna module 197 may transmit or receive a signal or power to or from the outside (e.g., the external electronic device) of the electronic device 101. According to an embodiment, the antenna module 197 may include an antenna including a radiating element composed of a conductive material or a conductive pattern formed in or on a substrate (e.g., PCB). According to an embodiment, the antenna module 197 may include a plurality of antennas (e.g., an array antenna). In such a case, at least one antenna appropriate for a communication scheme used in the communication network, such as the first network 198 or the second network 199, may be selected, for example, by the communication module 190 from the plurality of antennas. The signal or the power may then be transmitted or received between the communication module 190 and the external electronic device via the selected at least one antenna. According to an embodiment, another component (e.g., a radio frequency integrated circuit (RFIC)) other than the radiating element may be additionally formed as part of the antenna module 197.

[0033] According to various embodiments, the antenna module 197 may form an mmWave antenna module. According to an embodiment, the mmWave antenna module may include a printed circuit board, an RFIC disposed on a first surface (e.g., a bottom surface) of the printed circuit board, or disposed adjacent to the first surface to support the specific high frequency band (e.g., mmWave band), and a plurality of antennas (e.g., an array antenna) disposed on a second surface (e.g., a top surface or a side surface) of the printed circuit board or disposed adjacent to the second surface to transmit or receive a signal having the specified high frequency band.

[0034] At least some of the above-described components may be coupled mutually and communicate signals (e.g., commands or data) therebetween via an inter-peripheral communication scheme (e.g., a bus, general purpose input and output (GPIO), serial peripheral interface (SPI), or mobile industry processor interface (MIPI)).

[0035] According to an embodiment, commands or data may be transmitted or received between the electronic device 101 and the external electronic device 104 via the server 108 coupled with the second network 199. Each of the external electronic devices 102 or 104 may be a device of a same type as, or a different type, from the electronic device 101. According to an embodiment, all or some of operations to be executed at the electronic device 101 may be executed at one or more of the external electronic devices 102, 104, or 108. For example, when the electronic device 101 should perform a function or a service automatically, or in response to a request from a user or another device, the electronic device 101, instead of, or in addition to, executing the function or the service, may request the one or more external electronic devices to perform at least part of the function or the service. The one or more external electronic devices receiving the request may perform the at least part of the function or the service requested, or an additional function or an additional service related to the request, and transfer an outcome of the performing to the electronic device 101. The electronic device 101 may provide the outcome, with or without further processing of the outcome, as at least part of a reply to the request. To that end, a cloud computing, distributed computing, mobile edge computing (MEC), or client-server computing technology may be used, for example. The electronic device 101 may provide an ultra-latency service by using, for example, distributed computing or mobile edge computing. According to various embodiments, the external electronic device 104 may include the Internet of things (IoT). The server 108 may be an artificial server using machine learning and/or a neural network. According to an embodiment, the external electronic device 104 or the server 108 may be included in the second network 199. The electronic device 101 may be applied to an artificial intelligence service (e.g., a smart home, a smart city, a smart car, or healthcare service) based on the 5G communication technology and the IoT-related technology.

[0036] The electronic device according to various embodiments may be one of various types of electronic devices. The electronic devices may include, for example, a portable communication device (e.g., a smartphone), a computer device, a portable multimedia device, a portable medical device, a camera, a wearable device, or a home appliance. According to an embodiment of the disclosure, the electronic devices are not limited to those described above.

[0037] It should be appreciated that various embodiments of the disclosure and the terms used therein are not intended to limit the technological features set forth herein to particular embodiments and include various changes, equivalents, or replacements for a corresponding embodiment. With regard to the description of the drawings, similar reference numerals may be used to refer to similar or related elements. It is to be understood that a singular form of a noun corresponding to an item may include one or more of the things, unless the relevant context clearly indicates otherwise. As used herein, each of such phrases as "A or B," "at least one of A and B," "at least one of A or B," "A, B, or C," "at least one of A, B, and C," and "at least one of A, B, or C," may include any one of, or all possible combinations of the items enumerated together in a corresponding one of the phrases. As used herein, such terms as "1^{st}" and "2^{nd}," or "first" and "second" may be used to simply distinguish a corresponding component from another, and does not limit the components in other aspect (e.g., importance or order). It is to be understood that if an element (e.g., a first element) is referred to, with or without the term "operatively" or "communicatively", as "coupled with," "coupled to," "connected with," or "connected to" another element (e.g., a second element), it means that the element may be coupled with the other element directly (e.g., wiredly), wirelessly, or via a third element.

[0038] As used herein, the term "module" may include a unit implemented in hardware, software, or firmware, and may interchangeably be used with other terms, for example, "logic," "logic block," "part," or "circuitry". A module may be a single integral component, or a minimum unit or part thereof, adapted to perform one or more functions. For example, according to an embodiment, the module may be implemented in a form of an application-specific integrated circuit (ASIC).

[0039] Various embodiments as set forth herein may be implemented as software (e.g., the program 140) including one or more instructions that are stored in a storage medium (e.g., internal memory 136 or external memory 138) that is readable by a machine (e.g., the electronic device 101). For example, a processor(e.g., the processor 120) of the machine (e.g., the electronic device 101) may invoke at least one of the one or more instructions stored in the storage medium, and execute it, with or without using one or more other components under the control of the processor. This allows the machine to be operated to perform at least one function according to the at least one instruction invoked. The one or more instructions may include a code generated by a compiler or a code executable by an interpreter. The machine-readable storage medium may be provided in the form of a non-transitory storage medium. Wherein, the term "non-transitory" simply means that the storage medium is a tangible device, and does not include a signal (e.g., an electromagnetic wave), but this term does not differentiate between where data is semi-permanently stored in the storage medium and where the data is temporarily stored in the storage medium.

[0040] According to an embodiment, a method according to various embodiments of the disclosure may be included and provided in a computer program product. The computer program product may be traded as a product between a seller and a buyer. The computer program product may be distributed in the form of a machine-readable storage medium (e.g., compact disc read only memory (CD-ROM)), or be distributed (e.g., downloaded or uploaded) online via an application store (e.g., PlayStore™), or between two user devices (e.g., smart phones) directly. If distributed online, at least part of the computer program product may be temporarily generated or at least temporarily stored in the machine-readable storage medium, such as memory of the manufacturer's server, a server of the application store, or a relay server.

[0041] According to various embodiments, each component (e.g., a module or a program) of the above-described components may include a single entity or multiple entities and some of multiple entities may be separately disposed on the other components. According to various embodiments, one or more of the above-described components may be omitted, or one or more other components may be added. Alternatively or additionally, a plurality of components (e.g., modules or programs) may be integrated into a single component. In such a case, according to various embodiments, the integrated component may still perform one or more functions of each of the plurality of components in the same or similar manner as they are performed by a corresponding one of the plurality of components before the integration. According to various embodiments, operations performed by the module, the program, or another component may be carried out sequentially, in parallel, repeatedly, or heuristically, or one or more of the operations may be executed in a different order or omitted, or one or more other operations may be added.

[0042] FIG. 2 is a block diagram 200 of the display module 160, according to various embodiments. Referring to FIG. 2, the display module 160 may include a display 210 and a display deriver IC (DDI) 230 to control the display 210. The DDI 230 may include an interface module 231, a memory 233 (e.g., a buffer memory), an image processing module 235, or a mapping module 237. The DDI 230 may receive image information including, for example, image data or an image control signal corresponding to a command for controlling image data, from another component of the electronic device 101 through the interface module 231. For example, according to an embodiment, the image information may be received from the processor 120 (e.g., the main processor 121 (e.g., an application processor) or the auxiliary processor 123 (e.g., the graphic processing device) operated independently from the function of the main processor 121). The DDI 230 may make communication with a touch circuit 250 or the sensor module 176 through the interface module 231. The DDI 230 may store at least some of the received image information in the memory 233, for example, in unit of a frame. The image processing module 235 may perform pretreatment or post-treatment (e.g., adjusting a resolution, a brightness, or a size), with respect to, for example, at least some of the image data based at least on the characteristic of the image data or the characteristic of the display 210. The mapping module 237 may generate a voltage value or a current value corresponding to the image data subject to the pretreatment or the post-treatment through the image processing module 235. According to an embodiment, the voltage value and the current value may be generated based at least partially on attributes (e.g., the array (RGB stripe or pentile structure) of pixels or the size of each sub-pixel) of the display 210. At least some pixels of the display 201 may be driven based at least partially on, for example, the voltage value or the current value, such that visual information (e.g., a text, an image, or an icon) corresponding to the image data is displayed through the display 210.

[0043] According to an embodiment, the display module 160 may further include the touch circuit 250. The touch circuit 250 may include a touch sensor 251 and a touch sensor IC 253 for controlling the touch sensor 251. For example, the touch sensor IC 253 may control the touch sensor 251 to sense the touch input or the hovering input to a specified position of the display 210. For example, the touch sensor IC 253 may sense a touch input or a hovering input by measuring the change in the signal (e.g., a voltage, a light quantity, a resistance, or a charge amount) at a specific position of the display 210. The touch sensor IC 253 may provide, to the processor 120, information (e.g., a position, an area, pressure, or a time) on the sensed touch input or hovering input. According to an embodiment, at least a portion (e.g., the touch sensor IC 253) of the touch circuit 250 may be included in a portion of the display driver IC 230 or the display 210, or a portion of another component (e.g., the auxiliary processor 123) disposed outside the display module 160.

[0044] According to an embodiment, the display module 160 may further include at least one sensor (e.g., a fingerprint sensor, an iris sensor, a pressure sensor, or an illuminance sensor) of the sensor module 176 or a control circuit for the at least one sensor. In this case, the at least one sensor or the control circuit for the at least one sensor may be embedded in a portion (e.g., the display 210 or the DDI 230) of the display module 160 or a portion of the touch circuit 250. For example, when the sensor module 176 embedded in the display module 160 includes a biometric sensor (e.g., a fingerprint sensor), the biometric sensor may obtain biometric information (e.g., a fingerprint image) associated with a touch input through a partial area of the display 210. For another example, when the sensor module 176 embedded in the display module 160 includes a pressure sensor, the pressure sensor may obtain input information associated with the touch input through a partial area or the whole area of the display 210. According to an embodiment, the touch sensor 251 or the sensor module 176 may be disposed between pixels provided in a pixel layer or disposed on or under the pixel.

[0045] Hereinafter, the operation of the electronic device according to an embodiment will be described with reference to FIG. 3.

[0046] FIG. 3 is a view illustrating an electronic device, according to an embodiment.

[0047] Referring to FIG. 3, the electronic device 101 (e.g., the electronic device 101 of FIG. 1) may include a housing 310 constituting a body of the electronic device 101 and the display 210 (e.g., the display 210 of FIG. 2) disposed inside the housing 310. According to an embodiment, the display 210 may refer to a display panel, and may be at least partially viewed through a front plate substantially transparent in at least a portion of the front plate. According to an embodiment, the front plate may include a glass plate or a polymer plate including various coating layers.

[0048] The display 210 may include at least four edges of a second edge 221 in a left direction (e.g., -x direction), a first edge 222 in a right direction (e.g., +x direction), a third edge 223 in an upper direction (e.g., +y direction), and a fourth edge 224 in a lower direction (e.g., -y direction), when viewed from a front side of the electronic device 101. According to an embodiment, the edge may refer to the outermost edge of the display region of the display 210, and the display 210 having a quadrangular display region may include four edges. According to one embodiment, in the case of the display 210 having a quadrangular display region, a quadrangular part (corner part) of the display region may be in a round shape for aesthetics, and thus the edges (e.g., between the second edge 221 and the first edge 222) may be in a round shape without an angle.

