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(54) **FLEXIBLE DEVICE AND METHOD OF CONTROLLING SHAPE OF DISPLAY OF FLEXIBLE DEVICE**

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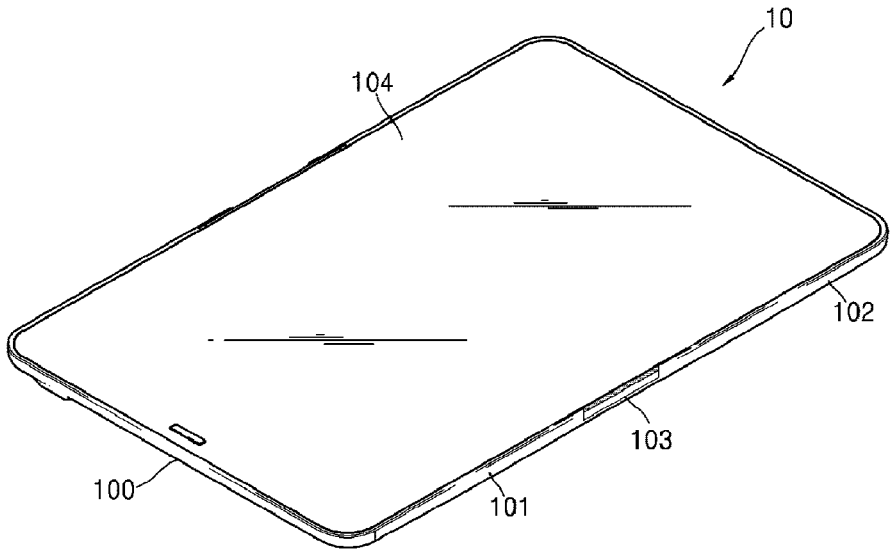
G06F 3/0487	(2006.01)
H04M 1/02	(2006.01)

(52) **U.S. Cl.**

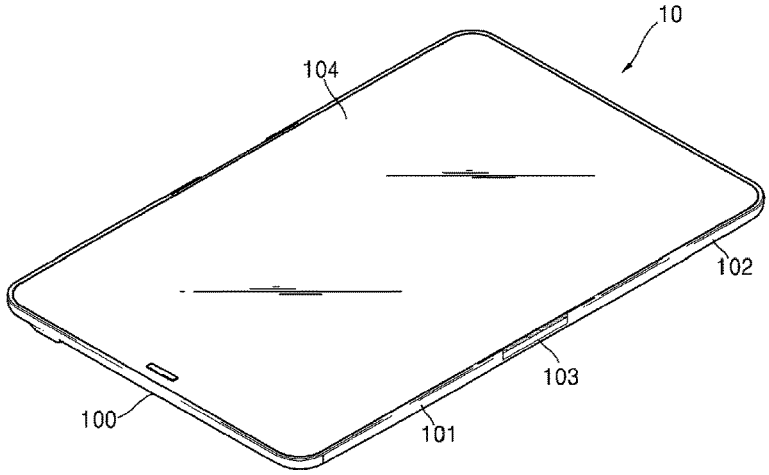
CPC ***G06F 1/1652*** (2013.01); ***G06F 1/1601*** (2013.01); ***G06F 1/1641*** (2013.01); ***G06F 1/1677*** (2013.01); *G09F 9/301* (2013.01); ***G06F 3/017*** (2013.01); ***G06F 3/0487*** (2013.01); ***H04M 1/0268*** (2013.01); ***G06F 3/0414*** (2013.01)

(57) **ABSTRACT**

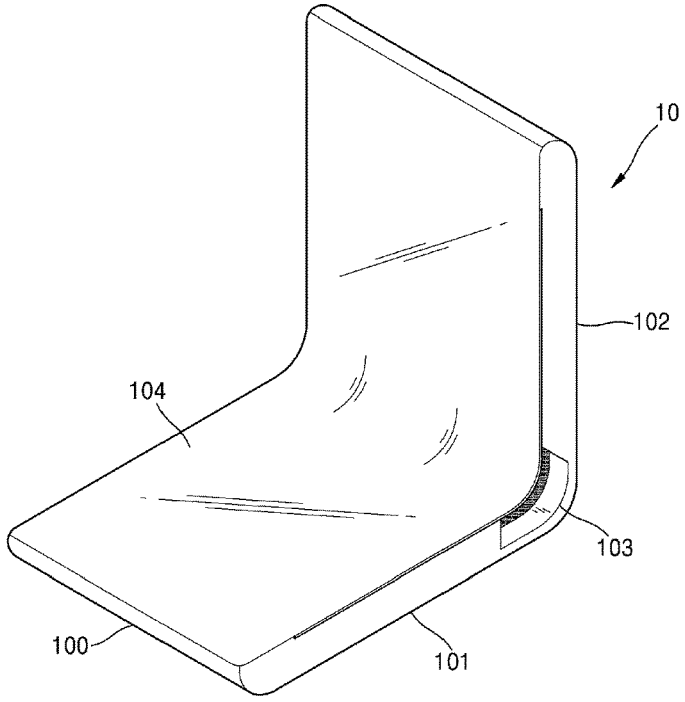
A flexible device comprises a flexible display that has a foldable deformable part; a housing that is foldable and forms an enclosure space in which the deformable part is enclosed when the flexible display is deformed; a shape maintaining part that is arranged in the enclosure space so as to control flexibility of the deformable part; and an electrical signal applier that applies an electrical signal to the shape maintaining part, based on a deformation state of the flexible display.



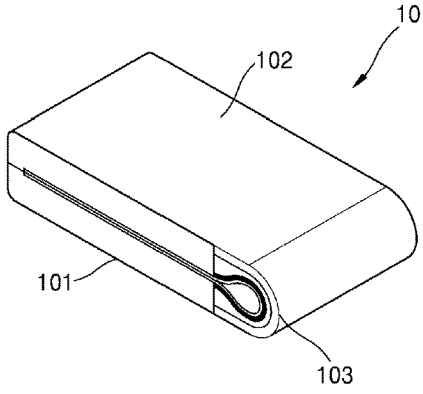
[Fig. 1a]



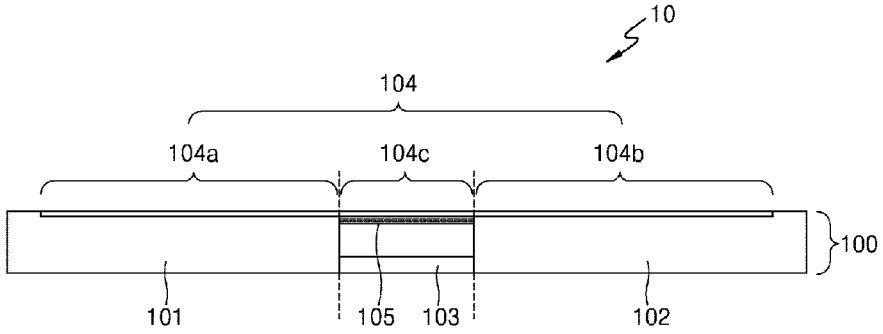
[Fig. 1b]



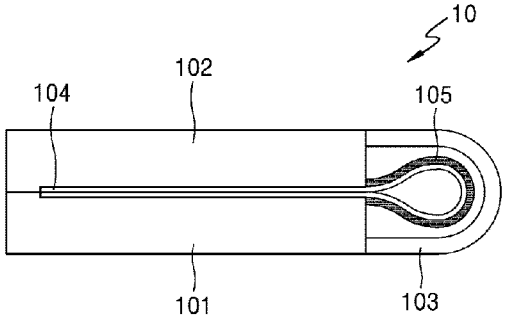
[Fig. 1c]



[Fig. 2]

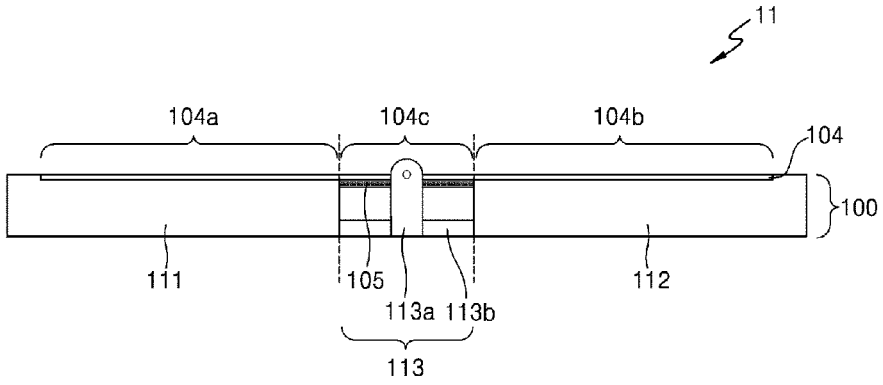


(a)



(b)

[Fig. 3]



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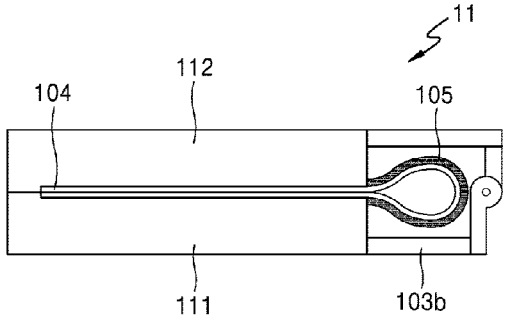
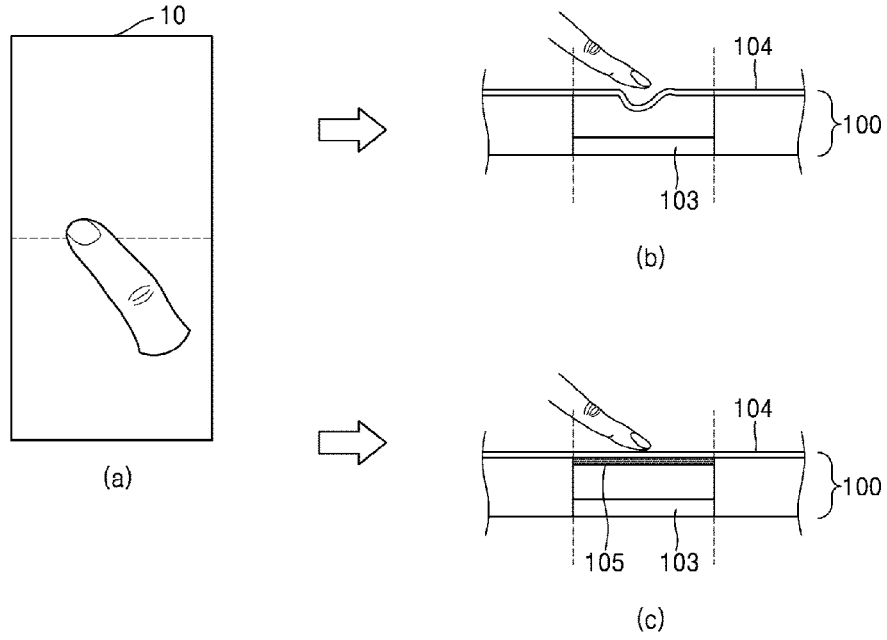
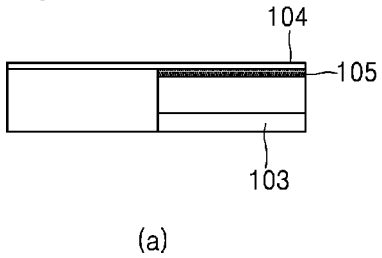


(b)

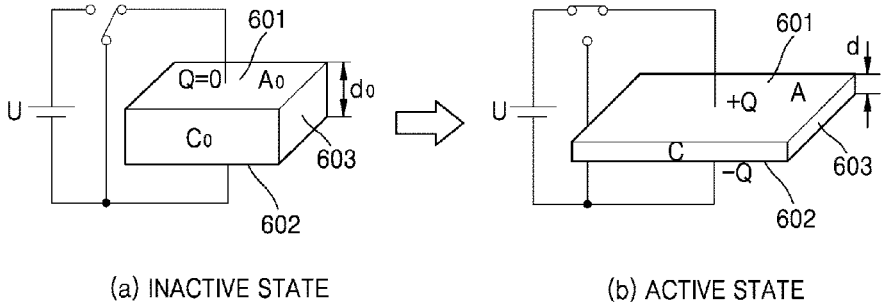
[Fig. 4]



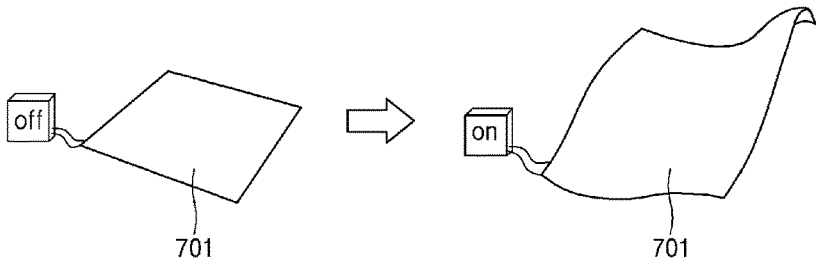
[Fig. 5]



[Fig. 6]

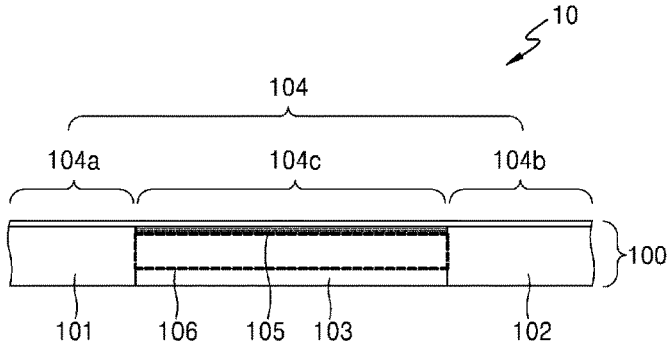


[Fig. 7]

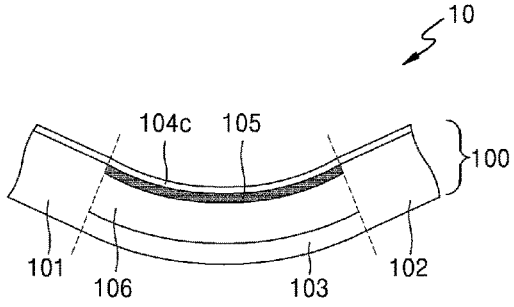


(a) INACTIVE STATE (b) ACTIVE STATE

[Fig. 8]



[Fig. 9]



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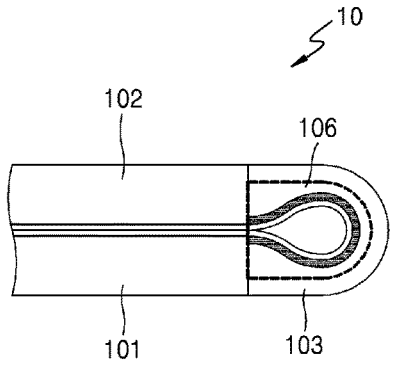
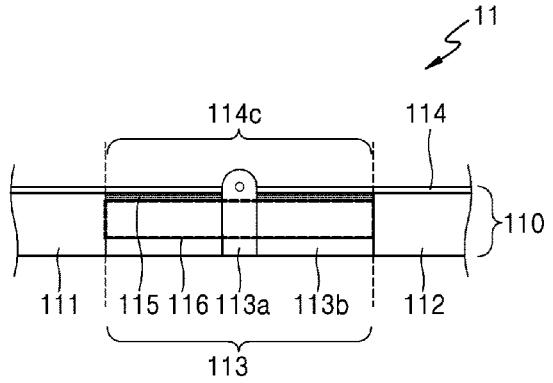


(b)

[Fig. 10]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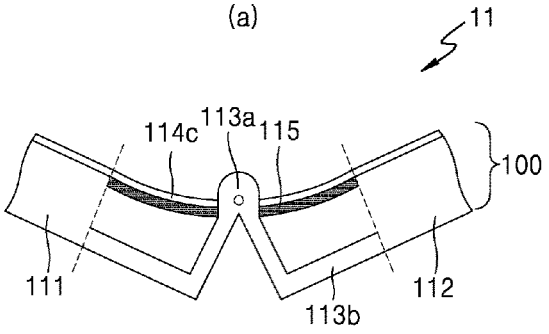
115
116
113a
113b
112
113