[0049] In addition, the display 210 may be expanded or reduced in a direction perpendicular to at least one edge. Regarding the expanding or the reducing of the display 210, the display 210 disposed inside the housing 310 may be implemented to be expanded or reduced in the same direction as the housing 310 is expanded or reduced. For example, the display 210 may include a form in which the display 210 is expanded or reduced in opposite directions to each other from opposite sides of the housing.

[0050] A first state 301 of FIG. 3 may represent a basic state, and may refer to a state before the display 210 and the housing 310 are expanded. A second state 302 of FIG. 3 may represent an expansion state, and may refer to a state in which the display 210 and the housing 310 are expanded in a direction perpendicular to at least one edge of the display 210 and the housing 310. The electronic device 101 may automatically change the state between the first state 301 and the second state 302 by external force or by a motor placed inside the electronic device 101.

[0051] According to an embodiment, as the state of the electronic device 101 is changed from the first state 301 to the second state 302, the housing 310 and the display 210 may be expanded in a direction perpendicular to the first edge 222 (e.g., +x direction).

[0052] According to an embodiment, when the electronic device 101 is in the first state 301, only a first region 211, which is the main region of the display 210, may be exposed to the user. Accordingly, in the first state 301, the processor of the electronic device 101 (e.g., the processor (120 of FIG. 1)) and/or the display driver IC (e.g., the display driver IC 230 of FIG. 2) (hereinafter referred to as the display driving circuit) may only drive the first region 211.

[0053] According to an embodiment, when the electronic device 101 is changed from the first state 301 to the second state 302, the display 210 may be expanded, so a second region 212, which serves as the sub-region of the display 210, may be additionally exposed to the user. Accordingly, the processor and/or the display driving circuit of the electronic device 101 may drive both of the first region 211 and the second region 212 in the second state 302.

[0054] According to an embodiment, when the electronic device 101 is changed from the second state 302 to the first state 301, the display 210 may be reduced. Accordingly, the second region 212 may not be used as the display region, and only the first region 211 is driven to be used as the display region.

[0055] According to an embodiment, for the illustrative purpose, "a", "b", and "c" illustrated in FIG. 3 may correspond to coordinates displayed on the display 210 in the x-axis direction, the distance between "a" and "b" may correspond to the width in the x-axis direction of the first region 211, and the distance between "b" and "c" may correspond to the width in the x-axis direction of the second region 212. The coordinates of "a", "b", and "c" illustrated in FIG. 3 may correspond to coordinates of "a", "b", and "c" illustrated on the display of drawings to be described later.

[0056] Hereinafter, the operation of the electronic device according to an embodiment will be described with reference to FIGS. 4 and 5.

[0057] FIG. 4 is a view illustrating the operation of an electronic device, according to an embodiment. FIG. 5 is a view illustrating a result of an electronic device having a display applied with dimming, according to an embodiment. The same components as those of the above described embodiment will be assigned with the same reference numerals and the duplication thereof will be omitted.

[0058] Referring to FIG. 4, a first drawing 410 of FIG. 4 illustrates a display region of the display 210 of the electronic device 101 in brief for the illustrative purpose. According to an embodiment, the display 210 of the electronic device 101 may include the first region 211 and the second region 212, and a black mark of the second region 212 may indicate the state in that the second region 212 is not currently driven. In other words, FIG. 4 illustrates the electronic device 101 in the first state (basic state) in which the second region 212 is not driven, according to an embodiment.

[0059] A second drawing 420 of FIG. 4 may illustrate the lifespan of the display 210. A vertical axis of the graph in the second drawing 420 may indicate the lifespan of the display, and a horizontal axis of the graph may correspond to the x-axis direction of the display 210. Referring to the second drawing 420, the first region 211 and the second region 212 are currently equal to each other in lifespan of the display 210. In other words, FIG. 4 illustrates the display 210 under the assumption that the first region 211 and the second region 212 hardly differ from each other in lifespan.

[0060] Although the second drawing 420 of FIG. 4 illustrates that the first region 211 and the second region 212 having equal lifespans, this is provided only for the illustrative purpose. Even the difference in average lifespan between the first region 211 and the second region 212, which is equal to or less than a first threshold value, may correspond to the embodiment of FIG. 4. In addition, the lifespan of the display may indicate the light emitting efficiency and/or the light emitting performance of the display. In addition, the deterioration in the light emitting efficiency and the light emitting performance, which results from the deterioration of the display, may mean the reduction in lifespan of the display.

[0061] A third drawing 430 of FIG. 4 illustrates a dimming layer to be output to the display 210, in the form of a dimming function. The processor and/or the display driving circuit of the electronic device 101 may implement edge dimming by outputting the dimming layer overlaid with content to be displayed on the display 210. According to an embodiment, the display 210 may include the second edge 221 at the left side and the first edge 222 at the right side. Applying dimming to a region adjacent to the second edge 221 and a region adjacent to the first edge 222 may be referred to "edge dimming".

[0062] According to an embodiment, the dimming function may be determined by a dimming start point S, and a width W and a dimming depth D for applying dimming. Referring to the third drawing 430 of FIG. 4, according to an embodiment, dimming is applied with a second dimming depth D2 in a direction of the second edge 221 from a second start point S2 spaced apart from the second edge 221 by a second width W2, and dimming is applied with a first dimming depth D1 in a direction of the first edge 222 from a first start point S 1 spaced apart from the first edge 222 by a first width W1. In this case, the dimming function may be expressed as in following Equation 1. Although the third drawing 430 of FIG. 4 illustrates that the dimming function is a first-order function, the disclosure is not limited thereto. The dimming function may be a second-order function.

Equation 1

$$y- (e-D2) = D2/W2 *(x -(S2-W2)) \quad (S2-W2 \leq x < S2)$$

$$y = e \quad (S2 \leq x < S1)$$

$$y - e = - D1/W1 * (x- S1) \quad (S1 \leq x \leq S1+W1)$$

[0063] According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may apply the same dimming to opposite edge regions when the difference in lifespan between the first region 211 and the second region 212 of the electronic device 101 is equal to or less than the first threshold, and when the state of the display 210 is a first state (basic state). In other words, regarding the processor and/or the display driving circuit of the electronic device 101, the first width W1 may be equal to the second width W2, and the first dimming depth D1 may be equal to the second dimming depth D2. According to an embodiment, the processor of the electronic device 101 and/or the display driving circuit may determine the start points, the widths, and/or the dimming depths, which serve as dimming parameters, based on whether the second region 212 is expanded, the width of the second region 212 to be expanded, and/or information on difference in lifespan (the deterioration degree, visibility or brightness) between the first region 211 and the second region 212, or preset values may be stored in a memory of the electronic device 101.

[0064] According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may calculate the lifespan or the deterioration degree of the display 210. The processor and/or the display driving circuit of the electronic device 101 may calculate, as a numeric value, the deterioration degree of the brightness of the display 210 by using display deterioration data which is accumulated. The processor and/or the display driving circuit of the electronic device 101 may calculate, as a numeric value, the maximum brightness difference or the average brightness difference between the plurality of pixels of the display 210, based on the accumulated display brightness deterioration degree. The processor and/or the display driving circuit of the electronic device 101 may calculate, as a numeric value, a variance value for the brightness deterioration information of the plurality of pixels of the display 210, based on the accumulated display brightness deterioration degree.

[0065] The following description will be described with reference to FIG. 5 regarding that the processor and/or the display driving circuit of the electronic device 101 applies a dimming layer formed based on the operation described with reference to FIG. 4.

[0066] A first drawing 510 of FIG. 5 illustrates content to be output to the first region 211 of the display.

[0067] A second drawing 520 of FIG. 5 illustrates that the processor and/or the display driving circuit of the electronic device 101 forms a dimming layer based on the dimming function described with reference to the third drawing 430 of FIG. 4. The processor and/or the display driving circuit of the electronic device 101 may form the dimming layer to have a transparency gradually increasing in the direction of the second edge 221, depending on the dimming function, from the first start point S1 spaced apart from the first edge 222 by the first width W1. In addition, the processor and/or the display driving circuit of the electronic device 101 may form the dimming layer to have a transparency gradually increasing in the direction of the first edge 222, depending on the dimming function, from the second start point S2 spaced apart from the second edge 221 by a second width W2.

[0068] Referring to the second drawing 520 of FIG. 5, the processor and/or the display driving circuit of the electronic device 101 may form the dimming layer such that the same dimming is applied in the direction of the first edge 222 and the direction of the second edge 221, because the difference in lifespan between the first region 211 and the second region 212 of the display 210 of the electronic device 101 is equal to or less than the first threshold value, and the state of the display 210 is the first state (basic state).

[0069] The third drawing 530 of FIG. 5 illustrates the final output image output to the first region 211, as image processing is completed. The electronic device 101 may form a dimming layer as illustrated in the second drawing 520 of FIG. 5, in the final stage of image processing performed inside the processor and/or the display driving circuit, and overlay the dimming layer to the first image as illustrated in the first drawing 510 of FIG. 5. Accordingly, the final output image applied with the edge dimming may be output to the display 210 as illustrated in the third drawing 530 of FIG. 5.

[0070] According to an embodiment of the disclosure, the electronic device may apply dimming to opposite edges by adjusting the dimming parameter, in case of the first state (basic state) and the difference in average lifespan between the first region (main region) and the second region (sub-region), which is equal to or less than the first threshold value, thereby preventing the burn-in phenomenon resulting from the difference in use time between the first region (main region) and the second region (sub-region), reducing a color shift viewed on a cross-section of the display, and reducing optical distortion visibility caused at an edge of a curved surface. Additionally, current consumption may be reduced by reducing the brightness of the edge region.

[0071] According to an embodiment, the first threshold value may be set to a numeric value that allows a user to view the deterioration caused to the image. The first threshold value may be stored in a memory (e.g., the memory 130 of FIG. 1) of the electronic device 101. For example, the first threshold value may be input in the form of a code when the electronic device 101 is manufactured. For another example, the first threshold value may be provided to the electronic device 101 in the form of a software update from a server (e.g., the server 108 of FIG. 1). The server 108 may statistically calculate a threshold value by collecting values in which the user starts to recognize the deterioration of the image.

[0072] Hereinafter, the operation of the electronic device according to an embodiment will be described with reference to FIGS. 6 and 7.

[0073] FIG. 6 is a view illustrating the operation of an electronic device, according to an embodiment. FIG. 7 is a view illustrating a result of an electronic device having a display applied with dimming, according to an embodiment. The same components as those of the above described embodiment will be assigned with the same reference numerals and the duplication thereof will be omitted.

[0074] Referring to FIG. 6, a first drawing 610 of FIG. 6 illustrates a display region of the display 210 of the electronic device 101 in brief for the illustrative purpose. According to an embodiment, the display 210 of the electronic device 101 may include the first region 211 and the second region 212. FIG. 6 illustrates a second state (expansion state) in which the housing and the display 210 of the electronic device 101 are expanded, which is the state in which both the first region 211 and the second region 212 are driven.

[0075] A second drawing 620 of FIG. 6 may be a graph illustrating the lifespan of the display 210. A vertical axis of the graph in the second drawing 620 may indicate the lifespan of the display, and a horizontal axis of the graph may correspond to the x-axis direction of the display 210. Referring to the second drawing 620, the first region 211 and the second region 212 are currently equal to each other in lifespan of the display 210. In other words, FIG. 6 illustrates the display 210 under the assumption that the first region 211 and the second region 212 hardly differ from each other in lifespan.