(a)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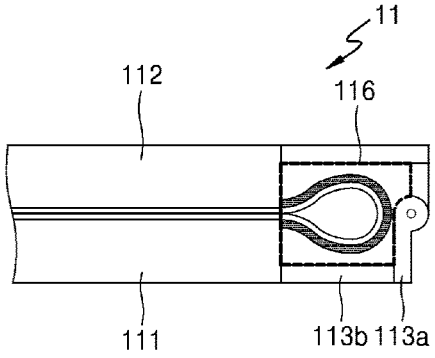
114c
113a
115
100
111
112
113b

(b)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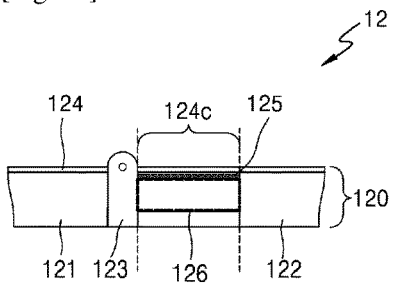
112
116
111
113b
113a

(c)

[Fig. 11]



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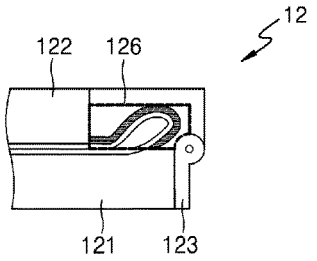
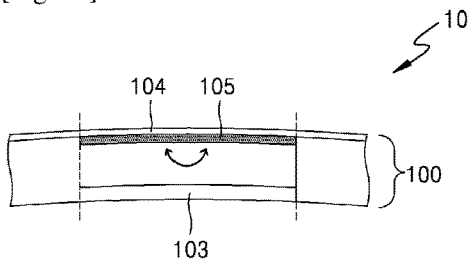
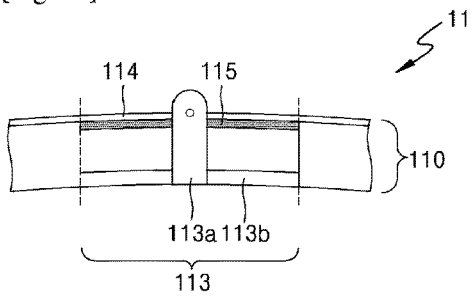


(b)

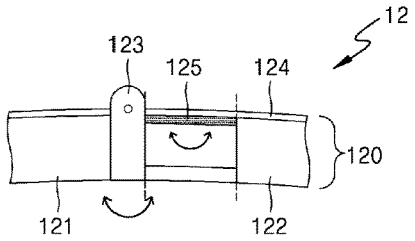
[Fig. 12]



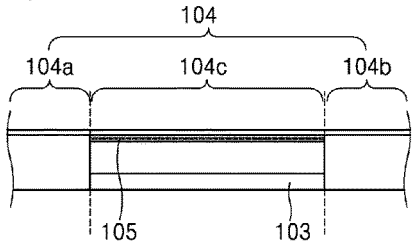
[Fig. 13]



[Fig. 14]



[Fig. 15]



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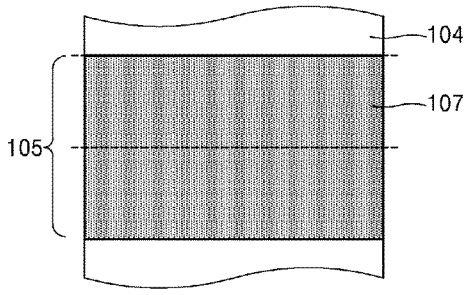
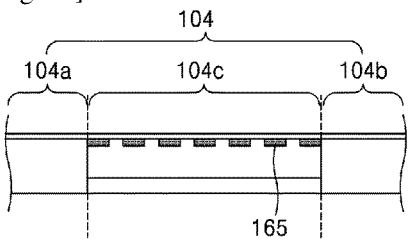


(b)

[Fig. 16]



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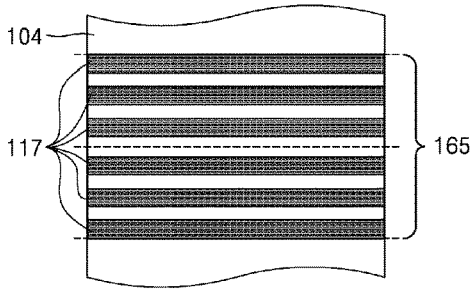
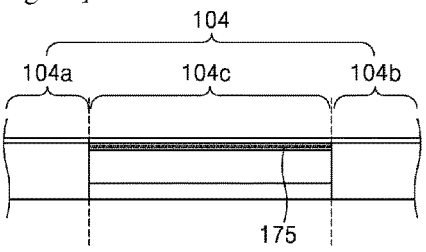


(b)

[Fig. 17]



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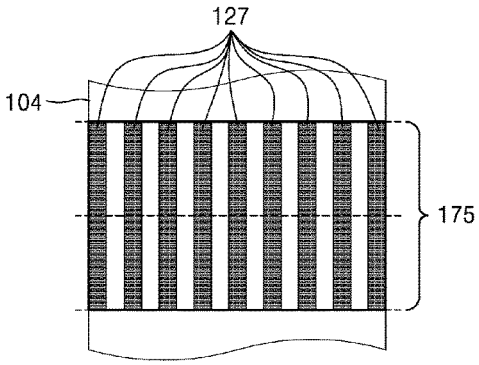
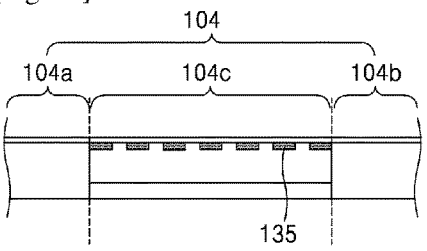
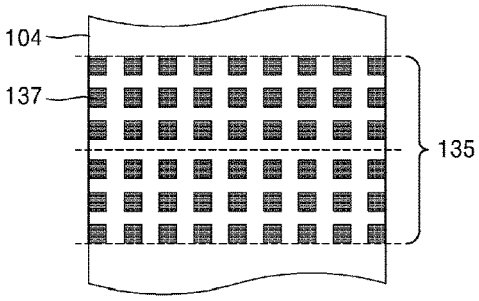


(b)

[Fig. 18]

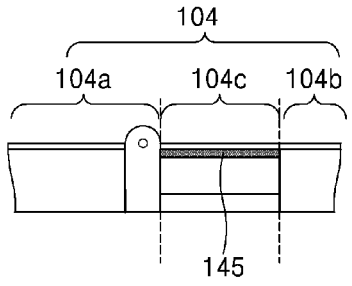


(a)

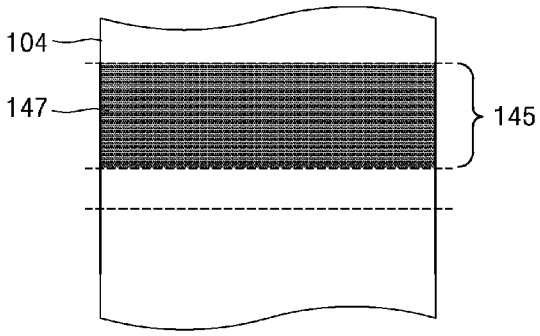


(b)

[Fig. 19]

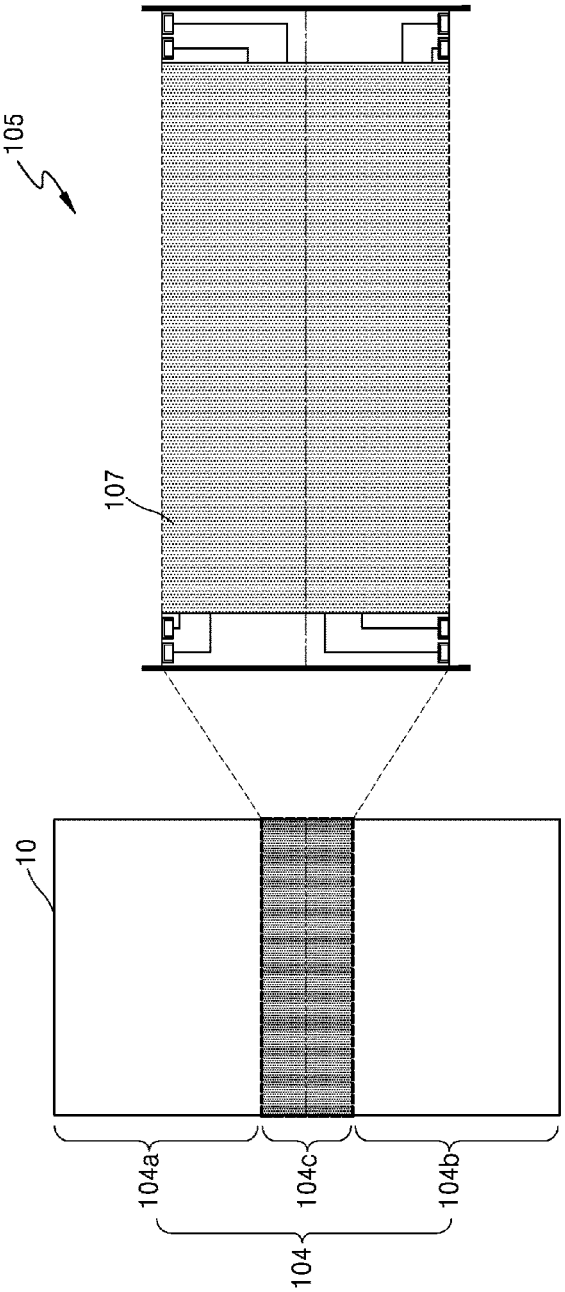


(a)

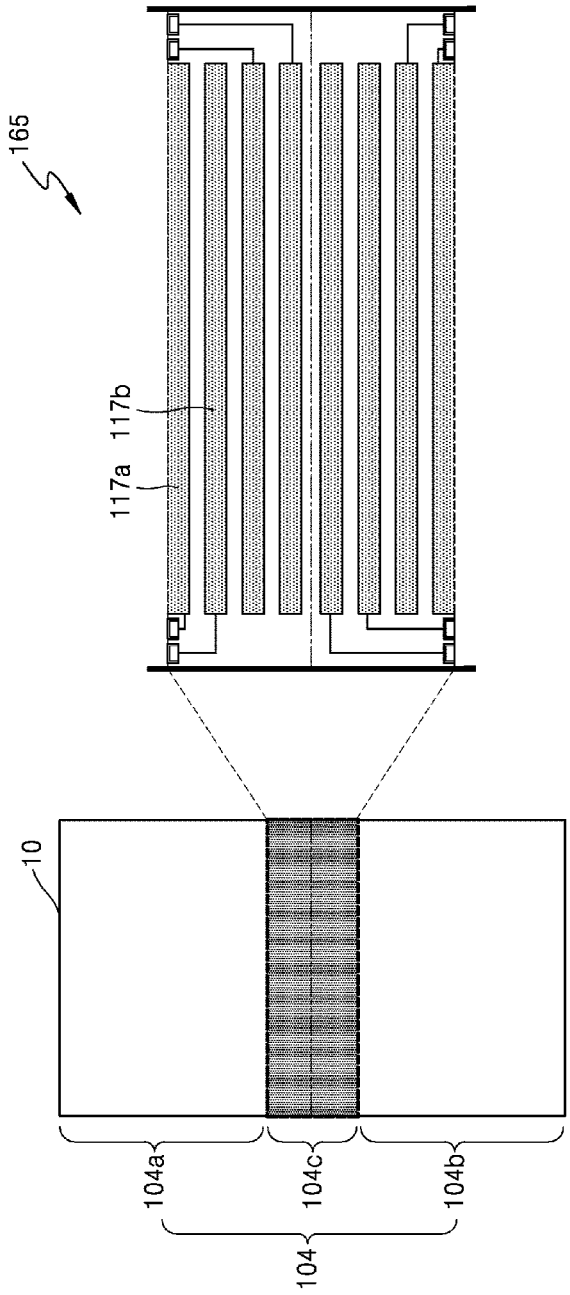


(b)

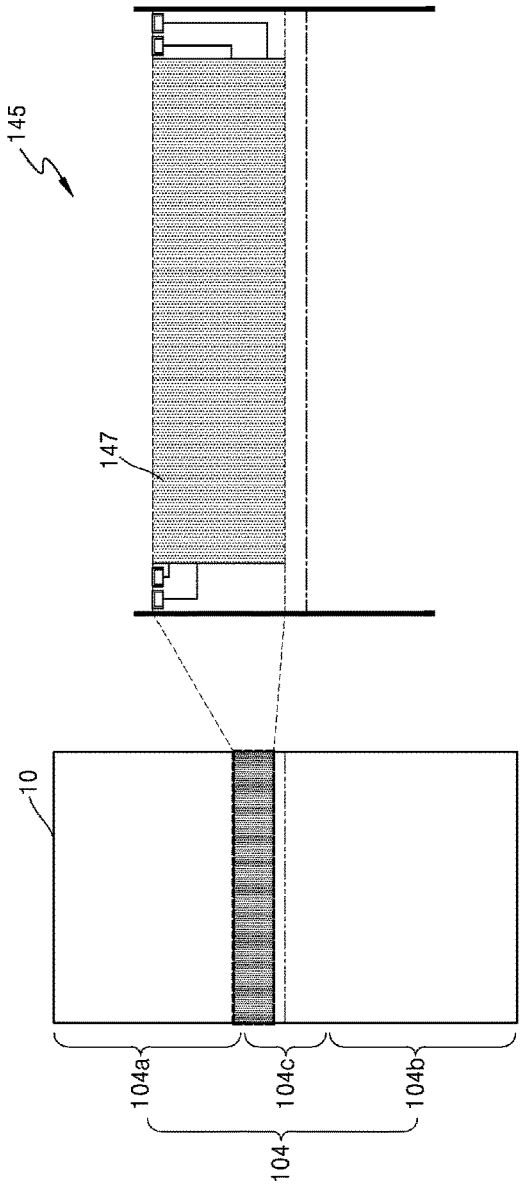
[Fig. 20]



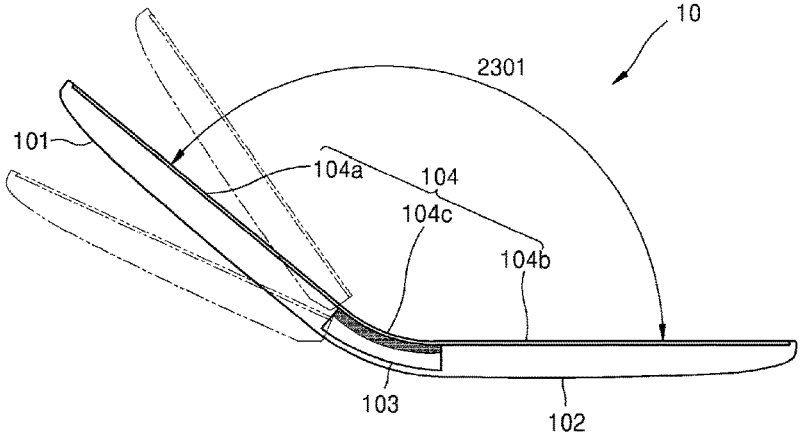
[Fig. 21]



[Fig. 22]


145
147
10
104a
104c
104b
104

[Fig. 23]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2301
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104a
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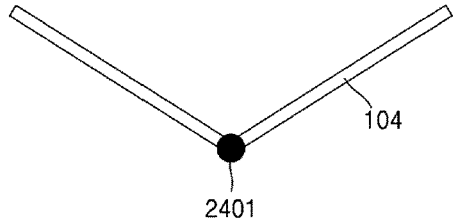
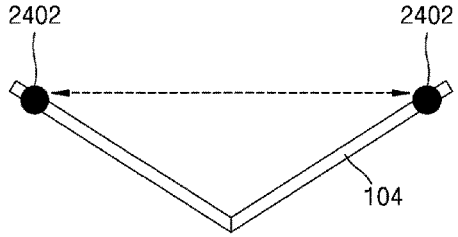
104c
104b
103
102

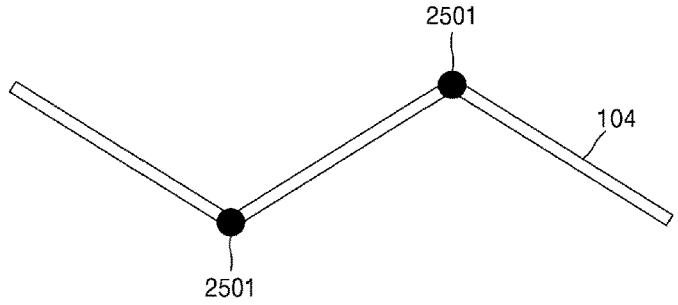
[Fig. 24a]



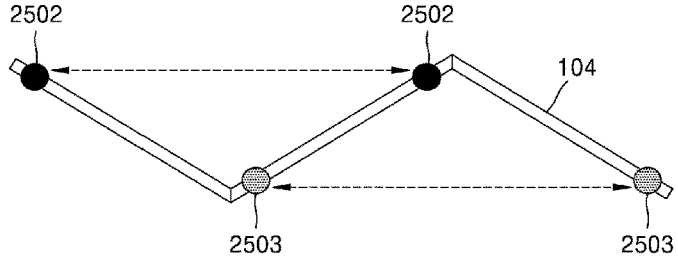
[Fig. 24b]



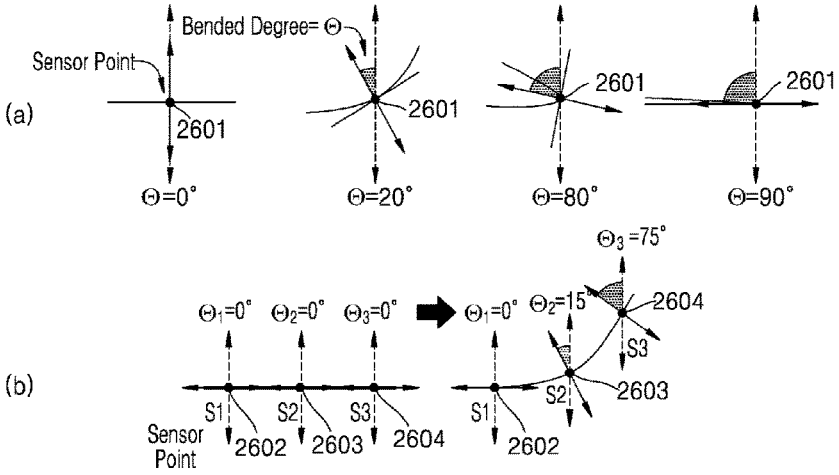
[Fig. 25a]



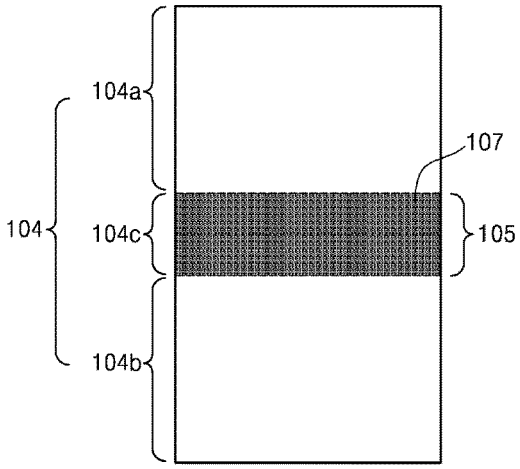
[Fig. 25b]



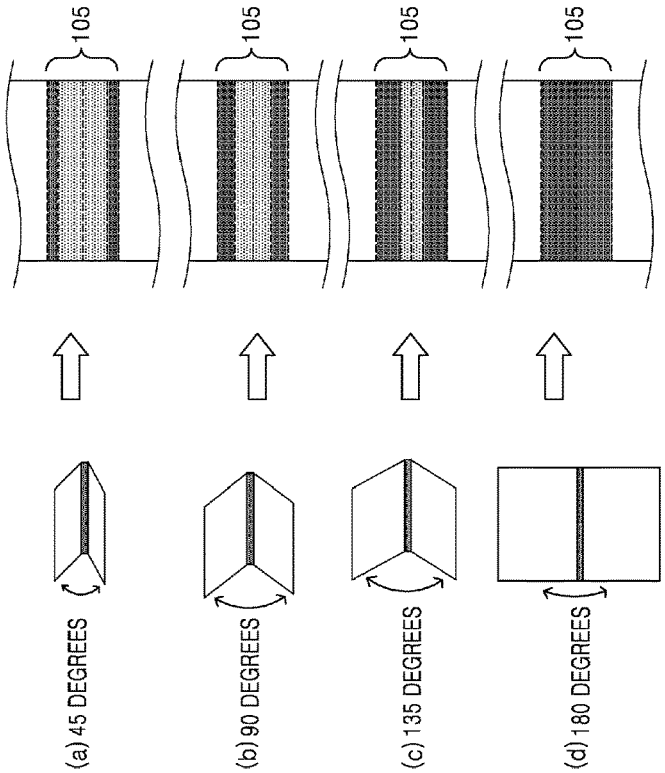
[Fig. 26]



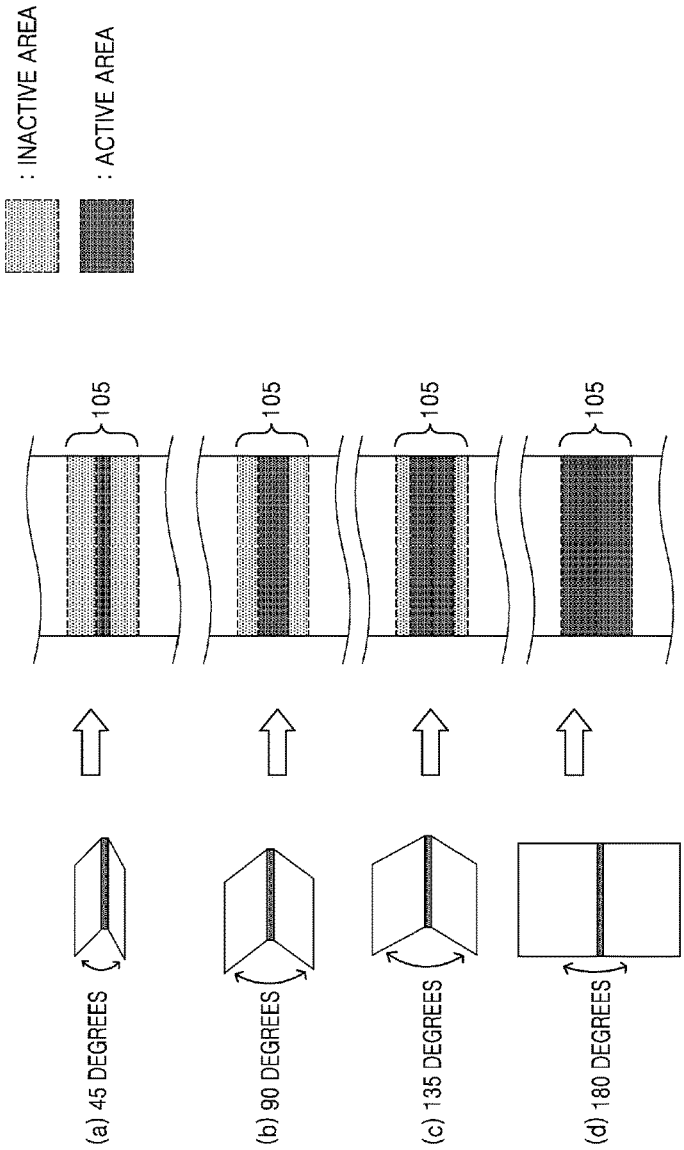
[Fig. 27a]



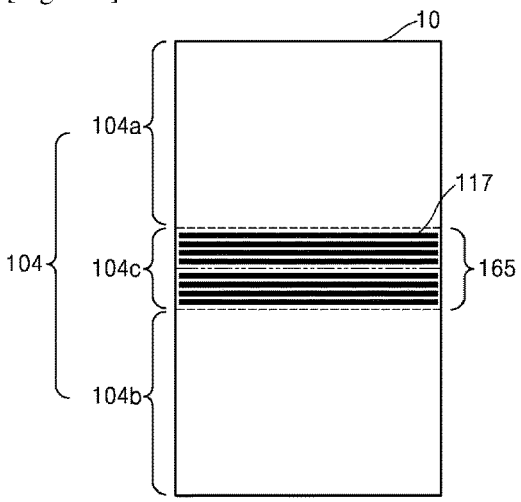
[Fig. 27b]



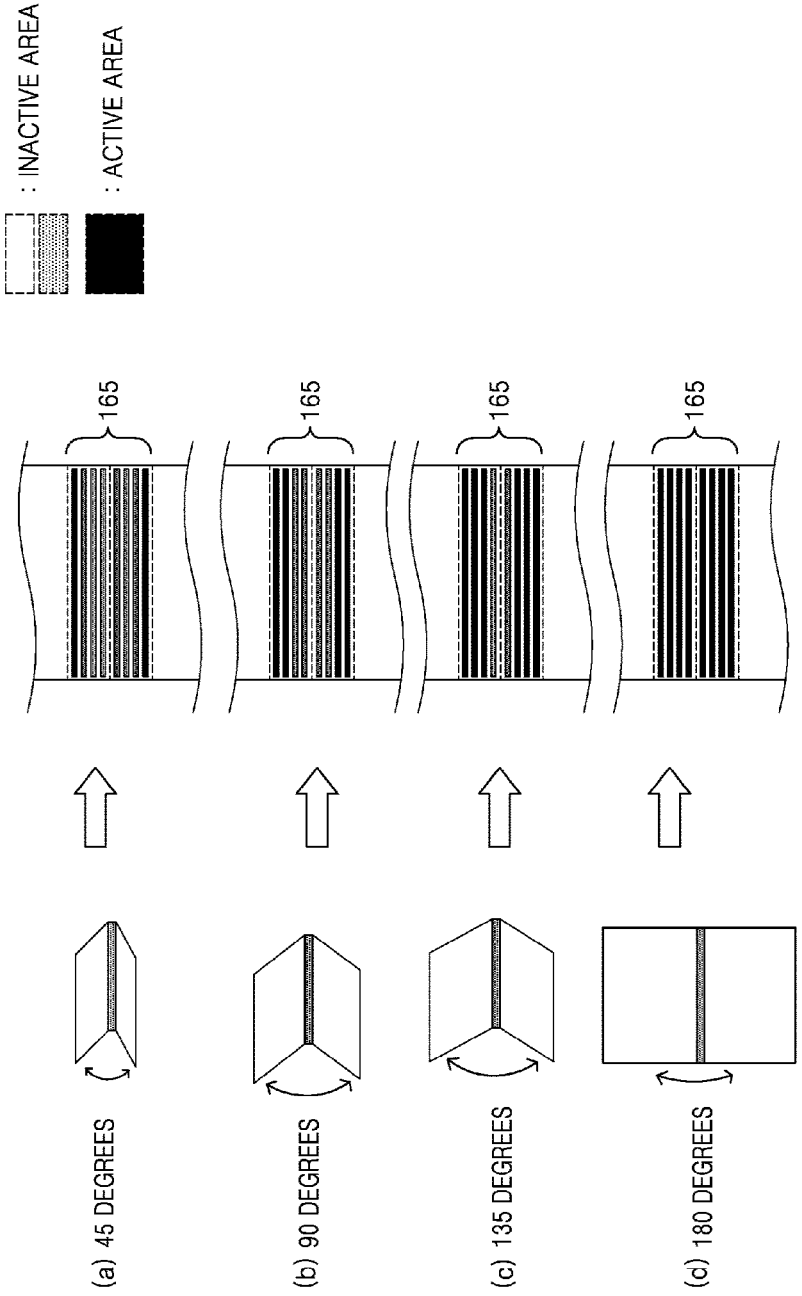
[Fig. 27c]



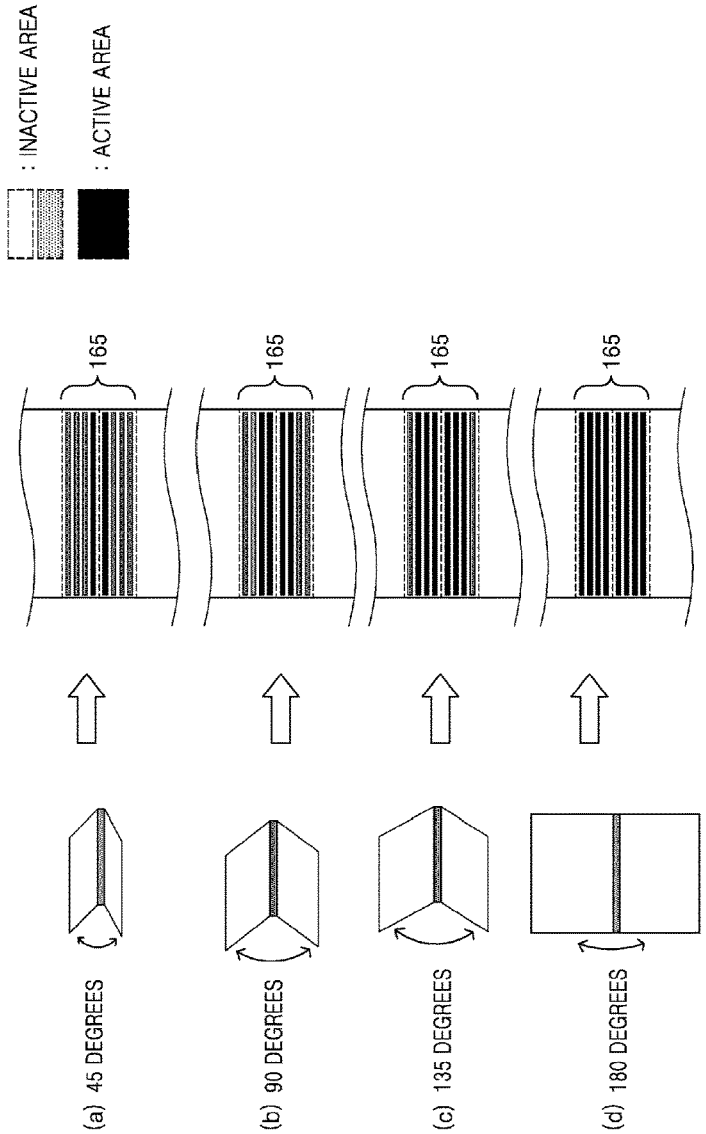
[Fig. 28a]



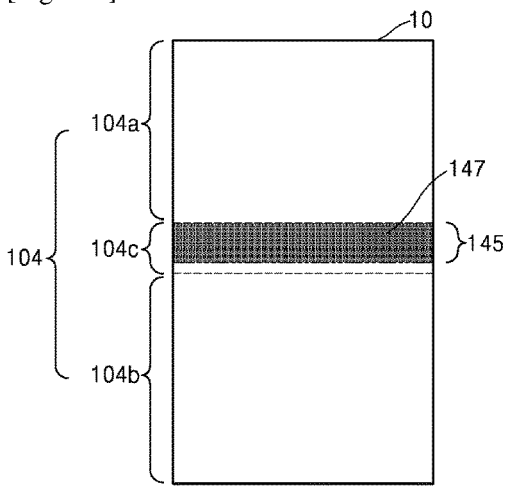
[Fig. 28b]