[0076] Although the second drawing 620 of FIG. 6 illustrates that the first region 211 and the second region 212 having equal lifespans, this is provided only for illustrative purposes. Even the difference in average lifespan between the first region 211 and the second region 212, which is equal to or less than a first threshold value, may correspond to the embodiment of FIG. 6. In addition, the lifespan of the display may indicate the light emitting efficiency and/or the light emitting performance of the display. In addition, the deterioration in the light emitting efficiency and the light emitting performance, which results from the deterioration of the display, may mean the reduction in lifespan of the display.

[0077] A third drawing 630 of FIG. 6 illustrates a dimming layer to be output to the display 210, in the form of a dimming function. Referring to the third drawing 630 of FIG. 6, according to an embodiment, dimming is applied with the second dimming depth D2 in a direction of the second edge 221 from the second start point S2 spaced apart from the second edge 221 by the second width W2, and dimming is applied with the first dimming depth D1 in a direction of the first edge 222 from the first start point S 1 spaced apart from the first edge 222 by the first width W1. In this case, the dimming function may be expressed as in following Equation 2. Although the third drawing 630 FIG. 6 illustrates that the dimming function is a first-order function, the disclosure is not limited thereto. The dimming function may be a second-order function.

Equation 2

$$y - (e - D2) = D2/W2 * (x - (S2 - W2)) \quad (S2 - W2 \leq x < S2)$$

$$y = e \quad (S2 \leq x < S1)$$

$$y - e = - D1/W1 * (x - S1) \quad (S1 \leq x \leq S1 + W1)$$

[0078] In Equation 2, the first width W1 may be a sum of a third width W3 and a fourth width W4. The third width W3 may be the width of a partial region of the first region 211, and the fourth width W4 may be the width of the second region 212 in which the display 210 is extended

[0079] According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may asymmetrically apply dimming to opposite edge regions, when the difference in lifespan between the first region 211 and the second region 212 of the electronic device 101 is equal to or less than the first threshold, and when the state of the display 210 is a second state (expansion state. In other words, the first width W1 may differ from the second width W2, and the first dimming depth D1 may differ from the second dimming depth D2.

[0080] According to an embodiment, the processor of the electronic device 101 and/or the display driving circuit may determine the start points S, the widths W, and/or the dimming depths D, which serve as dimming parameters, based on whether the second region 212 is expanded, the width of the second region 212 to be expanded, and/or information on difference in lifespan (the deterioration degree, visibility or brightness) between the first region 211 and the second region 212, or preset values may be stored in a memory of the electronic device 101.

[0081] According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may measure the deterioration degree of the display 210 by measuring the use time of the display 210 and/or analyzing a display image of the display 210, thereby acquiring the information on the use time and/or the information on the deterioration degree of the display 210. According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may determine the dimming depth D based on the information on the use time and/or the information on the deterioration degree of the display 210.

[0082] According to an embodiment, the use time of the first region 211 used in both the first state (basic state) and the second state (expansion state) may be longer than the use time of the second region 212. According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may determine to increase the first dimming depth D1 by Δd, whenever the difference in use time between the first region 211 and the second region 212 is increased by Δt.

[0083] Alternatively, according to an embodiment, the first region 211 may be deteriorated earlier due to the difference in use time between the first region 211 and the second region 212. When the first region 211 and the second region 212 are driven with the same power, the difference in average brightness between the first region 211 and the second region 212 may be made. According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may determine to increase the first dimming depth D1 by Δd, whenever the difference in average brightness between the first region 211 and the second region 212 is increased by Δd.

[0084] The following description will be described with reference to FIG. 7 regarding that the processor and/or the display driving circuit of the electronic device 101 applies a dimming layer formed based on the operation described with reference to FIGS. 4 and 6.

[0085] Referring to FIG. 7, when the electronic device 101 is in the first state (basic state) and the difference in average lifespan between the first region 211 and the second region is equal to or less than the first threshold value, the first drawing 710 of FIG. 7 illustrates a dimming layer formed by the processor and/or the display driving circuit of the electronic device 101, and the third drawing 730 illustrate the final output image overlaid with the dimming layer of the first drawing 710.

[0086] According to an embodiment, the dimming layer of the first drawing 710 of FIG. 7 may be formed based on the dimming function of the third drawing 430 of FIG. 4, by the processor and/or the display driving circuit. When the electronic device 101 is in the first state (the basic state), and when the difference in average lifespan between the first region 211 and the second region is less than or equal to the first threshold value, the electronic device 101 may form the dimming layer symmetrically to the region of the second edge 221 and the region of the first edge 222.

[0087] According to an embodiment, when the electronic device 101 is in the second state (expansion state) and the difference in average lifespan between the first region 211 and the second region is equal to or less than the first threshold value, the second drawing 720 of FIG. 7 illustrates a dimming layer formed by the processor and/or the display driving circuit of the electronic device 101, and the fourth drawing 740 illustrate the final output image overlaid with the dimming layer of the second drawing 720. According to an embodiment, the dimming layer of the second drawing 720 of FIG. 7 may be formed, based on the dimming function of the third drawing 630 of FIG. 6, by the processor and/or the display driving circuit.

[0088] According to an embodiment of the disclosure, when the electronic device is in the second state (expansion state), and the difference in average lifespan between the first region (main region) and the second region (sub-region) is equal to or less than the first threshold value, the electronic device may adjust a dimming parameter to expand and apply the dimming layer in the direction of the first edge 222 to be asymmetrical to the direction of the second edge 221, thereby preventing the burn-in phenomenon resulting from the difference in use time between the first region (main region) and the second region (sub-region), compensating for the difference in visibility between the first region (main region) and the second region (sub-region), reducing a color shift viewed on a cross-section of the display, and reducing optical distortion visibility caused at an edge of a curved surface. In addition, current consumption may be reduced by reducing the brightness of the edge region

[0089] Hereinafter, the operation of the electronic device will be described with reference to FIG. 8, according to an embodiment.

[0090] FIG. 8 is a view illustrating various dimming layers formed by an electronic device, according to an embodiment. The same components as those of the above described embodiment will be assigned with the same reference numerals and the duplication thereof will be omitted.

[0091] Referring to FIG. 8, the processor and/or the display driving circuit of the electronic device 101 may form various dimming layers depending on the change for the settings of parameters of the dimming function. The parameters of the dimming function may include the width W, the dimming depth D and a start point S of the dimming which is in the range of the x value. The parameters of the dimming function may be set in the processor and/or the display driving circuit, or the processor and/or the display driving circuit may determine the parameters of the dimming function depending on algorithms.

[0092] A first drawing 810 of FIG. 8 illustrates a dimming layer when the first start point S1 of the dimming in the direction of the first edge 222 is "k", the first dimming depth D1 is 10, and the first width W1 is 680.

[0093] A second drawing 820 of FIG. 8 illustrates a dimming layer when the first start point S1 of the dimming in the direction of the first edge 222 is "k", the first dimming depth D1 is 0, and the first width W1 is 680.

[0094] A third drawing 830 of FIG. 8 illustrates a dimming layer when the first start point S1 of the dimming in the direction of the first edge 222 is "k-100", the first dimming depth D1 is 10, and the first width W1 is 780.

[0095] A fourth drawing 840 of FIG. 8 illustrates a dimming layer when the first start point S1 of the dimming in the direction of the first edge 222 is "k+20", the first dimming depth D1 is 20, and the first width W1 is 660.

[0096] According to an embodiment, the electronic device 101 may asymmetrically apply dimming in the direction of the second edge 221 and dimming in the direction of the first edge 222 in the second state (expansion state). According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may form various dimming layers by determining the parameters of the dimming function, based on the width of the second region 212 expanded, the information (or information on the deterioration difference or information on the visibility difference) on the difference in use extent between the first region 211 and the second region 212.

[0097] When the electronic device 101 is in the second state (expansion state) and the difference in average life between the first region 211 and the second region is equal to or less than the first threshold value, the electronic device 101 applies the dimming layer, which is expanded asymmetrically with respect to the region of the first edge 222, to the region of the second edge 221. Accordingly, the burn-in phenomenon resulting from the difference in use time between the first region 211 and the second region 212 may be prevented. Accordingly, the color shift viewed on the cross-section of the display may be reduced, and the optical distortion visibility caused at the edge of the curved surface may be reduced. Additionally, current consumption may be reduced by reducing the brightness of the edge region

[0098] Hereinafter, the operation of the electronic device will be described according to an embodiment with reference to FIGS. 9 and 10.

[0099] FIG. 9 is a view illustrating the operation of an electronic device, according to an embodiment. FIG. 10 is a view illustrating a result of an electronic device having a display applied with dimming, according to an embodiment. The same components as those of the above described embodiment will be assigned with the same reference numerals and the duplication thereof will be omitted.

[0100] Referring to FIG. 9, a first drawing 910 of FIG. 9 illustrates a display region of the display 210 of the electronic device 101 in brief for the illustrative purpose. According to an embodiment, the display 210 of the electronic device 101 may include the first region 211 and the second region 212. FIG. 9 illustrates a second state (expansion state) in which the housing and the display 210 of the electronic device 101 are expanded, which is the state in which both the first region 211 and the second region 212 are driven.

[0101] A second drawing 920 of FIG. 9 may be a graph showing the lifespan of the display 210. A vertical axis of the graph in the second drawing 620 may indicate the lifespan of the display, and a horizontal axis of the graph may correspond to the x-axis direction of the display 210. Referring to the second drawing 920, the difference in average lifespan between the lifespan of the first region 211 and the lifespan of the second region 212 may be made. According to an embodiment, although the first region 211 is always used, the second region 212 may be used as the display region only in the second state (expansion state). Accordingly, the difference in use extent between the first region 211 and the second region 212 may be made. As the use extent of the first region 211 is greater than the use extent of the second region 212, the first region 211 may be deteriorated faster than the second region 212, and the lifespan of the first region 211 may be more reduced than the second region 212.

[0102] Although the second drawing 920 of FIG. 9 illustrates the difference in display lifespan between the first region 211 and the second region 212 according to an embodiment, this is provided only for the illustrative purpose. FIG. 9 illustrates a case in which the difference in average lifespan between the first region 211 and the second region 212 exceeds a first threshold value, according to an embodiment.

[0103] A third drawing 930 of FIG. 9 illustrates a dimming layer to be output to the display 210, in the form of a dimming function. Referring to the third drawing 930 of FIG. 9, the processor and/or the display driving circuit of the electronic device 101 may divide a region for dimming into a plurality of regions to compensate for the difference in visibility between the first region 211 and the second region 212, and may set a parameter such as a dimming start point, a width for applying dimming, and/or a dimming depth. According to an embodiment, the electronic device 101 may divide the dimming region applied in the direction of the first edge 222 into a first part region 920 and a second part region 930, such that mutually different dimming functions may be applied to the first part region 920 and the second part region 930.

[0104] According to an embodiment, the first part region 920 may be a region corresponding to the third width W3 in a -x-axis direction from the boundary line between the first region 211 and the second region 212. According to an embodiment, the second part region 930 may be a region corresponding to the fourth width W4 in an +x-axis direction from the boundary line between the first region 211 and the second region 212.

[0105] According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may additionally set a dimming offset parameter based on information on the difference in average deterioration degree between the first region 211 and the second region 212, such that the difference in visibility between the first region 211 and the second region 212 is not recognized by the user. Accordingly, the visibility may be more naturally improved. According to an embodiment, the dimming offset may be made between the first part region 920 and the second part region 930, and the size of the dimming offset may be determined based on the difference in use frequency between the first part region 920 and the second part region 930. According to an embodiment, the difference in use frequency between the first part region 920 and the second part region 930 may be information on a history related to the use of the display. The information on the history related to the use of the display may be information in which records, such as the screen brightness of the display, or information (OPRA) on a content grayscale, are accumulated.