: INACTIVE AREA
: ACTIVE AREA
165
165
165
165
(a) 45 DEGREES
(b) 90 DEGREES
(c) 135 DEGREES
(d) 180 DEGREES

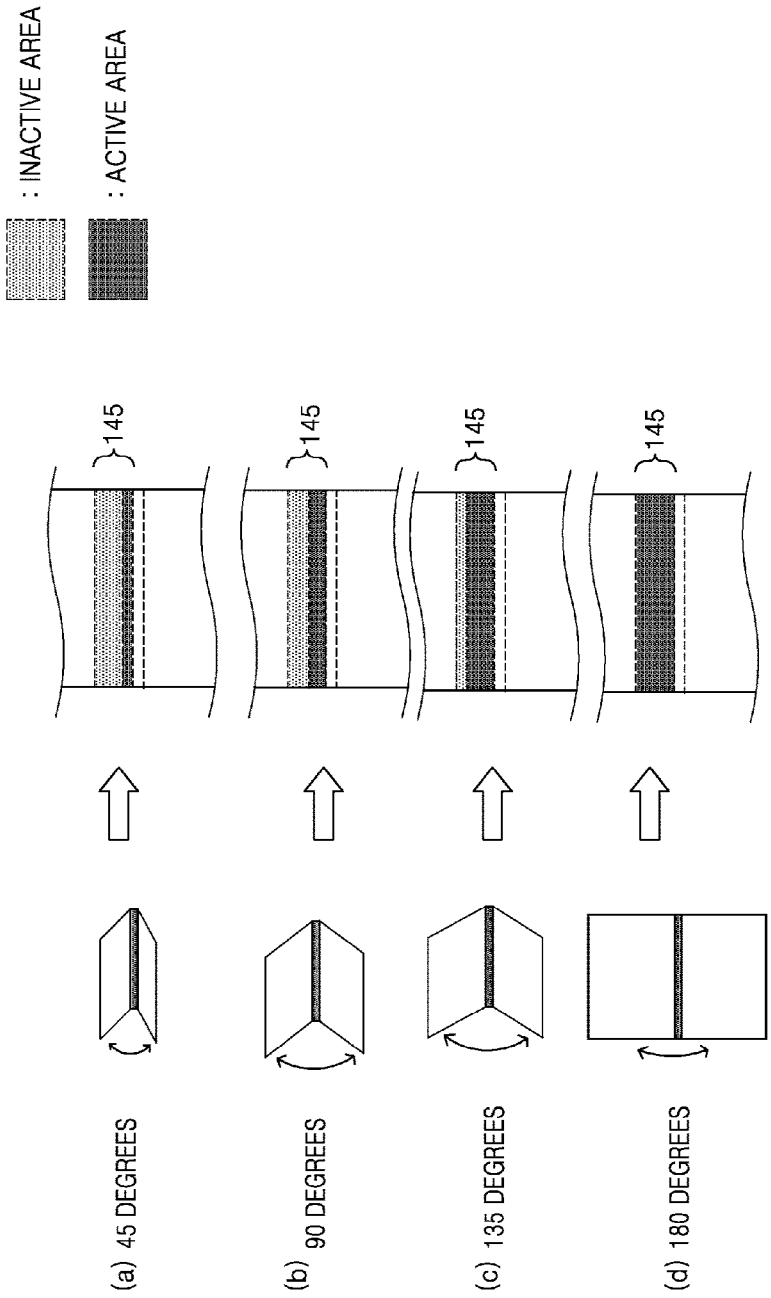
[Fig. 28c]



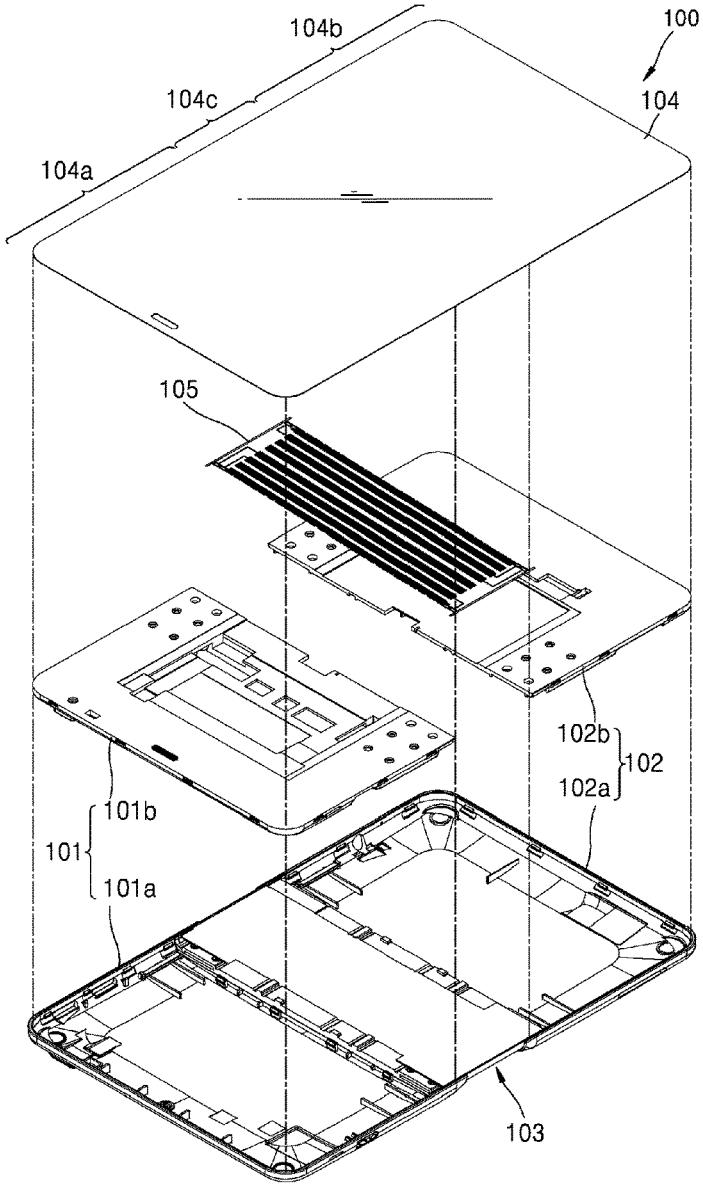
[Fig. 29a]



[Fig. 29b]


: INACTIVE AREA
: ACTIVE AREA
145
145
145
145
(a) 45 DEGREES
(b) 90 DEGREES
(c) 135 DEGREES
(d) 180 DEGREES

[Fig. 30]


104b
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104c
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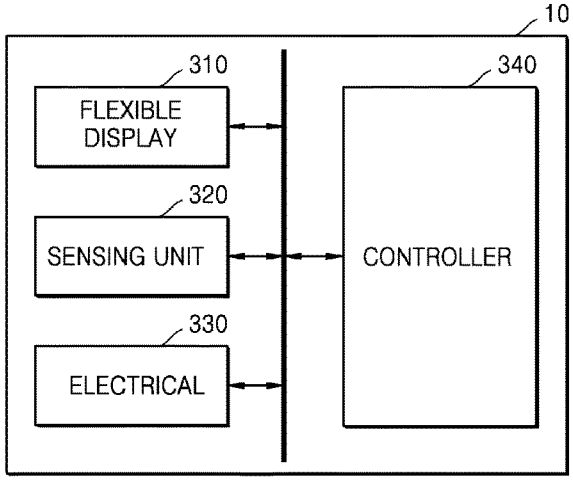
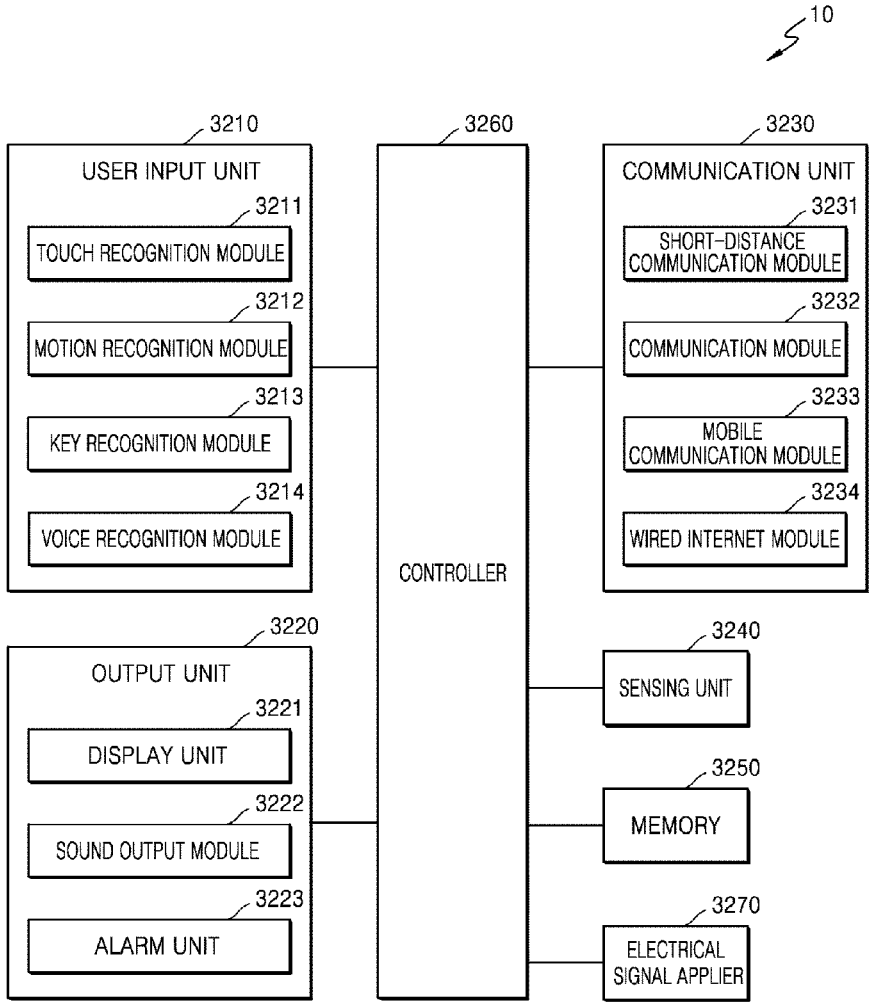
104a
105
102b
102
102a
101b
101
101a
103

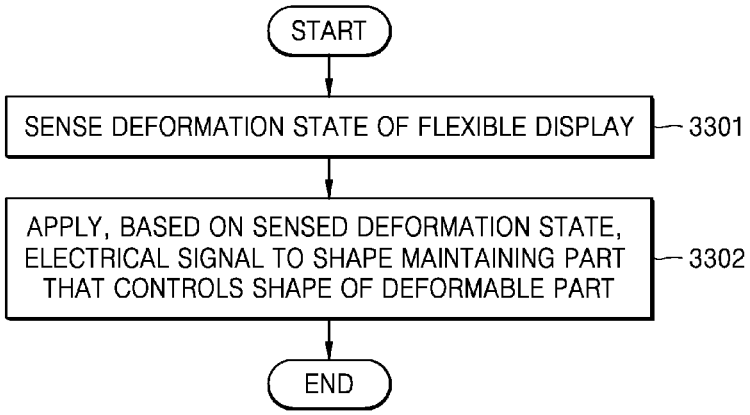
[Fig. 31]


10
310
340
FLEXIBLE DISPLAY
320
SENSING UNIT
CONTROLLER
330
ELECTRICAL

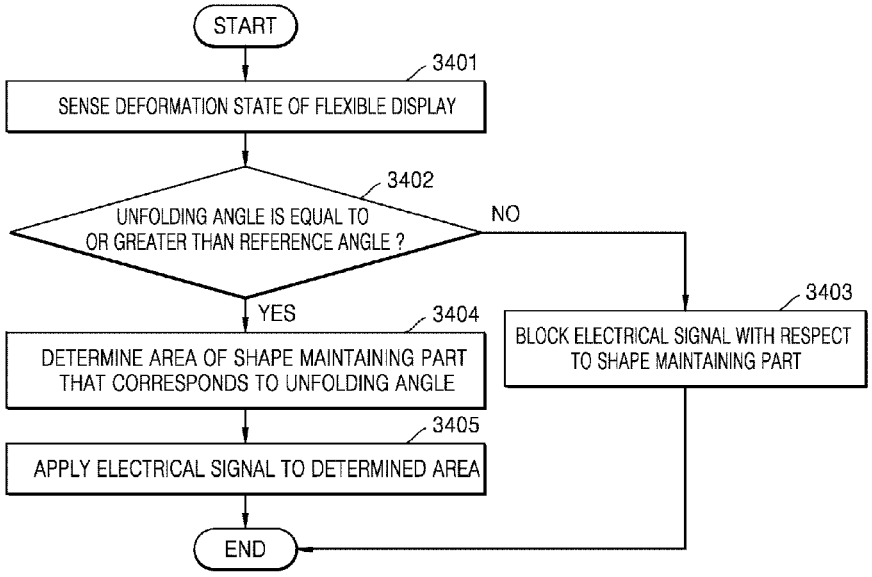
[Fig. 32]


10
3210
USER INPUT UNIT
3211
TOUCH RECOGNITION MODULE
3212
MOTION RECOGNITION MODULE
3213
KEY RECOGNITION MODULE
3214
VOICE RECOGNITION MODULE
3260
CONTROLLER
3230
COMMUNICATION UNIT
3231
SHORT-DISTANCE COMMUNICATION MODULE
3232
COMMUNICATION MODULE
3233
MOBILE COMMUNICATION MODULE
3234
WIRED INTERNET MODULE
3220
OUTPUT UNIT
3221
DISPLAY UNIT
3222
SOUND OUTPUT MODULE
3223
ALARM UNIT
3240
SENSING UNIT
3250
MEMORY
3270
ELECTRICAL SIGNAL APPLIER

[Fig. 33]


START
SENSE DEFORMATION STATE OF FLEXIBLE DISPLAY
3301
APPLY, BASED ON SENSED DEFORMATION STATE, ELECTRICAL SIGNAL TO SHAPE MAINTAINING PART THAT CONTROLS SHAPE OF DEFORMABLE PART
3302
END

[Fig. 34]


START
3401
SENSE DEFORMATION STATE OF FLEXIBLE DISPLAY
3402
UNFOLDING ANGLE IS EQUAL TO OR GREATER THAN REFERENCE ANGLE ?
NO
YES
3403
BLOCK ELECTRICAL SIGNAL WITH RESPECT TO SHAPE MAINTAINING PART
3404
DETERMINE AREA OF SHAPE MAINTAINING PART THAT CORRESPONDS TO UNFOLDING ANGLE
3405
APPLY ELECTRICAL SIGNAL TO DETERMINED AREA
END

FLEXIBLE DEVICE AND METHOD OF CONTROLLING SHAPE OF DISPLAY OF FLEXIBLE DEVICE

TECHNICAL FIELD

[0001] The present disclosure relates to a flexible device having a flexible display and a method of controlling a shape of the flexible display, the method performed by the flexible device having the flexible display.

BACKGROUND ART

[0002] According to developments in a display-related technology, a flexible display, a transparent display panel, or the like are being developed. The flexible display indicates a display device that may be bent.

[0003] The flexible display is manufactured in a manner that a plastic film is substituted for a glass substrate that encapsulates liquid crystals in a liquid crystal display (LCD) and an organic light-emitting display (OLED) according to the related art, thus, the flexible display has foldable and unfoldable flexibility. In the flexible display, a plastic substrate is used instead of a generally-used glass substrate, thus, a low temperature manufacturing process is performed, instead of a conventional manufacturing process, so as to prevent damage to a substrate.

[0004] The flexible display is thin, light-weighted, and resistant to a shock. In addition, the flexible display may be flexible or bent, and may be manufactured to have one of various shapes. In particular, the flexible display may be used in industrial applications where conventional glass-based displays are limitedly used or cannot be used.

[0005] For example, the flexible display may be used in electronic books that may be substituted for publications such as magazines, textbooks, general books, comic books, etc., and may be used in new portable Information Technology (IT) products such as ultra-small portable personal computers whose displays may be bent or rolled, a smart card capable of checking information in real-time, or the like. In addition, since a flexible plastic substrate is used in the flexible display, application fields of the flexible display may expand to wearable clothes and medical diagnosis fields.

DISCLOSURE OF INVENTION

[0006] Provided are a flexible device having a flexible display and a method of controlling a shape of the flexible display, the method performed by the flexible device having the flexible display.

[0007] Provided is a non-transitory computer-readable recording medium having recorded thereon a program for executing the method, by using a computer.

[0008] Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented exemplary embodiments.

[0009] According to an aspect of an exemplary embodiment, a flexible device includes a flexible display that has a foldable deformable part; a housing that is foldable and forms an enclosure space in which the deformable part is enclosed when the flexible display is deformed; a shape maintaining part that is arranged in the enclosure space so as to control flexibility of the deformable part; and an electrical signal applier that applies an electrical signal to the shape maintaining part, based on a deformation state of the flexible display.

BRIEF DESCRIPTION OF DRAWINGS

[0010] These and/or other aspects will become apparent and more readily appreciated from the following description of the exemplary embodiments, taken in conjunction with the accompanying drawings in which:

[0011] FIGS. **1**A through **1**C illustrate exterior shapes of a flexible device in correspondence to folding motions of the flexible device, according to exemplary embodiments;

[0012] FIG. **2** is a cross-sectional side view of the flexible device shown in FIG. **1**;

[0013] FIG. **3** is a cross-sectional side view of a flexible device, according to another exemplary embodiment;

[0014] FIG. **4** illustrates the flexible device according to the exemplary embodiment and another flexible device that does not include a shape maintaining part according to a comparative example;

[0015] FIG. **5** illustrates an operation principal with respect to the shape maintaining part shown in FIG. **4**;

[0016] FIGS. **6** and **7** illustrate characteristics of a device that is used in embodying the shape maintaining part described with reference to FIG. **5**;

[0017] FIG. **8** is a cross-sectional side view illustrating a portion of the flexible device, according to another exemplary embodiment;

[0018] FIG. **9** is a cross-sectional side view illustrating a portion of the flexible device shown in FIG. **8** when the flexible device is folded;

[0019] FIG. **10** is a cross-sectional side view illustrating a portion of the flexible device, according to another exemplary embodiment;

[0020] FIG. **11** is a cross-sectional side view illustrating a portion of a flexible device, according to another exemplary embodiment;

[0021] FIG. **12** is a cross-sectional side view illustrating a portion of the flexible device of FIG. **8** when the flexible device is bent in an opposite direction;

[0022] FIG. **13** is a cross-sectional side view illustrating a portion of the flexible device of FIG. **10** when the flexible device is bent in an opposite direction;

[0023] FIG. **14** is a cross-sectional side view illustrating a portion of the flexible device of FIG. **11** when the flexible device is bent in an opposite direction;

[0024] FIG. **15** illustrates the shape maintaining part of the flexible device, according to an exemplary embodiment;

[0025] FIG. **16** illustrates a shape maintaining part of the flexible device, according to another exemplary embodiment;

[0026] FIG. **17** illustrates a shape maintaining part of the flexible device, according to another exemplary embodiment;

[0027] FIG. **18** illustrates a shape maintaining part of the flexible device, according to another exemplary embodiment;

[0028] FIG. **19** illustrates a shape maintaining part of the flexible device, according to another exemplary embodiment;

[0029] FIG. **20** illustrates the shape maintaining part of FIG. **15**;

[0030] FIG. **21** illustrates the shape maintaining part of FIG. **16**;

[0031] FIG. **22** illustrates the shape maintaining part of FIG. **19**;

[0032] FIG. **23** illustrates a process of sensing a folding motion of the flexible display, according to an exemplary embodiment;

[0033] FIG. **24**A illustrates a process of sensing a folding motion of the flexible display, the process performed by a sensing unit, according to an exemplary embodiment;

[0034] FIG. **24**B illustrates a process of sensing a folding motion of the flexible display, the process performed by a sensing unit, according to another exemplary embodiment;

[0035] FIG. **25**A illustrates a process of sensing a folding motion of the flexible display, the process performed by a sensing unit, according to another exemplary embodiment;

[0036] FIG. **25**B illustrates a process of sensing a folding motion of the flexible display, the process performed by a sensing unit, according to another exemplary embodiment;

[0037] FIG. **26** illustrates a process of sensing a folding motion of the flexible display, the process performed by a sensing unit, according to another exemplary embodiment;

[0038] FIGS. **27**A through **27**C illustrate a procedure of controlling the flexible display of the flexible device including the shape maintaining part of FIG. **20**, the procedure performed by the flexible device, according to an exemplary embodiment;

[0039] FIGS. **28**A through **28**C illustrate a procedure of controlling the flexible display of the flexible device including the shape maintaining part of FIG. **21**, the procedure performed by the flexible device, according to another exemplary embodiment;

[0040] FIGS. **29**A and **29**B illustrate a procedure of controlling the flexible display of the flexible device including the shape maintaining part of FIG. **22**, the procedure performed by the flexible device, according to another exemplary embodiment;

[0041] FIG. **30** is an exploded perspective view of the flexible device, according to an exemplary embodiment;

[0042] FIG. **31** is a block diagram illustrating a configuration of the flexible device of FIG. **30**, according to an exemplary embodiment;

[0043] FIG. **32** is a block diagram illustrating a configuration of the flexible device, according to another exemplary embodiment;

[0044] FIG. **33** is a flowchart of a method of controlling flexibility of the flexible display, the method performed by the flexible device of FIG. **30**, according to an exemplary embodiment; and

[0045] FIG. **34** is a flowchart of a method of controlling flexibility of the flexible display, the method performed by the flexible device of FIG. **30**, according to another exemplary embodiment.

BEST MODE FOR CARRYING OUT THE INVENTION

[0046] According to an aspect of an exemplary embodiment, a flexible device includes a flexible display that has a foldable deformable part; a housing that is foldable and forms an enclosure space in which the deformable part is enclosed when the flexible display is deformed; a shape maintaining part that is arranged in the enclosure space so as to control flexibility of the deformable part; and an electrical signal applier that applies an electrical signal to the shape maintaining part, based on a deformation state of the flexible display.

[0047] The flexible display may include a first part, a second part, and the deformable part between the first part and the second part, and the first part and the second part may be fixed to the housing, and the deformable part may not be fixed to the housing.

[0048] The shape maintaining part may be arranged on a rear surface of the deformable part in the enclosure space.

[0049] The shape maintaining part may include a shape-maintaining device whose shape is deformed according to the electrical signal received from the electrical signal applier.

[0050] When the shape maintaining part receives the electrical signal from the electrical signal applier, the shape maintaining part may maintain a preset shape, and when the electrical signal is blocked, a shape of the shape maintaining part may be deformed according to a deformed shape of the deformable part having the shape maintaining part arranged on its rear surface.

[0051] The flexible device may further include a sensing unit that senses the deformation state of the flexible display.

[0052] The sensing unit may sense the deformation state of the flexible display by sensing an unfolding angle or an unfolding curvature of the flexible display.

[0053] The electrical signal applier may apply the electrical signal to an area of the shape maintaining part that corresponds to the deformation state of the flexible display.

[0054] According to an aspect of another exemplary embodiment, a flexible device includes a flexible display that has a foldable deformable part; a sensing unit that senses a deformation state of the flexible display; an electrical signal applier that applies an electrical signal to a shape maintaining part that is arranged on a rear surface of the deformable part in an enclosure space in which the deformable part is enclosed when the flexible display is deformed; and a controller that controls the electrical signal applier to apply the electrical signal to the shape maintaining part, based on the deformation state.

[0055] The sensing unit may sense an unfolding angle or an unfolding curvature of the flexible display, and the controller may determine, based on the sensed unfolding angle or the sensed unfolding curvature, whether or not to apply the electrical signal to the shape maintaining part.

[0056] The controller may determine, based on the deformation state, an area of the shape maintaining part to which the electrical signal is to be applied.

[0057] The controller may determine, based on the deformation state, a magnitude of the electrical signal to be applied to an area of the shape maintaining part.

[0058] According to an aspect of another exemplary embodiment, a method of controlling flexibility of a foldable deformable part of a flexible display includes operations of sensing a deformation state of flexible display; and applying, based on the deformation state, an electrical signal to a shape maintaining part that controls the flexibility of the deformable part, wherein the shape maintaining part is arranged on a rear surface of the deformable part in an enclosure space in which the deformable part is enclosed when the flexible display is deformed.

[0059] The sensing may include sensing the deformation state by sensing an unfolding angle or an unfolding curvature of the flexible display.

[0060] The applying may include applying the electrical signal to an area of the shape maintaining part that corresponds to the deformation state.

[0061] The applying may include, based on the deformation state, determining whether or not to apply the electrical signal to the shape maintaining part; and when it is determined to apply the electrical signal, applying the electrical signal to the shape maintaining part.

[0062] The applying may include, based on the deformation state, determining an area of the shape maintaining part to which the electrical signal is to be applied; and applying the electrical signal to the determined area of the shape maintaining part.

[0063] The applying may include, based on the deformation state, determining a magnitude of the electrical signal to be applied to an area of the shape maintaining part; and applying the electrical signal having the determined magnitude to the area of the shape maintaining part.

MODE FOR THE INVENTION

[0064] Hereinafter, terms that are used in the specification will be briefly described, and exemplary embodiments will be described in detail.

[0065] All terms including descriptive or technical terms which are used herein should be construed as having meanings that are obvious to one of ordinary skill in the art. However, the terms may have different meanings according to an intention of one of ordinary skill in the art, precedent cases, or the appearance of new technologies. Also, some terms may be arbitrarily selected by the applicant, and in this case, the meaning of the selected terms will be described in detail in the detailed description of exemplary embodiments. Thus, the terms used herein have to be defined based on the meaning of the terms together with the description throughout the specification.

[0066] Also, when a part "includes" or "comprises" an element, unless there is a particular description contrary thereto, the part can further include other elements, not excluding the other elements. In the following description, terms such as "unit" and "module" indicate a unit for processing at least one function or operation, wherein the unit and the block may be embodied as hardware or software or embodied by combining hardware and software.

[0067] Throughout the specification, the term "folding motion" or "bending motion" indicates a motion by which a flexible device or a flexible display is folded or is bent. On the other hand, throughout the specification, the term "unfolding motion" or "unbending motion" indicates a motion by which the flexible device or the flexible display is unfolded.

[0068] In particular, throughout the specification, the term "deforming" such as "folding" or "bending", means a status in which an exterior shape of the flexible device is changed. Therefore, throughout the specification, the term "deforming" may be substituted with the term "folding", "unfolding", "bending", or "unbending", which may all be interpreted as having the same meaning as "deforming".

[0069] Exemplary embodiments will now be described more fully with reference to the accompanying drawings. However, the exemplary embodiments may be embodied in many different forms, and should not be construed as being limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the concept of the exemplary embodiments to one of ordinary skill in the art. In the following description, well-known functions or constructions are not described in detail since they would obscure the exemplary embodiments with unnecessary detail, and like reference numerals in the drawings denote like or similar elements throughout the specification.

[0070] Expressions such as "at least one of," when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

[0071] FIGS. **1**A through **1**C illustrate exterior shapes of a flexible device **10** in correspondence to folding motions of the flexible device **10**, according to exemplary embodiments.

[0072] The flexible device **10** may be embodied as one of various devices with various purposes. For example, the flexible device **10** may be embodied as a mobile phone, a smart phone, a laptop computer, a tablet device, an electronic-book device, a smart television (TV), a device for digital broadcasting, a personal digital assistant (PDA), a portable multimedia player (PMP), navigation, or the like.

[0073] The flexible device **10** employs a flexible display **104**. The flexible display **104** may include various types of a display whose shape is deformable due to an external force, wherein the various types include a foldable display that may be folded or unfolded at a particular angle or to have a particular curvature, a bendable display that may be bent or unbent to have a particular curvature, a rollable display that may be cylindrically rolled, or the like.

[0074] It is assumed that the flexible device **10** shown in FIGS. **1**A through **1**C corresponds to a foldable device having the foldable display as a type of the flexible display **104**. However, as will be described later with reference to other drawings, the flexible device **10** may correspond to a bendable device having a bendable display, a rollable device having a rollable display, or the like.

[0075] Referring to FIGS. **1**A through **1**C, FIG. **1**A is a perspective view illustrating an exterior shape of the flexible device **10** in an unfolded state, according to an exemplary embodiment. FIG. **1**B is a perspective view illustrating an exterior shape of the flexible device **10** of FIG. **1**A in a bent state, according to another exemplary embodiment. FIG. **1**C is a perspective view illustrating an exterior shape of the flexible device **10** of FIG. **1**A in a completely folded state, according to another exemplary embodiment.

[0076] Referring to FIG. **1**A, when the flexible display **104** is used, the flexible device **10** may be completely unfolded, and here, an unfolding angle of the flexible display **104** may be 180 degrees.

[0077] According to a structure of the flexible device **10**, the flexible device **10** may include the flexible display **104** and a housing **100**. The housing **100** corresponds to a body of the flexible device **10**, and may support the flexible display **104**.

[0078] In more detail, the housing **100** may include a first housing **101**, a second housing **102**, and a connecting part **103**. The flexible display **104** may include a first part (e.g., a first part **104***a* of FIG. **2**) supported by the first housing **101**, a second part (e.g., a second part **104***b* of FIG. **2**) supported by the second housing **102**, and a deformable part **104***c* (refer to FIG. **2**) that is a foldable part between the first part **104***a* and the second part **104***b*. The first part **104***a* and the second part **104***b* of the flexible display **104** may be fixed parts that are not deformable.

[0079] The deformable part **104***c* of the flexible display **104** is a foldable part and may not be supported by the first housing **101** and the second housing **102**. The deformable part **104***c* of the flexible display **104** may not be supported

by the connecting part **103**, and may be simply connected with the first part **104***a* and the second part **104***b* of the flexible display **104**. The deformable part **104***c* of the flexible display **104** may be supported by a shape maintaining part **105** (refer to FIG. **2**) arranged on a rear surface of the deformable part **104***c*.

[0080] The flexible device **10** may be folded as shown in FIG. **1**B, and in this regard, an unfolding angle of the flexible display **104** may be between 0 degree and 180 degrees, e.g., 90 degrees. The flexible device **10** may be completely folded as shown in FIG. **1**C, and in this regard, the unfolding angle of the flexible display **104** may be 0 degree.

[0081] When the flexible device **10** is folded, the housing **100** and the flexible display **104** are also folded. The housing **100** may be folded in a manner that the first housing **101** and the second housing **102** are at a folding position, and the connecting part **103** is deformed while the connecting part **103** maintains its connection with the first housing **101** and the second housing **102**.

[0082] When the housing **100** is folded, the flexible display **104** is also folded. Here, the first part **104***a* and the second part **104***b* that are fixed parts of the flexible display **104** may not be deformed and only the deformable part **104***c* may be folded. The deformable part **104***c* of the flexible display **104** may not be sharply folded but may be deformed with a gently-curved shape so as to prevent damage to the flexible display **104**.

[0083] In more detail, when the flexible device **10** is folded, the housing **100** that supports the flexible display **104** may form a space in which the deformable part **104***c* that is deformed is enclosed. The space may be formed by the connecting part **103** of the housing **100** or may be formed by the first housing **101** and the second housing **102**. The deformable part **104***c* of the flexible display **104** may be bent in the formed space while the deformable part **104***c* maintains its curved shaped without being sharply bent.

[0084] In this regard, due to the space for preventing damage to the flexible display **104**, the flexible display **104** may not be supported such that the flexible display **104** may have an uneven portion. In addition, when a user touches the deformable part **104***c* of the flexible display **104**, the deformable part **104***c* may not be supported such that an error may occur with respect to a touch input by the user.

[0085] In order to solve these problems, the flexible device **10** according to the present exemplary embodiment may include the shape maintaining part **105** at a rear surface of the flexible display **104**.

[0086] The shape maintaining part **105** may be arranged on the rear surface of the deformable part **104***c* of the flexible display **104** and thus may control a shape of the deformable part **104***c*. The shape maintaining part **105** may control the shape of the deformable part **104***c* by controlling flexibility or flatness of the deformable part **104***c*. The shape maintaining part **105** may be attached to the rear surface of the deformable part **104***c* or may contact the deformable part **104***c* in a close range.

[0087] For example, when the flexible display **104** is folded, a shape of the shape maintaining part **105** may be changed according to a folded shape of the flexible display **104**. When the flexible display **104** is unfolded, the shape maintaining part **105** may be autonomously unfolded flat and may maintain its shape so as to allow the deformable part **104***c* of the flexible display **104** to be unfolded flat. Also, the shape maintaining part **105** may support the deformable part **104***c* by autonomously maintaining its flexibility, and thus may reduce the error with respect to the touch input by the user.

[0088] The shape maintaining part **105** may be partially flat unfolded according to an unfolding angle of the folded flexible display **104**, and thus may control the flexible display **104** to be smoothly unfolded or folded while the deformable part **104***c* of the flexible display **104** maintains its curved shape.

[0089] The shape maintaining part **105** may be embodied by using a device whose shape is deformed according to a preset condition. In more detail, the shape maintaining part **105** may be embodied of an electroactive device whose shape is deformed due to an electrical signal. For example, the electroactive material whose shape is deformed due to the electrical signal may include electroactive polymer (EAP). The electroactive material to be embodied as the shape maintaining part **105** will be described at a later time.