[0106] According to an embodiment, referring to the third drawing 930 of FIG. 9, when the difference in lifespan between the first region 211 and the second region 212 of the display 210 of the electronic device 101 exceeds a critical value, and when the state of the display 210 is the second state (expansion state), the dimming function used by the electronic device 101 to form the dimming layer may be determined as in Equation 3.

Equation 3

$$y-(e-D2) = D2/W2 * (x-(S2-W2)) \quad (S2-W2 \le x < S2)$$

$$y = e \quad (S2 \le x < S1)$$

$$y - e = -D1/W3 * (x- S1) \quad (S1 \le x < S1+W3)$$

$$y - (e-D1) = -D3/W4 * (x-(S1+W3)) - ofs \quad (S1+W3 \le x \le S1+W3+W4)$$

[0107] In Equation 3, the first width W1 may be a sum of the third width W3 and the fourth width W4. The third width W3 may be the width of a partial region of the first region 211, and the fourth width W4 may be the width of the second region 212 in which the display 210 is expanded.

[0108] In Equation 3, according to an embodiment, the dimming is applied with the second dimming depth D2 in the direction of the second edge 221 from the second start point S2 spaced apart from the second edge 221 by the second width W2.

[0109] In Equation 3, according to an embodiment, the dimming is applied with the first dimming depth D1 in the direction of the first edge 222 from the first start point S1 spaced apart from the first edge 222 by the first width W1. The dimming offset may be applied to the boundary between the first part region 920 and the second part region 930, and the dimming may be applied with the third dimming depth D3 with respect to the fourth width W4, in the direction of the first edge 222 from the third start point S3 spaced apart from the first edge 222 by the fourth width W4.

[0110] According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may asymmetrically apply dimming to opposite edge regions when the difference in lifespan between the first region 211 and the second region 212 of the electronic device 101 exceeds the first threshold, and when the state of the display 210 is a second state (basic state. In other words, the first width W1 may be different from the second width W2, and the first dimming depth D1, the second dimming depth D2, and the third dimming depth D3 may be different from each other.

[0111] Although the third drawing 930 FIG. 9 illustrates that the dimming function is partially a first-order function (piece-wise linear), the disclosure is not limited thereto. The dimming function may be a second-order function.

[0112] According to an embodiment, the processor of the electronic device 101 and/or the display driving circuit may determine the start points S, the widths W, the dimming depths D, and/or the dimming offset, based on whether the second region 212 is expanded, the width of the second region 212 to be expanded, the lifespans (or he deterioration degree, visibility or brightness) of the first region 211 and the second region 212 and/or information on difference in lifespan (the deterioration degree, visibility or brightness) between the first region 920 and the second region 930, or preset values may be stored in a memory of the electronic device 101.

[0113] According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may measure the deterioration degree of the display 210 by measuring the use time of the display 210 and/or analyzing a display image of the display 210, to measure the deterioration degree, thereby acquiring the information on the use time and/or the information on the deterioration degree of the display 210.

[0114] According to an embodiment, the method in which the processor and/or the display driving circuit of the electronic device 101 determines the dimming depth D may the same the method described with reference to FIG. 6.

[0115] According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may determine the offset ofs based on the information on the use time and/or the information on the deterioration degree of the display 210. According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may calculate the dimming offset ofs through Equation 4, when the difference in average brightness difference between the first region 211 and the second region 212 exceeds the first threshold value.

Equation 4

$$(\alpha 1)*(Y1)= [(\alpha 1)- (ofs)] *(Y2)$$

[0116] Wherein

$\alpha 1$ = Transparency of the dimming layer at a boundary line 911 of the first partial region 920,
Y1 = the average brightness value of the first partial region 920,
Y2 = average brightness value of the second partial region 930)

[0117] According to an embodiment, the transparency α may have a value between 0 and 255. When the transparency α is '255' , the dimming layer may be completely transparent, and when the transparency α is 0, the dimming layer may be completely opaque.

[0118] According to an embodiment, although the third drawing 930 of FIG. 9 illustrates that a region for applying dimming in the direction of the first edge 222 is divided into two parts of the first part region 920 and the second part region 930, and mutually different dimming functions are applied to the first part region 920 and the second part region 930, the disclosure is not limited thereto. For example, the region is divided into at least three partial regions, and the dimming function may be applied to each partial region. In this case, the dimming depth and/or the offset may be differently applied to each region, and the dimming depth may be gradually increased in the direction of the first edge 222. In addition, as the deterioration is deepened, the region may be divided into more many parts. In addition, when the display 210 is expanded in the direction of the second edge 221, the region for applying the dimming may be divided in the direction of the second edge 221 and the dimming may be applied to the region. In addition, when the display 210 is expanded in both directions of the second edge 221 and the first edge 222, the region for applying the dimming may be divided in opposite edge directions and the dimming may be applied.

[0119] The following description will be described with reference to FIG. 10 regarding that the processor and/or the display driving circuit of the electronic device 101 applies a dimming layer formed based on the operation described with reference to FIG. 9.

[0120] FIG. 10 illustrates the final output screen in which the dimming layer formed by the electronic device 101 is applied. Referring to FIG. 10, according to an embodiment, when the electronic device 101 is in the second state (expansion state), and when the difference in average lifespan between the first region 211 and the second region exceeds the first threshold value, the processor and/or the display driving circuit of the electronic device 101 may determine the dimming parameter as illustrated in the third drawing 930 of FIG. 9, and the dimming layer may be formed based on the third drawing 930.

[0121] According to an embodiment, the processor and/or the display driving circuit of the electronic device 101 may determine two start points, two dimming depths, two widths, and an offset to apply the dimming to the first part region 920 and the second part region 930, as the difference in average lifespan between the first region 211 and the second region 212 exceeds the first threshold value.

[0122] FIG. 10 is a view illustrating that content to be output is applied with a dimming layer in which a first start point S1 in the direction of the first edge 222 is 'k', the first dimming depth D1 is 5, the third width W3 is 200, the third start point S3 is 'k+200', the third dimming depth D3 is 5, the fourth width W4 is 480, and the offset ofs is 5.

[0123] According to the electronic device of the disclosure, as it is determined that the electronic device 101 is in the second state (expansion state) and the difference in average life between the first region 211 and the second region exceeds the first threshold value, the electronic device 101 adjusts the dimming parameter to apply a discrete dimming function to the region of the first edge 222. Accordingly, the burn-in phenomenon resulting from the difference in use time between the first region (main region) and the second region (sub-region) is prevented to compensate for the difference in visibility between the first region (main region) and the second region (sub-region). Accordingly, the color shift viewed on a cross-section of the display may be reduced, and optical distortion visibility caused at an edge of a curved surface may be reduced. Additionally, current consumption may be reduced by reducing the brightness of the edge region.

[0124] According to an embodiment of the disclosure, an electronic device may include a flexible display expandable in at least a direction of a first edge, in which the flexible display operates a first region in a first state, and operates the first region and a second region expanded in the direction of the first edge, in a second state, a housing included inside the flexible display and expandable in the direction of the first edge, a display driving circuit to drive the flexible display, and a processor electrically connected to the flexible display and the display driving circuit. The processor or the display driving circuit may form a dimming layer to apply dimming based on a first dimming depth in the direction of the first edge from a first starting point spaced apart from the first edge by a first width, and to apply the dimming based on a second dimming depth in a direction of a second edge from a second starting point spaced apart from the second edge, which is opposite to the first edge, by a second width, set the first width and the second width to be equal to each other, as the first state is identified, and set the first dimming depth and the second dimming depth to be equal to each other, and set the first width and the second width to be different from each other, as the second state is identified, and set the first dimming depth and the second dimming depth to be different from each other.

[0125] According to an embodiment of the disclosure, the first state may be a basic state, and the second state may be an expansion state in which the flexible display is expanded.

[0126] According to an embodiment of the disclosure, the processor or the display driving circuit may overlay and output the formed dimming layer with content to be output to the flexible display.

[0127] According to an embodiment of the disclosure, the processor or the display driving circuit may determine the first starting point, the second starting point, the first width, the second width, the first dimming depth, and the second dimming depth, based on information on difference in deterioration degree between the first region and the second region.

[0128] According to an embodiment of the disclosure, the processor or the display driving circuit may determine the first starting point, the second starting point, the first width, the second width, the first dimming depth, and the second dimming depth, based on a width of the second region.

[0129] According to an embodiment of the disclosure, the processor or the display driving circuit may form the dimming layer by applying dimming based on the first dimming depth to a third width in the direction of the first edge from the first starting point, and apply the dimming based on a third dimming depth to a fourth width in the direction of the first edge from a third starting point spaced from the first starting point by the third width, as the electronic device is determined as being in the second state, and difference in deterioration degree between the first region and the second region is determined as exceeding a first threshold value.

[0130] According to an embodiment of the disclosure, the processor or the display driving circuit may apply a dimming offset to the second starting point.

[0131] According to an embodiment of the disclosure, the processor or the display driving circuit may determine the dimming offset based on information on difference in deterioration degree between the first region and the second region.

[0132] According to an embodiment of the disclosure, the processor or the display driving circuit may determine the dimming offset, such that a value, which is obtained by multiplying transparency at the third starting point of dimming applied to the third width by an average brightness value of a region corresponding to the third width, is equal to a value which is obtained by multiplying a value obtained by adding the dimming offset to the transparency at the third starting point of the dimming applied to the fourth width by an average brightness value corresponding to the fourth width .

[0133] According to an embodiment of the disclosure, the first width may be obtained by adding a width of the second region to the second width, when the electronic device is in the second state.

[0134] According to an embodiment of the disclosure, a method for operating an electronic device including a flexible display expandable in at least a direction of a first edge, in which the flexible display operates a first region in a first state, and operates the first region and a second region expanded in the direction of the first edge in the second state, the method may include forming a dimming layer to apply dimming based on a first dimming depth in the direction of the first edge from a first starting point spaced apart from the first edge by a first width, and to apply the dimming based on a second dimming depth in a direction of the second edge from a second starting point spaced apart from a second edge, which is opposite to the first edge, by a second width, setting the first width and the second width to be equal to each other and setting the first dimming depth and the second dimming depth to be equal to each other, as the first state is identified, and setting the first width and the second width to be different from each other, and setting the first dimming depth and the second dimming depth to be different from each other, as the second state is identified.

[0135] According to an embodiment of the disclosure, the first state may be a basic state, and the second state is an expansion state in which the flexible display is expanded.

[0136] According to an embodiment of the disclosure, the formed dimming layer may be overlaid and output with content to be output to the flexible display.

[0137] According to an embodiment of the disclosure, the method may further include determining the first starting point, the second starting point, the first width, the second width, the first dimming depth, and the second dimming depth, based on information on difference in deterioration degree between the first region and the second region.

[0138] According to an embodiment of the disclosure, the method may further determining the first starting point, the second starting point, the first width, the second width, the first dimming depth, and the second dimming depth, based on a width of the second region.

[0139] According to an embodiment of the disclosure, the dimming layer may be formed by applying dimming based on the first dimming depth to a third width in the direction of the first edge from the first starting point, and apply the dimming based on a third dimming depth to a fourth width in the direction of the first edge from a third starting point spaced from the first starting point by the third width, as the electronic device is determined as being in the second state, and difference in deterioration degree between the first region and the second region is determined as exceeding a first threshold value.

[0140] According to an embodiment of the disclosure, a dimming offset may be applied to the second starting point.

[0141] According to an embodiment of the disclosure, the dimming offset may be determined based on information on difference in deterioration degree between the first region and the second region.