[0090] The shape maintaining part **105** may receive an electrical signal from an electrical signal applier **330** (refer to FIG. **31**) to be described later, so as to maintain its shape in correspondence to an unfolding angle of the flexible display **104**. In more detail, when the electrical signal applier **330** applies an electrical signal to the shape maintaining part **105**, the shape maintaining part **105** may maintain its set shape by contracting or relaxing itself. When the electrical signal applier **330** blocks the electrical signal, the shape maintaining part **105** may be in a flexible state without the set shape and may be deformed according to a shape of the flexible display **104**.

[0091] For example, when the flexible display **104** is unfolded, the electrical signal applier **330** may apply an electrical signal to the shape maintaining part **105** and may maintain a shape of the shape maintaining part **105**. When the flexible display **104** is folded, the electrical signal applier **330** may block the electrical signal with respect to the shape maintaining part **105** and thus may allow the shape of the shape maintaining part **105** to be changed according to a folded shape of the flexible display **104**.

[0092] The electrical signal applier **330** may apply an electrical signal to all or some portions of the shape maintaining part **105**, according to the unfolding angle of the flexible display **104**. At least one area and position of an entire area of the shape maintaining part **105** to which the electrical signal is to be applied may be determined according to an unfolding angle of the flexible device **10** or the flexible display **104**. For example, as the flexible display **104** is stepwise unfolded and thus the unfolding angle increases, the area of the entire area of the shape maintaining part **105** to which the electrical signal is to be applied may be increased.

[0093] The flexible device **10** may determine the unfolding angle of the flexible display **104** by using a sensing unit **320** (refer to FIG. **31**) to be described later and may determine, by using the determined unfolding angle, a target area of the entire area of the shape maintaining part **105** to which the electrical signal is to be applied.

[0094] The flexible device **10** may maintain flatness and flexibility of the flexible display **104** by using the shape maintaining part **105** that received the electrical signal from the electrical signal applier **330**, and thus may allow the flexible display **104** to be smoothly unfolded or folded while the deformable part **104***c* of the flexible display **104** maintains its curved shape.

[0095] FIG. **2** is a cross-sectional side view of the flexible device **10** shown in FIG. **1**.

[0096] Referring to FIG. **2**, (a) of FIG. **2** is a cross-sectional view illustrating a case in which the flexible device **10** is completely unfolded and thus an unfolding angle of the flexible device **10** is 180 degrees, and (b) of FIG. **2** is a cross-sectional view illustrating a case in which the flexible device **10** is completely folded and thus the unfolding angle of the flexible device **10** is 0 degree.

[0097] Referring to FIG. **2**, the flexible device **10** includes the flexible display **104**, and in this regard, the flexible display **104** may be a display that includes the first part **104***a* and the second part **104***b* that are fixed and are not deformed, and the deformable part **104***c* that is foldable.

[0098] The flexible device **10** may include the housing **100** that corresponds to a body of the flexible device **10**.

[0099] The housing **100** may include an exterior case of the flexible device **10** as the body of the flexible device **10**, and may include internal configurations for supporting devices. For example, referring to FIG. **2**, the housing **100** may include the first housing **101** for supporting the first part **104***a*, the second housing **102** for supporting the second part **104***b*, and the connecting part **103** for connecting the first housing **101** and the second housing **102**. The internal configurations of the flexible device **10** which include the sensing unit **320**, the electrical signal applier **330**, a controller (not shown), etc. may be included in the first housing **101** or the second housing **102** of the housing **100**.

[0100] The first part **104***a* and the second part **104***b* of the flexible display **104** may be supported by the first housing **101** and the second housing **102**, respectively, in a manner that the first part **104***a* and the second part **104***b* are bonded to the first housing **101** and the second housing **102** by using a bonding element such as a bonding material, but one or more exemplary embodiments are not limited thereto and thus the first part **104***a* and the second part **104***b* may be fixed through various elements.

[0101] The deformable part **104***c* of the flexible display **104** may not be supported by the housing **100**. The deformable part **104***c* may be neither attached to the first housing **101** and the second housing **102** nor attached to the connecting part **103** but may only depend on its connection with the first part **104***a* and the second part **104***b* of the flexible display **104**. Alternatively, the deformable part **104***c* of the flexible display **104** may be supported by the shape maintaining part **105** arranged on a rear surface of the deformable part **104***c*.

[0102] The shape maintaining part **105** may be attached to the rear surface of the deformable part **104***c*. When the flexible display **104** is unfolded as shown in (a) of FIG. **2**, the shape maintaining part **105** may receive an electrical signal from the electrical signal applier **330** and may maintain a preset shape.

[0103] In more detail, the flexible device **10** may determine an unfolding angle of the flexible display **104** by using the sensing unit **320**, and may determine whether or not to apply the electrical signal to the shape maintaining part **105**, according to the unfolding angle. When the flexible device **10** determines that the unfolding angle is **180** degrees, the flexible device **10** may allow the electrical signal applier **330** to apply the electrical signal to the shape maintaining part **105**. The shape maintaining part **105** that received the electrical signal may maintain the preset shape and thus may maintain flatness with respect to the attached deformable part **104***c*.

[0104] Comparing (a) and (b) of FIG. **2**, since the flexible device **10** is folded, the housing **100** and the flexible display **104** may be folded.

[0105] The housing **100** may be folded in a manner that the first housing **101** and the second housing **102** are at a folding position, and the connecting part **103** is deformed while maintaining its connection with the first housing **101** and the second housing **102**. The connecting part **103** may be embodied in various ways, and for example, referring to FIG. **2**, the connecting part **103** may be embodied of a flexible device such as rubber and may include an internal slit structure.

[0106] Even if the unfolding angle of the flexible display **104** is 0 degree as shown in (b) of FIG. **2**, the housing **100** may maintain a curved shape by using the slit structure of the connecting part **103** and thus may form a round space in which the deformable part **104***c* is to be enclosed. The space in the side surface shown in (b) of FIG. **2** may have a cylindrical shape.

[0107] The flexible display **104** may be folded because the deformable part **104***c* is deformed. The first part **104***a* and the second part **104***b* that are bonded to the first housing **101** and the second housing **102**, respectively, may not be deformed. In this regard, when the housing **100** is folded while forming the space, the deformable part **104***c* may be deformed while maintaining its curved shape in the space.

[0108] When the flexible device **10** is folded as shown in (b) of FIG. **2**, the shape maintaining part **105** may be deformed according to a folded shape of the attached flexible display **104**.

[0109] In more detail, the flexible device **10** may determine, by using the sensing unit **320**, the unfolding angle of the flexible display **104** as 0 degree, and may block the electrical signal with respect to the shape maintaining part **105**. The shape maintaining part **105** to which the electrical signal is blocked may have a flexible status and thus may be deformed according to the folded shape of the attached flexible display **104**.

[0110] The deformable part **104***c* of the flexible display **104** may be tightly enclosed in the round space, and thus may be deformed while the deformable part **104***c* maintains well its curved shape.

[0111] FIG. **3** is a cross-sectional side view of a flexible device **11**, according to another exemplary embodiment.

[0112] In more detail, (a) of FIG. **3** illustrates a cross-sectional view of a case in which the flexible device **11** is completely unfolded and thus has an unfolding angle of 180 degrees, and (b) of FIG. **3** illustrates a cross-sectional view of a case in which the flexible device **11** is completely folded and thus has the unfolding angle of 0 degree.

[0113] With respect to the flexible device **11** of FIG. **3**, parts of the flexible device **11** that are same as those of the flexible device **10** of FIG. **2** are not described here.

[0114] Referring to FIG. **3**, a connecting part **113** of the flexible device **11** may include a hinge **113***a* including a cylindrical axis, and connectors **113***b*, and may be embodied to be foldable with respect to the axis of the hinge **113***a*.

[0115] Even if an unfolding angle of a flexible display **104** is 0 degree as shown in (b) of FIG. **3**, a housing **110** may form an empty space in the connecting part **113** that is deformed by using a hinge structure, and thus may form a

quadrangular space in which a deformable part **104***c* is to be enclosed. The space shown in (b) of FIG. **3** may have a quadrangular-column shape.

[0116] When the housing **110** is folded, the deformable part **104***c* is deformed so that the flexible display **104** may be folded. A first part **104***a* and a second part **104***b* that are bonded to a first housing **111** and a second housing **122**, respectively, may not be deformed. In this regard, when the housing **110** is folded while forming the quadrangular space, the deformable part **104***c* may not be sharply bent and may be deformed while maintaining its curved shape in the space.

[0117] FIG. **4** illustrates the flexible device **10** according to the exemplary embodiment and another flexible device **10** that does not include the shape maintaining part **105** according to a comparative example.

[0118] In this regard, (a) of FIG. **4** illustrates that a user touches a folded area of the flexible display **104** of the foldable flexible device **10**. The folded area of the flexible display **104** may be a deformable part that is foldable, so that, in order to protect the deformable part, the housing **100** of the flexible device **10** may form an enclosure space at a rear surface of the deformable part.

[0119] In this regard, (b) and (c) of FIG. **4** indicate cross-sectional views of the flexible devices **10**, each of which having the enclosure space at the rear surface of the deformable part of the flexible display **104**. In this regard, (b) of FIG. **4** illustrates the flexible device **10** that does not include the shape maintaining part **105**, and (c) of FIG. **4** illustrates the flexible device **10** that includes the shape maintaining part **105**. For example, the shape maintaining part **105** may be tightly attached to the rear surface of the deformable part of the flexible display **104**.

[0120] Regarding (b) of FIG. **4**, if the shape maintaining part **105** is not included, the deformable part of the flexible display **104** may not be supported by the housing **100** but may be simply connected with a fixed part of the flexible display **104**. Therefore, when the user touches the deformable part of the flexible display **104**, the deformable part may be pressed or curved and thus may not correctly receive a touch input by the user.

[0121] On the other hand, regarding (c) of FIG. **4**, if the shape maintaining part **105** is included, the deformable part of the flexible display **104** may be supported by the shape maintaining part **105**. In more detail, the shape maintaining part **105** that received an electrical signal from the electrical signal applier **330** may maintain a preset shape and thus may maintain flatness and flexibility. The shape maintaining part **105** may maintain the preset shape and thus may maintain flatness of the attached deformable part. Therefore, even if the user touches the deformable part, the deformable part may not be pressed or curved and may correctly receive a touch input by the user.

[0122] FIG. **5** illustrates an operation principal with respect to the shape maintaining part **105** shown in FIG. **4**.

[0123] In this regard, (a) and (b) of FIG. **5** illustrate a portion of a cross-sectional side view of the flexible device **10** including the shape maintaining part **105**, according to an exemplary embodiment.

[0124] In more detail, (a) of FIG. **5** illustrates the shape maintaining part **105** to which an electrical signal is applied. For example, when the flexible device **10** is unfolded, the flexible device **10** may determine an unfolding angle by using the sensing unit **320** and may apply the electrical signal to the shape maintaining part **105**. The flexible device **10** may apply the electrical signal to the shape maintaining part **105** by using the electrical signal applier **330**.

[0125] The shape maintaining part **105** that received the electrical signal may maintain its preset shape by contracting or relaxing itself. The shape maintaining part **105** may autonomously maintain the preset shape and thus may support the deformable part **104***c* of the attached flexible display **104** so as to allow the flexible display **104** to maintain a shape of the flexible display **104**. Therefore, the flexible display **104** may maintain flatness and flexibility of the flexible display **104** without a support by the housing **100**.

[0126] Also, (b) of FIG. **5** illustrates the shape maintaining part **105** to which an electrical signal is not applied. For example, when the flexible device **10** is folded, the flexible device **10** may determine an unfolding angle by using the sensing unit **320** and may block the electrical signal with respect to the shape maintaining part **105**. The flexible device **10** may block the electrical signal with respect to the shape maintaining part **105** by using the electrical signal applier **330**.

[0127] The shape maintaining part **105** that did not receive the electrical signal is in a flexible state, and is deformed according to a deformed shape of a deformable part of the flexible display **104**. For example, as shown in (b) of FIG. **5**, in a case where one end from among both ends of the deformable part of the flexible display **104** is connected to a fixed part of the flexible display **104**, and the other end is not connected, the flexible display **104** may be deformed while being bent downward. The shape maintaining part **105** is also deformed according to the deformed shape of the deformable part of the flexible display **104**.

[0128] When the flexible device **10** is unfolded again, the flexible device **10** applies an electrical signal to the shape maintaining part **105**, so that the flexible display **104** and the shape maintaining part **105** may return to shapes as shown in (a) of FIG. **5**.

[0129] FIGS. **6** and **7** illustrate characteristics of a device that is used in embodying the shape maintaining part **105** described with reference to FIG. **5**.

[0130] The shape maintaining part **105** may be embodied by using the device whose shape is deformed according to a preset condition. The preset condition may include a preset temperature, a preset pressure, a preset voltage, or the like. For example, the shape maintaining part **105** may include a device such as a shape-memory alloy that is deformed to a preset shape according to the preset temperature.

[0131] In the present exemplary embodiment, the shape maintaining part **105** may be embodied of an electroactive device whose shape is deformed due to an electrical signal. For example, the electroactive material whose shape is deformed due to the electrical signal may include electroactive polymer (EAP).

[0132] With reference to FIGS. **6** and **7**, a characteristic of the EAP for embodying the shape maintaining part **105** is described. Materials other than the EAP may be used in embodying the shape maintaining part **105** by using characteristics similar to the characteristic.

[0133] The EAP collectively indicates a polymer material capable of being deformed due to electrical stimulation. Types of the EAP may include a polymer gel, a conducting polymer, an ionic polymer metal composite (IPMC), carbon nanotube (CNT), dielectric elastomer, polyvinylidene fluo-

ride resin (PVDF resin), a shape-memory polymer, electroactive ceramics (EAC), a piezoelectric element, or the like.

[0134] Referring to FIG. **6**, the EAP may be formed of two electrodes **601** and **602**, and an electric material **603** inserted between the two electrodes **601** and **602**. For example, the electric material **603** indicates a material such as elastomer whose shape is deformed due to an external force and is returned to its original shape when the external force is removed.

[0135] Referring to FIG. **6**, (a) of FIG. **6** illustrates the EAP in an inactive state since a voltage is not applied to the EAP, and (b) of FIG. **6** illustrates the EAP in an active state since a voltage is applied to the EAP. When the voltage is applied to the EAP, a voltage difference between the two electrodes **601** and **602** occurs, and then the two electrodes **601** and **602** pressurize the electric material **603** therebetween so as to meet each other, so that deformation as shown (b) of FIG. **6** may be achieved. A shape of the EAP may be differently deformed by adjusting a structure of the EAP or by adjusting strength of the voltage applied thereto.

[0136] When the voltage is not applied to the EAP, the EAP may return to its original shape as shown in (a) of FIG. **6**, according to a characteristic of the elastomer.

[0137] FIG. **7** illustrates an actuator **701** that is a power transmitter for converting an electric energy using the EAP to a mechanical energy.

[0138] In this regard, (a) of FIG. **7** illustrates the actuator **701** in an inactive state since a voltage is not applied to the actuator **701**, and (b) of FIG. **7** illustrates the actuator **701** in an active state since a voltage is applied to the actuator **701**. The actuator **701** in the inactive state may have a flexible status without a fixed shape. The actuator **701** may be controlled in such a manner that, when the voltage is applied to the actuator **701**, a shape of the actuator **701** may be deformed to a preset shape according to the characteristic of the EAP described with reference to FIG. **6**. In more detail, a structure of the EAP, whether or not to apply a voltage, strength of the voltage to be applied, etc., with respect to each of points of the actuator **701** may be controlled, so that the shape of the actuator **701** may be deformed to the preset shape.

[0139] As described above, by using the characteristic of the EAP, the shape maintaining part **105** of the flexible device **10** according to the present exemplary embodiment may be embodied.

[0140] The shape maintaining part **105** may be attached to a rear surface of the deformable part of the flexible display **104**, and may include a shape maintaining device such as the electroactive device. The shape maintaining device may be disposed so as to allow the shape maintaining part **105** to maintain the preset shape.

[0141] The shape maintaining part **105** may include a circuit so as to apply an electrical signal to the shape maintaining device. The shape maintaining part **105** may receive the electrical signal from the electrical signal applier **330** by using the circuit, wherein the electrical signal depends on a deformed status of the flexible display **104**.