[0142] According to an embodiment of the disclosure, the dimming offset may be determined, such that a value, which is obtained by multiplying transparency at the third starting point of dimming applied to the third width by an average brightness value of a region corresponding to the third width, is equal to a value which is obtained by multiplying a value obtained by adding the dimming offset to the transparency at the third starting point of the dimming applied to the fourth width by an average brightness value corresponding to the fourth width .

[0143] According to an embodiment of the disclosure, the first width may be obtained by adding a width of the second region to the second width, when the electronic device is in the second state.

Claims

1. An electronic device comprising:

a flexible display expandable in at least a direction of a first edge, wherein the flexible display operates a first region in a first state, and operates the first region and a second region expanded in the direction of the first edge, in a second state;
a housing included inside the flexible display and expandable in the direction of the first edge;
a display driving circuit configured to drive the flexible display; and
a processor electrically connected to the flexible display and the display driving circuit,
wherein the processor or the display driving circuit is configured to:

form a dimming layer to apply dimming based on a first dimming depth in the direction of the first edge from a first starting point spaced apart from the first edge by a first width, and to apply the dimming based on a second dimming depth in a direction of a second edge from a second starting point spaced apart from the second edge, which is opposite to the first edge, by a second width,

set the first width and the second width to be equal to each other, as the first state is identified, and set the first dimming depth and the second dimming depth to be equal to each other, and
set the first width and the second width to be different from each other, as the second state is identified, and set the first dimming depth and the second dimming depth to be different from each other.

2. The electronic device of claim 1, wherein the first state is a basic state, and the second state is an expansion state in which the flexible display is expanded.

3. The electronic device of claim 1, wherein the processor or the display driving circuit is configured to:
overlay and output the formed dimming layer with content to be output to the flexible display.

4. The electronic device of claim 1, wherein the processor or the display driving circuit is configured to:
determine the first starting point, the second starting point, the first width, the second width, the first dimming depth, and the second dimming depth, based on information on difference in deterioration degree between the first region and the second region.

5. The electronic device of claim 1, wherein the processor or the display driving circuit is configured to:
determine the first starting point, the second starting point, the first width, the second width, the first dimming depth, and the second dimming depth, based on a width of the second region.

6. The electronic device of claim 1, wherein the processor or the display driving circuit is configured to:
form the dimming layer by applying dimming based on the first dimming depth to a third width in the direction of the first edge from the first starting point, and apply the dimming based on a third dimming depth to a fourth width in the direction of the first edge from a third starting point spaced from the first starting point by the third width, as the electronic device is determined as being in the second state, and difference in deterioration degree between the first region and the second region is determined as exceeding a first threshold value.

7. The electronic device of claim 6, wherein the processor or the display driving circuit is configured to apply a dimming offset to the second starting point.

8. The electronic device of claim 7, wherein the processor or the display driving circuit is configured to:
determine the dimming offset based on information on difference in deterioration degree between the first region and the second region.

9. The electronic device of claim 6, wherein the processor or the display driving circuit is configured to:
determine the dimming offset, such that a value, which is obtained by multiplying transparency at the third starting point of dimming applied to the third width by an average brightness value of a region corresponding to the third width, is equal to a value which is obtained by multiplying a value obtained by adding the dimming offset to the transparency at the third starting point of the dimming applied to the fourth width by an average brightness value corresponding to the fourth width.

10. The electronic device of claim 1, wherein the first width is obtained by adding a width of the second region to the second width, when the electronic device is in the second state.

11. A method for operating an electronic device including a flexible display expandable in at least a direction of a first edge, wherein the flexible display operates a first region in a first state, and operates the first region and a second region expanded in the direction of the first edge in the second state, the method comprising:

forming a dimming layer to apply dimming based on a first dimming depth in the direction of the first edge from a first starting point spaced apart from the first edge by a first width, and to apply the dimming based on a second dimming depth in a direction of the second edge from a second starting point spaced apart from a second edge, which is opposite to the first edge, by a second width;
setting the first width and the second width to be equal to each other and setting the first dimming depth and the second dimming depth to be equal to each other, as the first state is identified; and
setting the first width and the second width to be different from each other, and setting the first dimming depth and the second dimming depth to be different from each other, as the second state is identified.

12. The method of claim 11, wherein the first state is a basic state, and the second state is an expansion state in which the flexible display is expanded.

13. The method of claim 11, wherein the formed dimming layer is overlaid and output with content to be output to the flexible display.

14. The method of claim 11, further comprising:
determining the first starting point, the second starting point, the first width, the second width, the first dimming depth, and the second dimming depth, based on information on difference in deterioration degree between the first region and the second region.

15. The method of claim 11, further comprising:
determining the first starting point, the second starting point, the first width, the second width, the first dimming depth, and the second dimming depth, based on a width of the second region.

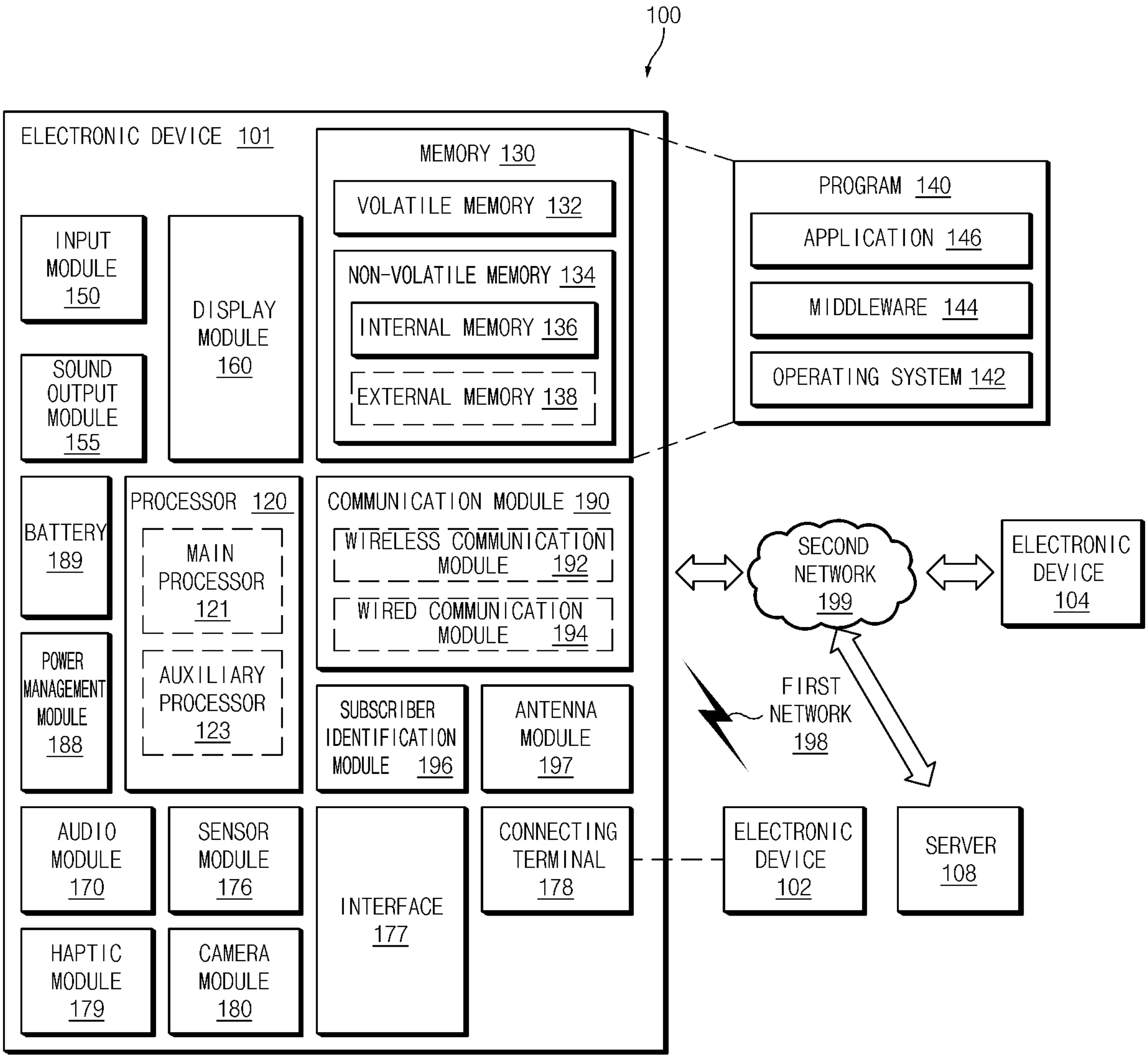

100
ELECTRONIC DEVICE 101
MEMORY 130
VOLATILE MEMORY 132
NON-VOLATILE MEMORY 134
INTERNAL MEMORY 136
EXTERNAL MEMORY 138
PROGRAM 140
APPLICATION 146
MIDDLEWARE 144
OPERATING SYSTEM 142
INPUT MODULE 150
SOUND OUTPUT MODULE 155
DISPLAY MODULE 160
BATTERY 189
POWER MANAGEMENT MODULE 188
PROCESSOR 120
MAIN PROCESSOR 121
AUXILIARY PROCESSOR 123
COMMUNICATION MODULE 190
WIRELESS COMMUNICATION MODULE 192
WIRED COMMUNICATION MODULE 194
SUBSCRIBER IDENTIFICATION MODULE 196
ANTENNA MODULE 197
SECOND NETWORK 199
ELECTRONIC DEVICE 104
FIRST NETWORK 198
AUDIO MODULE 170
SENSOR MODULE 176
INTERFACE 177
CONNECTING TERMINAL 178
ELECTRONIC DEVICE 102
SERVER 108
HAPTIC MODULE 179
CAMERA MODULE 180

FIG.1

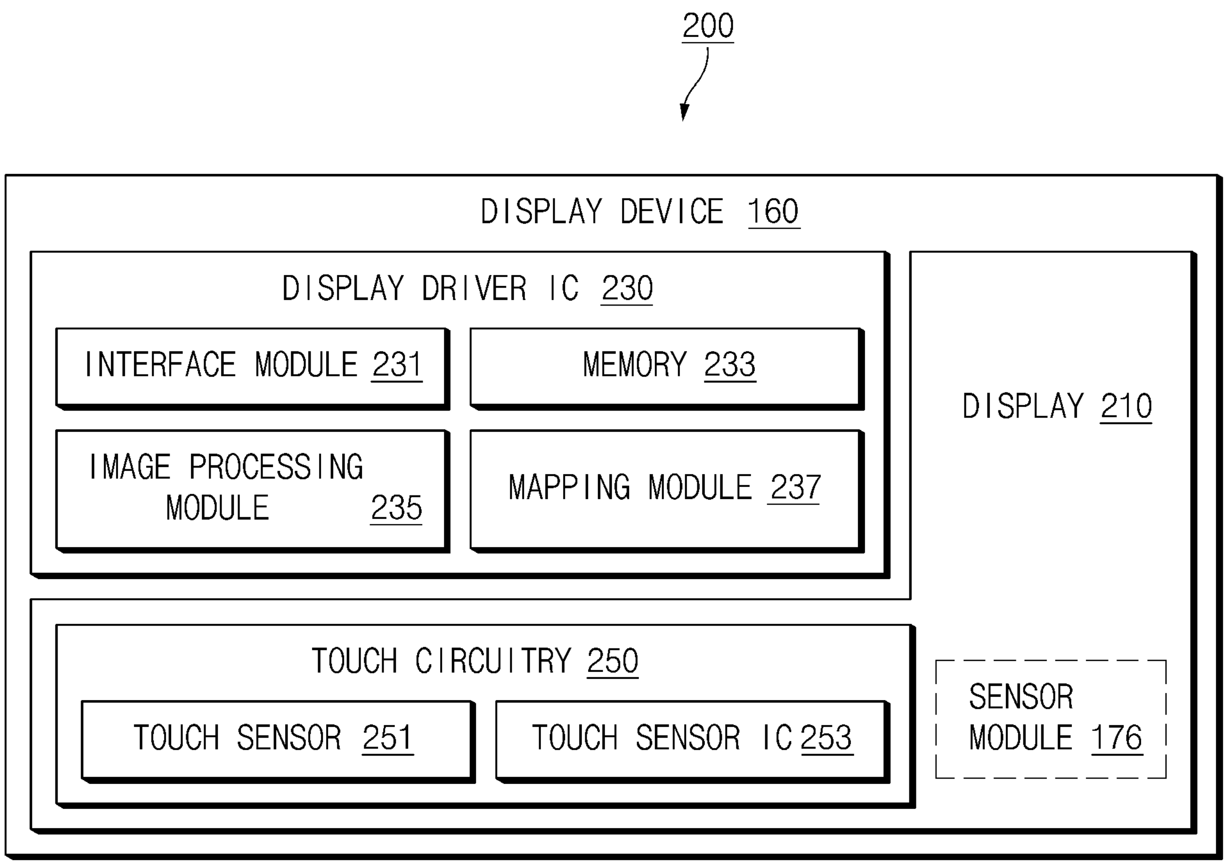

200
DISPLAY DEVICE 160
DISPLAY DRIVER IC 230
INTERFACE MODULE 231
MEMORY 233
IMAGE PROCESSING MODULE 235
MAPPING MODULE 237
DISPLAY 210
TOUCH CIRCUITRY 250
TOUCH SENSOR 251
TOUCH SENSOR IC 253
SENSOR MODULE 176