[0142] FIG. **8** is a cross-sectional side view illustrating a portion of the flexible device **10**, according to another exemplary embodiment.

[0143] In more detail, FIG. **8** is a cross-sectional side view illustrating a folded portion of the flexible device **10** in an unfolded state.

[0144] The flexible display **104** of the flexible device **10** may include the first part **104***a* and the second part **104***b* that are fixed parts, and the deformable part **104***c* connected between the first part **104***a* and the second part **104***b*.

[0145] The first part **104***a* and the second part **104***b* may be supported by the first housing **101** and the second housing **102**, respectively. The deformable part **104***c* is not supported by the first housing **101** or the second housing **102** and is simply connected to the first part **104***a* and the second part **104***b*.

[0146] The first housing **101** and the second housing **102** are foldably connected to each other via the connecting part **103**. The first housing **101**, the second housing **102**, and the connecting part **103** form the housing **100** that is a body of the flexible device **10**. The connecting part **103** may be embodied of a flexible device such as rubber and may include an internal slit structure.

[0147] The connecting part **103** may have a thickness less than that of each of the first housing **101** and the second housing **102**, and an empty space may be formed between the deformable part **104***c* of the flexible display **104** and the connecting part **103**.

[0148] The empty space between the deformable part **104***c* and the connecting part **103** may correspond to an enclosure space **106** in which the deformable part **104***c* that is deformed when the flexible device **10** is folded is enclosed. The enclosure space **106** is formed to allow the deformable part **104***c* of the flexible display **104** not to be sharply bent but to be deformed with a curved shape. The enclosure space **106** may be formed when the flexible device **10** is folded or may have been formed since the flexible device **10** is unfolded.

[0149] In order to prevent deformation, which is not desired by a user, from occurring at the flexible display **104** due to the enclosure space **106** between the deformable part **104***c* and the connecting part **103**, the flexible device **10** may include the shape maintaining part **105** arranged on a rear surface of the deformable part **104***c*. The shape maintaining part **105** may include the shape maintaining device, may be attached to the rear surface of the deformable part **104***c*, and thus may maintain a shape of the deformable part **104***c*.

[0150] FIG. **9** is a cross-sectional side view illustrating a portion of the flexible device **10** shown in FIG. **8** when the flexible device **10** is folded.

[0151] When the flexible device **10** is folded, the housing **100** and the flexible display **104** may be folded.

[0152] The housing **100** may be folded in a manner that the first housing **101** and the second housing **102** are at a folding position, and the connecting part **103** that connects the first housing **101** and the second housing **102** is deformed while the connecting part **103** maintains its connection with the first housing **101** and the second housing **102**. The flexible display **104** may be folded in a manner that the deformable part **104***c* is deformed. The deformable part **104***c* may be deformed while maintaining a curved shape of the deformable part **104***c*.

[0153] Referring to (a) of FIG. **9**, when the housing **100** is folded, a shape of the enclosure space **106** may be deformed while maintaining room for enclosing the deformable part **104***c*. The deformable part **104***c* may be enclosed in the maintaining enclosure space **106** and thus may be deformed while the deformable part **104***c* maintains the curved shape. Here, the shape maintaining part **105** arranged on the rear surface of the deformable part **104***c* may maintain a flexible

state and thus may be deformed according to a folded shape of the attached deformable part **104***c*.

[0154] As shown in (b) of FIG. **9**, when the housing **100** is completely folded, the enclosure space **106** may be formed as a round shape. The housing **100** may actually have a semicircular-column shape. The deformable part **104***c* of the flexible display **104** may be tightly enclosed in a round space, and thus may be deformed while the deformable part **104***c* maintains well its curved shape.

[0155] FIG. **10** is a cross-sectional side view illustrating a portion of the flexible device **11**, according to another exemplary embodiment.

[0156] In more detail, (a) of FIG. **10** is a cross-sectional side view illustrating a folded portion of the flexible device **11** in an unfolded state.

[0157] With respect to the flexible device **11** of FIG. **10**, parts of the flexible device **11** that are same as those of the flexible device **10** of FIG. **8** are not described here.

[0158] Referring to (a) of FIG. **10**, the first housing **111** and the second housing **112** are foldably connected to each other via the connecting part **113**. The first housing **111**, the second housing **112**, and the connecting part **113** form the housing **110** that is a body of the flexible device **11**. The connecting part **113** may include the hinge **113***a* including a cylindrical axis, and the connectors **113***b*, and may be embodied to be foldable with respect to the axis of the hinge **113***a*.

[0159] The connecting part **113** may have a thickness less than that of each of the first housing **111** and the second housing **112**, and an empty space may be formed between a deformable part **114***c* of a flexible display **114** and the connecting part **113**.

[0160] The empty space between the deformable part **114***c* and the connecting part **113** may correspond to an enclosure space **116** in which the deformable part **114***c* that is deformed when the flexible device **11** is folded is enclosed. In order to prevent deformation, which is not desired by a user, from occurring at the flexible display **114** due to the enclosure space **116**, the flexible device **11** may include a shape maintaining part **115** arranged on a rear surface of the deformable part **114***c*.

[0161] Also, (b) and (c) of FIG. **10** are cross-sectional side views, each of which illustrating a portion of the flexible device **11** when the flexible device **11** is folded.

[0162] Referring to (b) of FIG. **10**, when the housing **110** is folded, a shape of the enclosure space **116** may be deformed while maintaining room for enclosing the deformable part **114***c*. The deformable part **114***c* may be enclosed in the maintaining enclosure space **116** and thus may be deformed while the deformable part **114***c* maintains the curved shape. Here, the shape maintaining part **115** arranged on the rear surface of the deformable part **114***c* may maintain a flexible state and thus may be deformed according to a folded shape of the attached deformable part **114***c*.

[0163] As shown in (c) of FIG. **10**, when the housing **110** is completely folded, the enclosure space **116** may be formed as a quadrangular shape. The housing **110** may actually have a quadrangular-column shape. The flexible device **11** may be embodied to have an appropriately-adjusted horizontal length of the connecting part **113** shown in (a) of FIG. **10**, so that the flexible display **114** may not be sharply bent. For example, a cusp of a curved surface of the deformable part **114***c* contacts a central axis of the connecting part **113**, so that the deformable part **114***c* may be deformed while the deformable part **114***c* is not sharply bent and maintains well a shape of the curved surface.

[0164] FIG. **11** is a cross-sectional side view illustrating a portion of a flexible device **12**, according to another exemplary embodiment.

[0165] In more detail, (a) of FIG. **11** is a cross-sectional side view illustrating a folded portion of the flexible device **12** in an unfolded state.

[0166] With respect to the flexible device **12** of FIG. **11**, parts of the flexible device **12** that are same as those of the flexible device **10** of FIG. **8** are not described here.

[0167] Referring to (a) of FIG. **11**, a first housing **121** and a second housing **122** are foldably connected to each other via a connecting part **123**. The first housing **121**, the second housing **122**, and the connecting part **123** form a housing **120** that is a body of the flexible device **12**. The connecting part **123** may correspond to a hinge including a cylindrical-shape axis between the first housing **121** and the second housing **122**.

[0168] An enclosure space **126** in which a deformable part **124***c* that is deformed when the flexible device **12** is folded is enclosed may be formed due to an internal structure of the first housing **121** or the second housing **122**. For example, the enclosure space **126** may be formed due to a groove in a side or both sides of the first housing **121** or the second housing **122**.

[0169] In order to prevent deformation, which is not desired by a user, from occurring at a flexible display **124** due to the enclosure space **126**, the flexible device **12** may include a shape maintaining part **125** arranged on a rear surface of the deformable part **124***c*.

[0170] Also, (b) of FIG. **11** is a cross-sectional side view illustrating a portion of the flexible device **12** when the flexible device **12** is folded.

[0171] Referring to FIG. **11**, when the housing **120** is folded, the enclosure space **126** may not be deformed and may maintain its shape. The deformable part **124***c* may be enclosed in the enclosure space **126** and thus may be deformed while the deformable part **124***c* maintains a curved shape of the deformable part **124***c*. Here, the shape maintaining part **125** arranged on the rear surface of the deformable part **124***c* may maintain a flexible state and thus may be deformed according to a folded shape of the attached deformable part **124***c*.

[0172] As shown in (b) of FIG. **11**, when the housing **120** is completely folded, the enclosure space **126** may be formed as a quadrangular shape. The housing **120** may actually have a quadrangular-column shape. The flexible device **12** may be embodied to have an appropriately-adjusted horizontal length of the enclosure space **126** that corresponds to a groove in the second housing **122** shown in (b) of FIG. **11**, so that the flexible display **124** may not be sharply bent and may be deformed while the flexible display **124** maintains well its curved shape.

[0173] FIG. **12** is a cross-sectional side view illustrating a portion of the flexible device **10** of FIG. **8** when the flexible device **10** is bent in an opposite direction.

[0174] The flexible device **10** according to the previous exemplary embodiment may be a foldable device having a foldable display that is foldable or unfoldable in one direction. For example, when the flexible device **10** is completely unfolded, an unfolding angle of the flexible device **10** may be 180 degrees, and when the flexible device **10** is completely folded, the unfolding angle of the flexible device **10**

may be 0 degree. Therefore, when the flexible device **10** is completely unfolded and thus has the unfolding angle of 180 degrees, the flexible device **10** cannot be folded in a direction (i.e., an opposite direction) in which the unfolding angle further increases. If the flexible device **10** is excessively bent in the opposite direction due to an external force, the flexible device **10** may be damaged.

[0175] In order to prevent damage to the flexible display **104**, the shape maintaining part **105** arranged on the rear surface of the deformable part **104***c* of the flexible display **104** may maintain a shape of the shape maintaining part **105** and thus may protect the flexible display **104**.

[0176] In more detail, the flexible device **10** may determine an unfolding angle of the flexible display **104** by using the sensing unit **320**, and when the flexible device **10** determines, according to the unfolding angle, that the flexible device **10** is bent in the opposite direction, the flexible device **10** may apply an electrical signal to the shape maintaining part **105**. The flexible device **10** may control the electrical signal applier **330** to apply the electrical signal to the shape maintaining part **105**.

[0177] The shape maintaining part **105** that received the electrical signal may maintain a preset shape and thus may autonomously maintain flatness and flexibility, and may prevent the deformable part **104***c* of the attached flexible display **104** from being bent in the opposite direction.

[0178] FIG. **13** is a cross-sectional side view illustrating a portion of the flexible device **11** of FIG. **10** when the flexible device **11** is bent in an opposite direction.

[0179] In order to prevent damage to the flexible device **11**, the connecting part **113** may be formed so as to prevent the flexible device **11** from being bent in the opposite direction. The connecting part **113** may be bent in only one direction by limiting a rotating angle of the hinge **113***a*.

[0180] In order to prevent damage to the flexible display **114**, the shape maintaining part **115** arranged on the rear surface of the deformable part **114***c* of the flexible display **114** may maintain a shape of the shape maintaining part **115** and thus may protect the flexible display **114**.

[0181] In more detail, when the flexible device **11** is completely unfolded, the flexible device **11** may determine an unfolding angle of the flexible display **114** by using the sensing unit **320**, and may apply an electrical signal to the shape maintaining part **115**. The shape maintaining part **115** that received the electrical signal may maintain a preset shape and thus may autonomously maintain flatness and flexibility, and may prevent the flexible display **114** from being bent in the opposite direction.

[0182] FIG. **14** is a cross-sectional side view illustrating a portion of the flexible device **12** of FIG. **11** when the flexible device **12** is bent in an opposite direction.

[0183] In order to prevent damage to the flexible device **12**, the connecting part **123** may be formed so as to prevent the flexible device **12** from being bent in the opposite direction. The connecting part **123** may be bent in only one direction by limiting a rotating angle of a hinge (not shown). The connecting part **123** may prevent that, when the flexible device **12** is bent in the opposite direction, the first housing **121** and the second housing **122** contact each other at a point other than the connecting part **123** and are bent in the opposite direction.

[0184] In order to prevent damage to the flexible display **124**, the shape maintaining part **125** arranged on the rear surface of the deformable part **124***c* of the flexible display **124** may maintain a shape of the shape maintaining part **125** and thus may protect the flexible display **124**.

[0185] In more detail, when the flexible device **12** is completely unfolded, the flexible device **12** may determine an unfolding angle of the flexible display **124** by using the sensing unit **320**, and may apply an electrical signal to the shape maintaining part **125**. The shape maintaining part **125** that received the electrical signal may maintain a preset shape and thus may autonomously maintain flatness and flexibility, and may prevent the flexible display **124** from being bent in the opposite direction.

[0186] FIG. **15** illustrates the shape maintaining part **105** of the flexible device **10**, according to an exemplary embodiment.

[0187] The flexible device **10** may include the shape maintaining part **105** arranged on a rear surface of the deformable part **104***c* that is a deformable part of the flexible display **104**. For example, the shape maintaining part **105** may be attached to the rear surface of the deformable part **104***c*, and may include a shape maintaining device and a circuit for applying an electrical signal to the shape maintaining device.

[0188] FIGS. **15** through **19** illustrate a shape maintaining device arranged on a shape maintaining part, according to various exemplary embodiments. In FIGS. **15** through **19**, a gray area in the shape maintaining part indicates an area to which the shape maintaining device is attached.

[0189] FIG. **15** illustrates an example in which a shape maintaining device **107** is arranged in an entire area of the shape maintaining part **105**. In this regard, (a) of FIG. **15** is a cross-sectional side view illustrating a portion of the flexible device **10** including the shape maintaining part **105**, and (b) of FIG. **15** is a cross-sectional rear view illustrating a portion of the flexible device **10**.

[0190] The shape maintaining part **105** including the shape maintaining device **107** arranged in the entire area of the shape maintaining part **105** may collectively control the deformable part **104***c*. When the shape maintaining part **105** receives an electrical signal from the electrical signal applier **330**, the shape maintaining part **105** may maintain a shape of an entire area of the deformable part **104***c*.

[0191] FIG. **16** illustrates a shape maintaining part **165** of the flexible device **10**, according to another exemplary embodiment.

[0192] FIG. **16** illustrates an example in which shape maintaining devices **117** are arranged in some areas of the shape maintaining part **165**. The shape maintaining devices **117** in the form of a plurality of horizontally-long bars may be disposed in the shape maintaining part **165**. In this regard, (a) of FIG. **16** is a cross-sectional side view illustrating a portion of the flexible device **10** including the shape maintaining part **165**, and (b) of FIG. **16** is a cross-sectional rear view illustrating a portion of the flexible device **10**.

[0193] Since the shape maintaining devices **117** are arranged at regular intervals, the shape maintaining part **165** may collectively control a shape of the deformable part **104***c*.

[0194] If whether or not to apply an electrical signal varies in the shape maintaining devices **117** in the form of the bars, the shape maintaining part **165** may control a portion of the shape of the deformable part **104***c*. Since the shape maintaining part **165** controls a portion of the shape of the deformable part **104***c*, the shape maintaining part **165** may allow the flexible display **104** to be smoothly unfolded or

folded while the flexible display **104** maintains a curved shape of the flexible display **104**.

[0195] FIG. **17** illustrates a shape maintaining part **175** of the flexible device **10**, according to another exemplary embodiment.

[0196] FIG. **17** illustrates an example in which shape maintaining devices **127** are arranged in some areas of the shape maintaining part **175**. The shape maintaining devices **127** in the form of a plurality of vertically-long bars may be disposed in the shape maintaining part **175**. In this regard, (a) of FIG. **17** is a cross-sectional side view illustrating a portion of the flexible device **10** including the shape maintaining part **175**, and (b) of FIG. **17** is a cross-sectional rear view illustrating a portion of the flexible device **10**.

[0197] Since the shape maintaining devices **127** are arranged at regular intervals, the shape maintaining part **175** may collectively control a shape of the deformable part **104***c*.

[0198] If whether or not to apply an electrical signal varies in the shape maintaining devices **127** in the form of the bars, the shape maintaining part **175** may control a portion of the shape of the deformable part **104***c*. Since the shape maintaining part **175** controls a portion of the shape of the deformable part **104***c*, the shape maintaining part **175** may allow the flexible display **104** to be smoothly unfolded or folded while the flexible display **104** maintains a curved shape of the flexible display **104**.