FIG.2

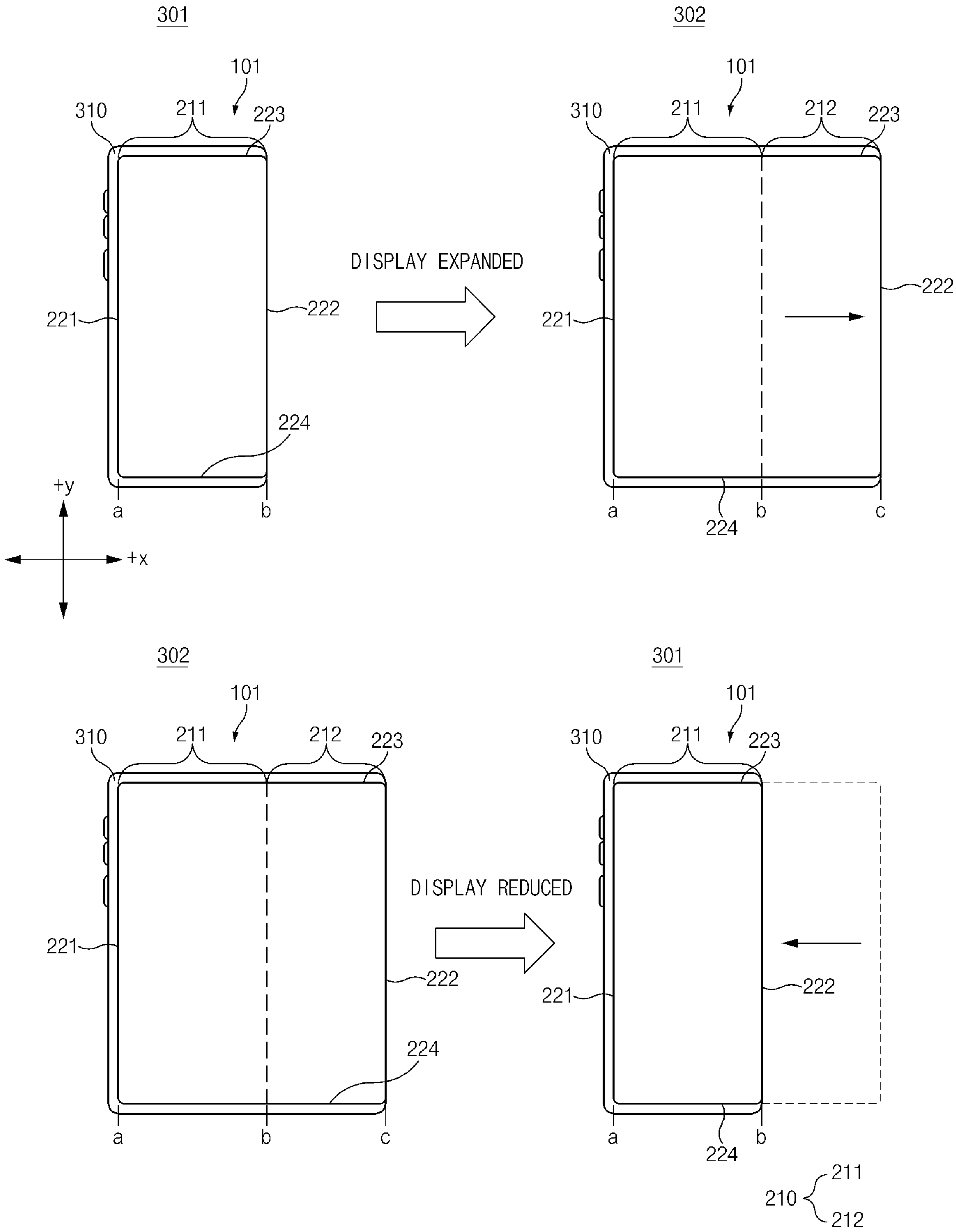

301
101
310
211
223
221
222
224
+y
a
b
+x
DISPLAY EXPANDED
302
101
310
211
212
223
221
222
a
224
b
c
302
101
310
211
212
223
221
222
224
a
b
c
DISPLAY REDUCED
301
101
310
211
223
221
222
a
224
b
210
211
212

FIG.3

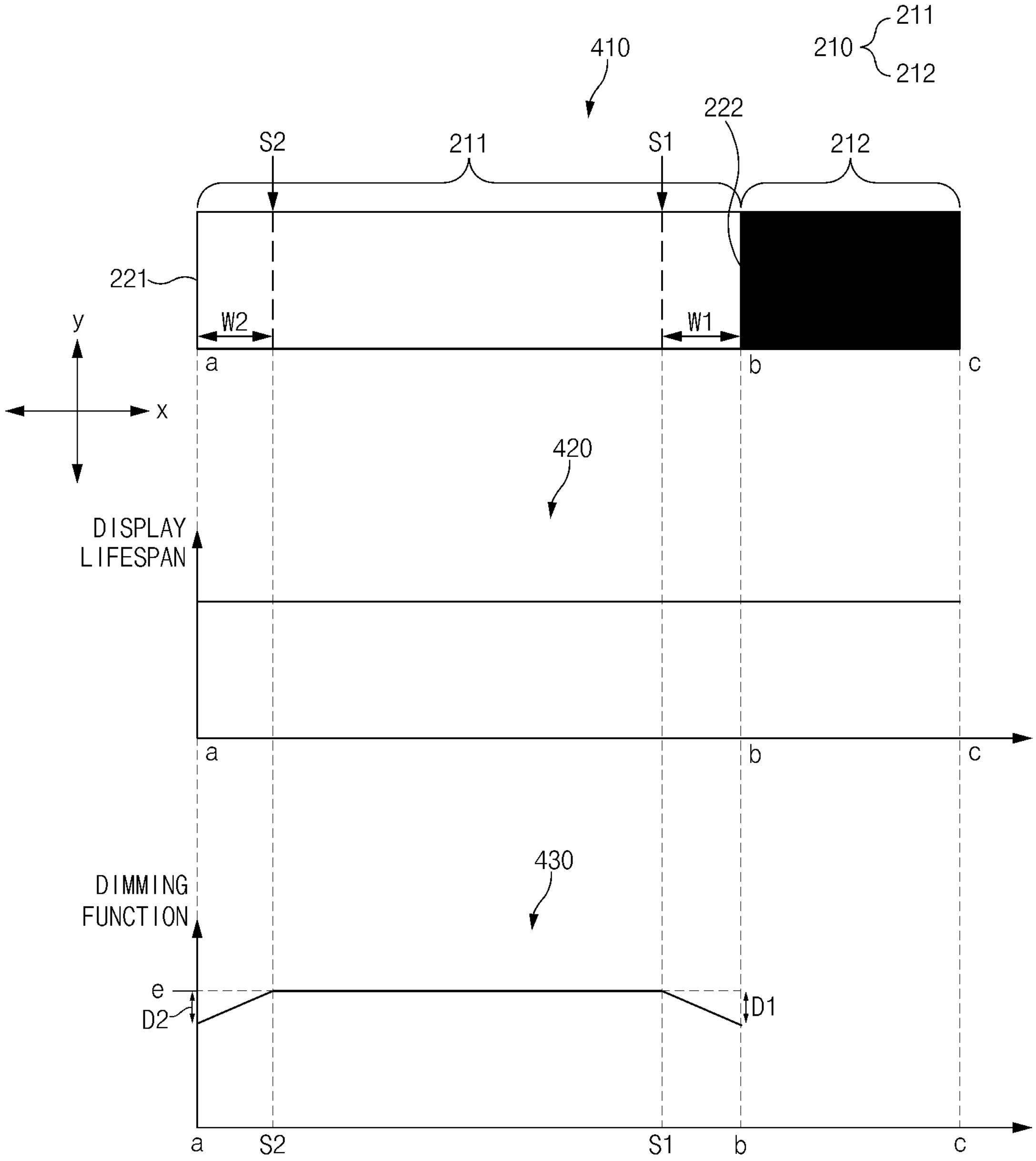

410
210
211
212
222
S2
211
S1
212
221
y
x
W2
W1
a
b
c
420
DISPLAY LIFESPAN
a
b
c
430
DIMMING FUNCTION
e
D2
D1
a
S2
S1
b
c

FIG.4

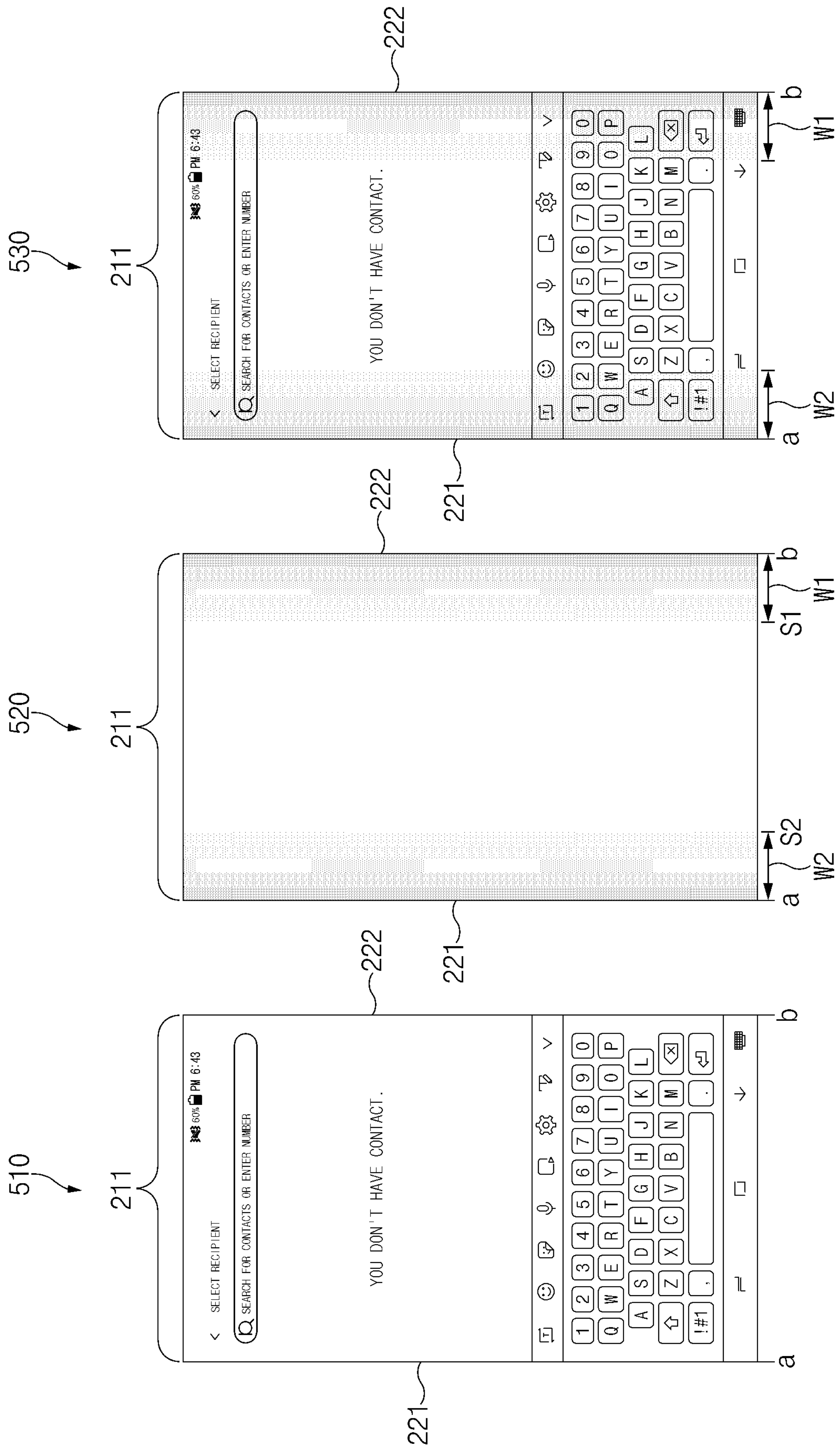
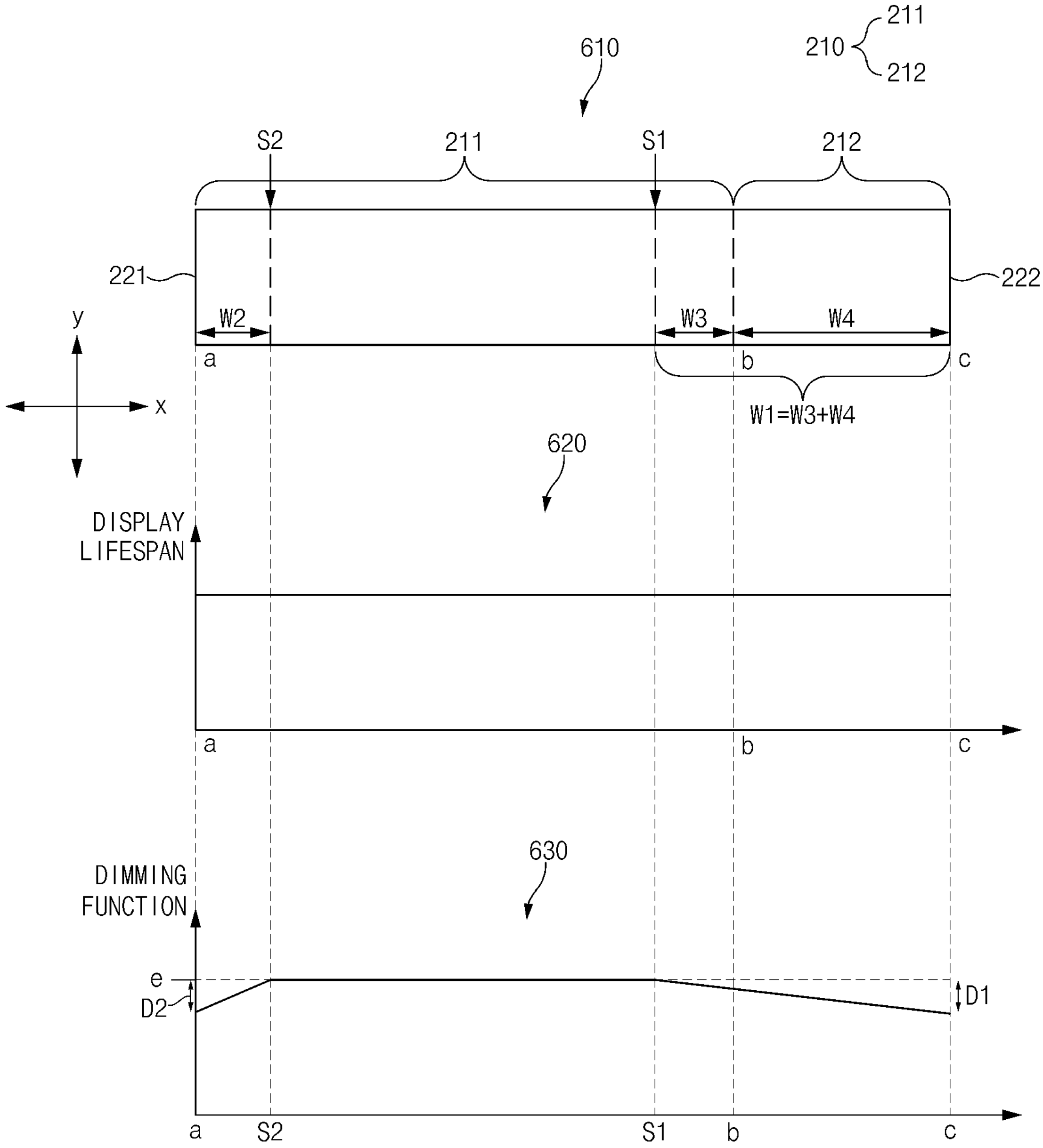

510
520
530
211
221
222
SELECT RECIPIENT
SEARCH FOR CONTACTS OR ENTER NUMBER
PM 6:43
YOU DON'T HAVE CONTACT.
W1
W2
S1
S2
a
b

FIG.5



210
211
212
610
S2
211
S1
212
221
222
y
x
W2
W3
W4
a
b
c
W1=W3+W4
620
DISPLAY LIFESPAN
a
b
c
630
DIMMING FUNCTION
e
D2
D1
a
S2
S1
b
c

FIG.6

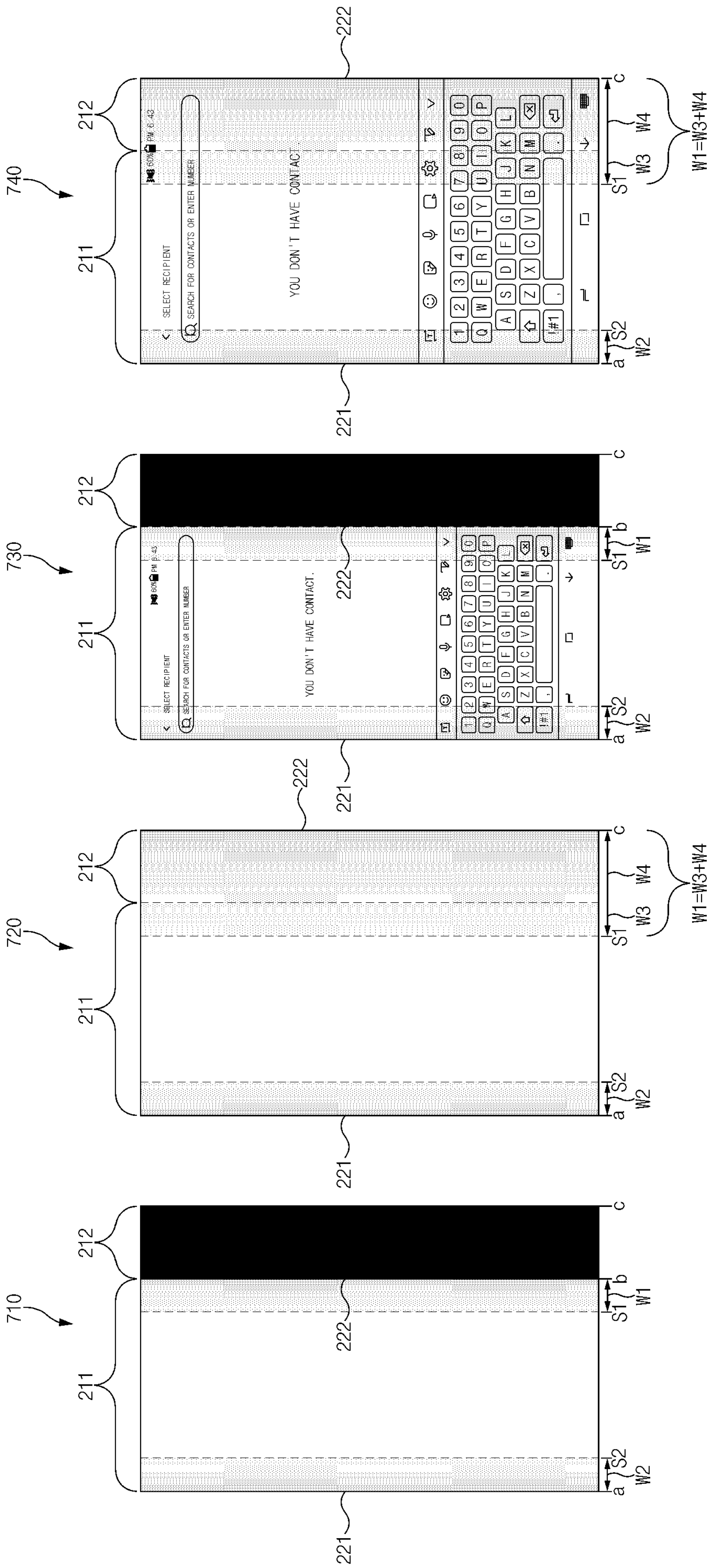

710
720
730
740
211
212
221
222
a
b
c
S1
S2
W1
W2
W3
W4
W1=W3+W4
SELECT RECIPIENT
SEARCH FOR CONTACTS OR ENTER NUMBER
YOU DON'T HAVE CONTACT.

FIG.7

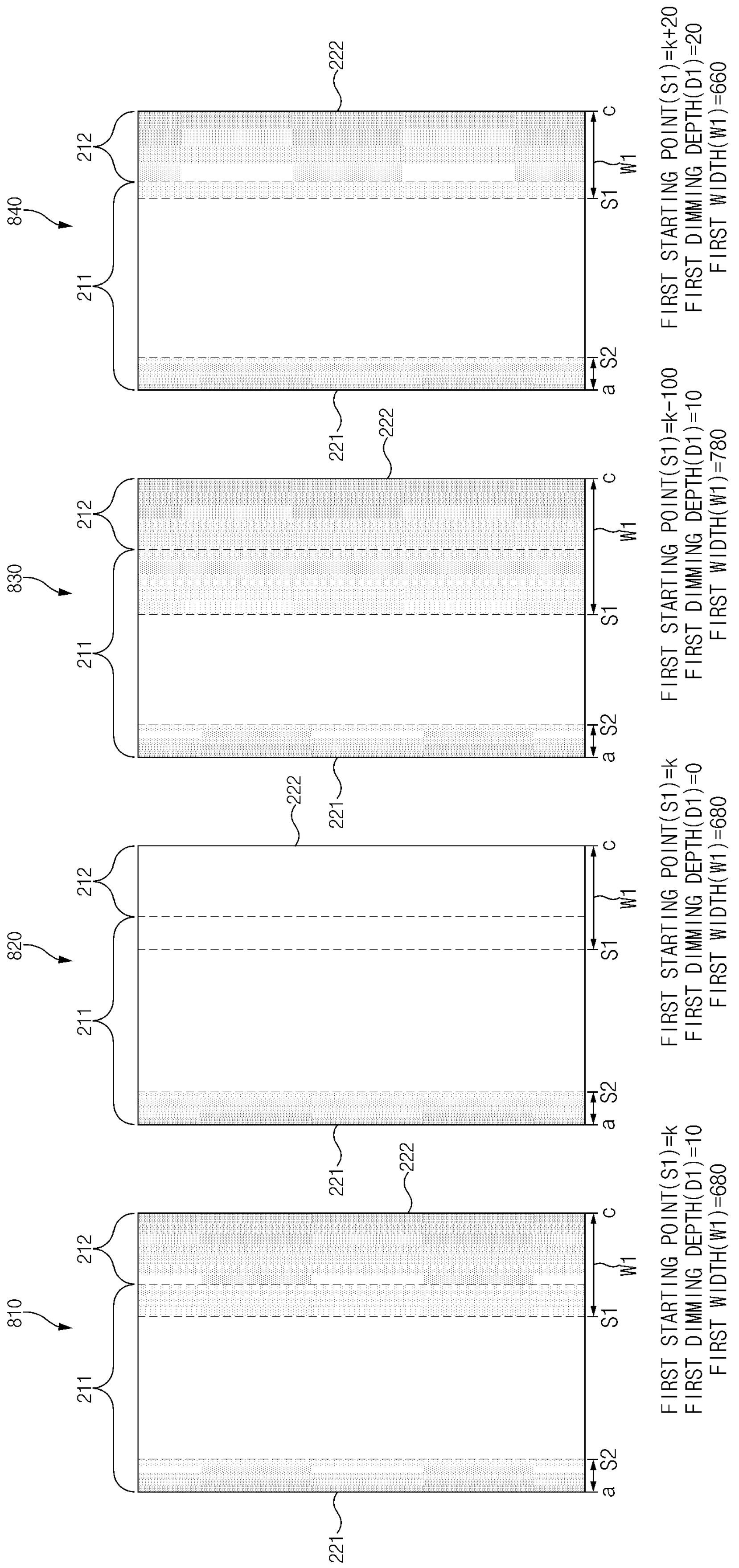

810
211
212
221
222
S2
S1
W1
a
c
FIRST STARTING POINT(S1)=k
FIRST DIMMING DEPTH(D1)=10
FIRST WIDTH(W1)=680
820
FIRST STARTING POINT(S1)=k
FIRST DIMMING DEPTH(D1)=0
FIRST WIDTH(W1)=680
830
FIRST STARTING POINT(S1)=k-100
FIRST DIMMING DEPTH(D1)=10
FIRST WIDTH(W1)=780
840
FIRST STARTING POINT(S1)=k+20
FIRST DIMMING DEPTH(D1)=20
FIRST WIDTH(W1)=660

FIG.8

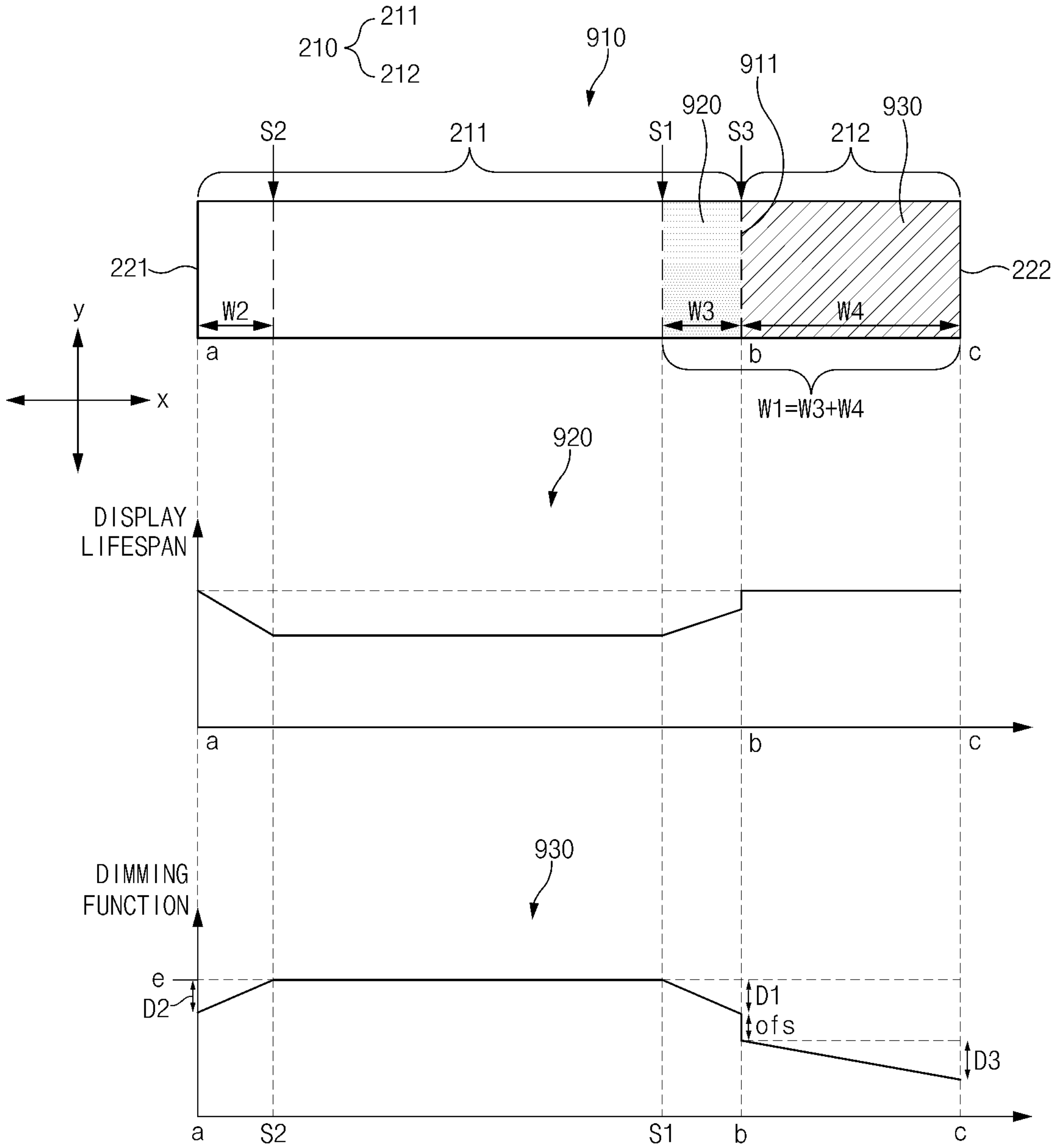

211
210
212
910
911
920
930
S2
211
S1
S3
212
221
222
y
x
W2
W3
W4
a
b
c
W1=W3+W4
920
DISPLAY
LIFESPAN
a
b
c
930
DIMMING
FUNCTION
e
D2
D1
ofs
D3
a
S2
S1
b
c

FIG.9

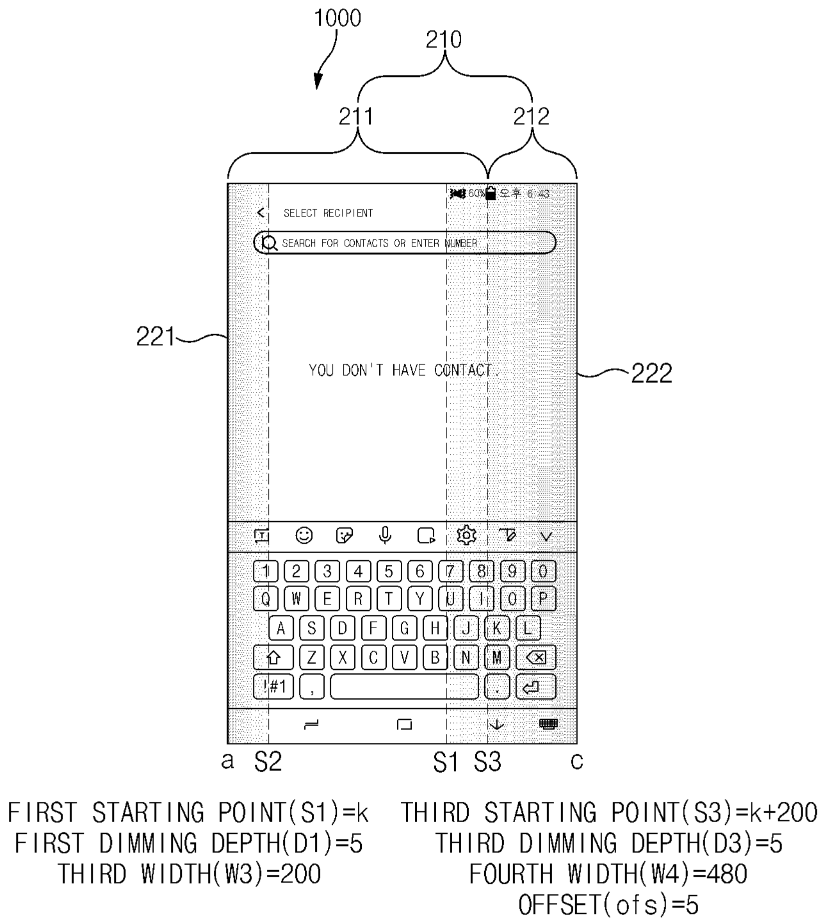

1000
210
211
212
221
222
SELECT RECIPIENT
SEARCH FOR CONTACTS OR ENTER NUMBER
YOU DON'T HAVE CONTACT.
a
S2
S1
S3
c
FIRST STARTING POINT(S1)=k
FIRST DIMMING DEPTH(D1)=5
THIRD WIDTH(W3)=200
THIRD STARTING POINT(S3)=k+200
THIRD DIMMING DEPTH(D3)=5
FOURTH WIDTH(W4)=480
OFFSET(ofs)=5

FIG.10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2022/005316

A. CLASSIFICATION OF SUBJECT MATTER

G09G 5/10(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G09G 5/10(2006.01); G06F 1/16(2006.01); G09G 3/20(2006.01); G09G 3/32(2006.01); G09G 3/3208(2016.01); G09G 5/00(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & keywords: 확장(expansion), 플렉서블 디스플레이(flexible display), 제1 상태(first state), 제2 상태(second state), 디밍(dimming), 엣지(edge), 폭(width), 뎁스(depth)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2019-0110318 A (SAMSUNG ELECTRONICS CO., LTD.) 30 September 2019 (2019-09-30) See paragraphs [0085]-[0102] and [0118]-[0125]; and figures 6-7 and 10.	1-15
A	KR 10-2016-0018937 A (LG DISPLAY CO., LTD.) 18 February 2016 (2016-02-18) See paragraphs [0053]-[0069]; claim 1; and figures 3-5.	1-15
A	KR 10-2021-0013507 A (SAMSUNG DISPLAY CO., LTD.) 04 February 2021 (2021-02-04) See paragraphs [0132]-[0156]; and figures 12-13.	1-15
A	KR 10-2017-0080890 A (LG DISPLAY CO., LTD.) 11 July 2017 (2017-07-11) See paragraphs [0068]-[0074]; and figures 10-12.	1-15
A	US 2017-0309226 A1 (SAMSUNG DISPLAY CO., LTD.) 26 October 2017 (2017-10-26) See paragraphs [0094]-[0099]; and figure 11.	1-15

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search	Date of mailing of the international search report
22 July 2022	**25 July 2022**

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2022/005316

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