[0199] In addition, when a user unfolds the flexible device **10**, the shape maintaining part **175** may create elasticity to make the flexible device **10** unfolded well by using the shape maintaining devices **127** arranged in the form of the vertically-long bars.

[0200] FIG. **18** illustrates a shape maintaining part **135** of the flexible device **10**, according to another exemplary embodiment.

[0201] FIG. **18** illustrates an example in which shape maintaining devices **137** are arranged in some areas of the shape maintaining part **135**. The shape maintaining devices **137** having a quadrangular shape may be arrayed in a matrix form in the shape maintaining part **135**. In this regard, (a) of FIG. **18** is a cross-sectional side view illustrating a portion of the flexible device **10** including the shape maintaining part **135**, and (b) of FIG. **18** is a cross-sectional rear view illustrating a portion of the flexible device **10**.

[0202] Since the shape maintaining devices **137** are arranged at regular intervals, the shape maintaining part **135** may collectively control a shape of the deformable part **104***c*.

[0203] If whether or not to apply an electrical signal varies in the shape maintaining devices **137** having the quadrangular shape, the shape maintaining part **135** may control a portion of the shape of the deformable part **104***c*. Since the shape maintaining part **135** controls a portion of the shape of the deformable part **104***c*, the shape maintaining part **135** may allow the flexible display **104** to be smoothly unfolded or folded while the flexible display **104** maintains a curved shape of the flexible display **104**.

[0204] The flexible device **10** may apply an electrical signal to the shape maintaining device **137** that is arranged on a rear surface of an area of the flexible display **104**, wherein the area of the flexible display **104** is frequently touched or is expected to be touched, so that the flexible device **10** may control a portion of a shape of the deformable part **104***c*.

[0205] FIG. **19** illustrates a shape maintaining part **145** of the flexible device **10**, according to another exemplary embodiment.

[0206] FIG. **19** illustrates an example in which a shape maintaining device **147** is arranged in an entire area of the shape maintaining part **145**.

[0207] However, the shape maintaining part **145** may not be positioned at a folded center of the flexible device **10**. According to how a connecting part and an enclosure space of the flexible device **10** are embodied, the deformable part **104***c* of the flexible device **10** may be arranged at only one of a first housing and a second housing. Therefore, the shape maintaining part **145** arranged on the rear surface of the deformable part **104***c* may also be arranged at only one of the first housing and the second housing.

[0208] In this regard, (a) of FIG. **19** is a cross-sectional side view illustrating a portion of the flexible device **10** including the shape maintaining part **145**, and (b) of FIG. **19** is a cross-sectional rear view illustrating a portion of the flexible device **10**.

[0209] The shape maintaining part **145** including the shape maintaining device **147** arranged in the entire area of the shape maintaining part **145** may collectively control the deformable part **104***c*. When the shape maintaining part **145** receives an electrical signal from the electrical signal applier **330**, the shape maintaining part **145** may maintain a shape of an entire area of the deformable part **104***c*.

[0210] Alternatively, as shown in FIGS. **16** through **18**, a plurality of shape maintaining devices may be arranged in some areas of the shape maintaining part **145**.

[0211] FIGS. **20** through **22** illustrate the shape maintaining parts **105**, **165**, and **145**, according to exemplary embodiments.

[0212] In FIGS. **20** through **22**, gray areas of the shape maintaining parts **105**, **165**, and **145** indicate areas to which shape maintaining devices are attached.

[0213] FIG. **20** illustrates the shape maintaining part **105** of FIG. **15**.

[0214] The flexible device **10** may include the shape maintaining part **105** arranged on a rear surface of the deformable part **104***c* that is a foldable part of the flexible display **104**. In more detail, the shape maintaining part **105** may include a shape maintaining device and a circuit, wherein the shape maintaining device maintains a preset shape due to an electrical signal, and the circuit applies the electrical signal to the shape maintaining device. The shape maintaining part **105** may receive the electrical signal from the electrical signal applier **330** via the included circuit.

[0215] Referring to FIG. **20**, the shape maintaining device **107** may be seamlessly arranged in an entire area of the shape maintaining part **105**.

[0216] The shape maintaining part **105** may collectively control the deformable part **104***c*. When the shape maintaining part **105** receives an electrical signal from the electrical signal applier **330**, the shape maintaining part **105** may maintain a shape of an entire area of the deformable part **104***c*.

[0217] The shape maintaining part **105** may receive a plurality of electrical signals and may apply different electrical signals to some areas of an entire area of the shape maintaining device **107**. In this case, the shape maintaining part **105** may control the shape of the deformable part **104***c*

to another shape or another flexibility while the shape maintaining part **105** collectively controls the deformable part **104***c*.

[0218] FIG. **21** illustrates the shape maintaining part **165** of FIG. **16**.

[0219] Referring to FIG. **21**, a plurality of shape maintaining devices **117***a* and **117***b* may be sequentially arranged in an area of the shape maintaining part **165**.

[0220] The shape maintaining part **165** may collectively control the deformable part **104***c* by using the plurality of shape maintaining devices **117***a* and **117***b*.

[0221] The shape maintaining part **165** may receive different electrical signals with respect to the plurality of shape maintaining devices **117***a* and **117***b* and may control a portion of a shape of the deformable part **104***c*. For example, when a remaining power is insufficient and thus there is a demand for power-saving, the flexible device **10** may apply an electrical signal only to the shape maintaining devices **117***b* from among the plurality of shape maintaining devices **117***a* and **117***b*.

[0222] The flexible device **10** may apply different electrical signals to the plurality of shape maintaining devices **117***a* and **117***b*, respectively, and thus may allow the flexible display **104** to be smoothly folded or unfolded according to an unfolding angle of the flexible display **104** while the deformable part **104***c* maintains a curved shape.

[0223] Compared to the shape maintaining part **105** of FIG. **20**, when the shape maintaining part **165** receives different electrical signals and thus controls a shape of the deformable part **104***c*, the shape maintaining part **165** may further precisely divide and control an area of the shape of the deformable part **104***c*.

[0224] FIG. **22** illustrates the shape maintaining part **145** of FIG. **19**.

[0225] Referring to FIG. **22**, the shape maintaining part **145** may not be positioned at a folded center of the flexible device **10**. The shape maintaining part **145** may be arranged at only one of the first housing and the second housing.

[0226] Referring to FIG. **22**, the shape maintaining device **147** is seamlessly arranged in an entire area of the shape maintaining part **145**. Alternatively, as shown in FIG. **21**, the shape maintaining device **147** may be disposed in some areas of the shape maintaining part **145**.

[0227] When the shape maintaining device **147** is arranged in the entire area, the shape maintaining part **145** may collectively control the deformable part **104***c*. When the shape maintaining part **145** receives an electrical signal from the electrical signal applier **330**, the shape maintaining part **145** may maintain a shape of an entire area of the deformable part **104***c*.

[0228] The shape maintaining part **145** may receive a plurality of electrical signals and may apply different electrical signals to some areas of an entire area of the shape maintaining device **147**. In this case, the shape maintaining part **145** may control the shape of the deformable part **104***c* to another shape or another flexibility while the shape maintaining part **145** collectively controls the deformable part **104***c*.

[0229] FIG. **23** illustrates a process of sensing a folding motion of the flexible display **104**, according to an exemplary embodiment.

[0230] Referring to FIG. **23**, the flexible device **10** may sense in real-time a motion for unfolding or folding the flexible display **104** by measuring an unfolding angle **2301**. The flexible device **10** may measure the unfolding angle **2301** of the flexible display **104** by using embedded folding sensors.

[0231] FIG. **24**A illustrates a process of sensing a folding motion of the flexible display **104**, the process performed by a sensing unit, according to an exemplary embodiment.

[0232] Referring to FIG. **24**A, it is assumed that the flexible display **104** may be folded by one folding axis. A folding sensor **2401** of the sensing unit may be arranged at a folding axis of the flexible display **104** and may measure an unfolding angle of the flexible display **104**. The folding axis indicates a line along which the flexible display **104** is folded, and when the flexible display **104** is symmetrically folded, the folding axis may indicate a center line of the flexible display **104**. However, when the flexible display **104** is asymmetrically folded, the folding axis may not indicate the center line of the flexible display **104**.

[0233] FIG. **24**B illustrates a process of sensing a folding motion of the flexible display **104**, the process performed by a sensing unit, according to another exemplary embodiment.

[0234] Referring to FIG. **24**B, similar to FIG. **24**A, it is assumed that the flexible display **104** may be folded by one folding axis. However, unlike from the folding sensor **2401** of FIG. **23**A, a pair of folding sensors **2402** of the sensing unit shown in FIG. **24**B may not be positioned at the folding axis of the flexible display **104** but may be positioned at both ends of the flexible display **104**, respectively, and may measure an unfolding angle of the flexible display **104**. Here, the pair of folding sensors **2402** of the sensing unit may measure the unfolding angle of the flexible display **104** by measuring a distance between the pair of folding sensors **2402**. In this regard, the pair of folding sensors **2402** may be embodied as infrared sensors for distance measurement.

[0235] FIG. **25**A illustrates a process of sensing a folding motion of the flexible display **104**, the process performed by a sensing unit, according to another exemplary embodiment.

[0236] Referring to FIG. **25**A, it is assumed that the flexible display **104** may be folded by a plurality of folding axes (e.g., two folding axes). Two folding sensors **2501** may be positioned at the two folding axes of the flexible display **104**, respectively, and may measure an unfolding angle of the flexible display **104**.

[0237] FIG. **25**B illustrates a process of sensing a folding motion of the flexible display **104**, the process performed by a sensing unit, according to another exemplary embodiment.

[0238] Referring to FIG. **25**B, it is assumed that the flexible display **104** may be folded by a plurality of folding axes (e.g., two folding axes), as shown in FIG. **25**A. However, unlike from the folding sensors **2501** of FIG. **25**A, two pairs of folding sensors **2502** and **2503** of the sensing unit shown in FIG. **25**B may be positioned at both ends of each of the folding axes of the flexible display **104**, and may measure unfolding angles of the flexible display **104**. Here, the two pairs of folding sensors **2502** and **2503** of the sensing unit may measure the respective unfolding angles of the flexible display **104** by using respective distances between the pair of folding sensors **2502** and between the pair of folding sensors **2503**. In this regard, the pair of folding sensors **2502** and **2503** may be embodied as infrared sensors for distance measurement.

[0239] FIG. **26** illustrates a process of sensing a folding motion of the flexible display **104**, the process performed by a sensing unit, according to another exemplary embodiment.

[0240] Referring to FIG. **26**, the sensing unit may collect changes in a value of a sensor point where a folding sensor **2601** is positioned.

[0241] Referring to (a) of FIG. **26**, the folding sensor **2601** may sense a bending curvature at the sensor point. For example, the folding sensor **2601** may sense the bending curvature from +180 degrees through −180 degrees. Comparing to (b) of FIG. **26**, a plurality of folding sensors **2602**, **2603**, and **2604** arranged at preset intervals may sense bending curvatures at sensor points, respectively.

[0242] FIGS. **27**A through **27**C illustrate a procedure of controlling the flexible display **104** of the flexible device **10** including the shape maintaining part **105** of FIG. **20**, the procedure performed by the flexible device **10**, according to an exemplary embodiment.

[0243] As illustrated in FIG. **27**A, the flexible device **10** may include the shape maintaining part **105** having the shape maintaining device **107** arranged in an entire area of the shape maintaining part **105**.

[0244] The shape maintaining part **105** that is tightly attached to a rear surface of the deformable part **104***c* of the flexible display **104** may receive an electrical signal from the electrical signal applier **330** and thus may be activated. In more detail, an area that is from among the entire area of the shape maintaining part **105** and to which the electrical signal is applied from the electrical signal applier **330** may become an active area, and another area of the entire area to which the electrical signal is not applied may become an inactive area.

[0245] The active area of the shape maintaining part **105** may maintain its preset shape and thus may maintain a shape of the deformable part **104***c* to which the active area is tightly attached. The inactive area of the shape maintaining part **105** may be in a flexible state and thus may be deformed according to a shape of the deformable part **104***c* to which the inactive area is attached.

[0246] The flexible device **10** may allow the electrical signal applier **330** to apply an electrical signal to an entire area or some areas of the shape maintaining part **105**, and thus may control the shape of the deformable part **104***c* attached to the shape maintaining part **105**. The flexible device **10** may control the shape of the deformable part **104***c* to be flat, or may control the flexible display **104** to be smoothly unfolded or folded according to an unfolding angle of the flexible display **104** while the deformable part **104***c* maintains a curved shape. The flexible device **10** may control the shape and flexibility of the deformable part **104***c*.

[0247] In more detail, FIGS. **27**B and **27**C illustrate examples of an active area and an inactive area of the shape maintaining part **105** according to unfolding angles of the flexible display **104**.

[0248] The more the flexible display **104** is unfolded, the wider the area of the shape maintaining part **105** to which an electrical signal is applied by the flexible device **10**. In more detail, the flexible device **10** may measure an unfolding angle of the flexible display **104**, may determine a position and area of an active area of the shape maintaining part **105** according to the unfolding angle, and may apply the electrical signal to the determined active area.

[0249] For example, as the unfolding angle of the flexible display **104** is increased, the flexible device **10** may apply an electrical signal to a wider area of the shape maintaining part **105**.

[0250] When the unfolding angle of the flexible display **104** is less than 45 degrees, the flexible device **10** may block an electrical signal with respect to the entire area of the shape maintaining part **105**, and when the unfolding angle of the flexible display **104** is equal to or greater than 45 degrees, the flexible device **10** may apply the electrical signal to an area of the shape maintaining part **105**.

[0251] Referring to (a) of FIG. **27**B, when the unfolding angle of the flexible display **104** is 45 degrees, the flexible device **10** may apply an electrical signal to some areas of the shape maintaining part **105** that are close to fixed parts of the flexible display **104**. Some areas of the shape maintaining part **105** to which the electrical signal was applied become active areas, and other areas of the shape maintaining part **105** become inactive areas. The active areas may be symmetrical with respect to a folding axis of the flexible display **104**.

[0252] Referring to (b) of FIG. **27**B, when the unfolding angle of the flexible display **104** is 90 degrees, the flexible device **10** may apply an electrical signal to some wider areas of the shape maintaining part **105**, and thus active areas may be enlarged. Referring to (c) of FIG. **27**B, when the unfolding angle of the flexible display **104** is 135 degrees, the flexible device **10** may apply an electrical signal to some wider areas of the shape maintaining part **105**, and thus active areas may be further enlarged.

[0253] Referring to (d) of FIG. **27**B, when the flexible display **104** is completely unfolded and thus the unfolding angle of the flexible display **104** is 180 degrees, the flexible device **10** may apply an electrical signal to the entire area of the shape maintaining part **105**, so that the entire area of the shape maintaining part **105** may become a whole active area. The active area may maintain a preset shape and thus may control the shape of the deformable part **104***c* so as to maintain flatness and flexibility of an attached area of the deformable part **104***c*.

[0254] Referring to FIG. **27**C, when an unfolding angle of the flexible display **104** is equal to or greater than 45 degrees, the flexible device **10** may apply an electrical signal to some areas of the shape maintaining part **105** that are close to a folding axis of the flexible display **104**. Some areas of the shape maintaining part **105** to which the electrical signal was applied become active areas that are symmetrical with respect to the folding axis of the flexible display **104**.

[0255] As shown in (b) and (c) of FIG. **27**C, when unfolding angles of the flexible display **104** are increased to 90 degrees and 135 degrees, the flexible device **10** may apply an electrical signal to some wider areas of the shape maintaining part **105**.

[0256] Referring to (d) of FIG. **27**C, when the flexible display **104** is completely unfolded and thus the unfolding angle of the flexible display **104** is 180 degrees, the flexible device **10** may apply an electrical signal to an entire area of the shape maintaining part **105**, so that the entire area of the shape maintaining part **105** may become a whole active area. The active area may maintain a preset shape and thus may control the shape of the deformable part **104***c* so as to maintain flatness and flexibility of an attached area of the deformable part **104***c*.

[0257] The flexible device **10** may determine a position and area of an active area of the shape maintaining part **105** according to the unfolding angle of the flexible display **104**, and thus may control the flexible display **104** to be smoothly

unfolded or folded while the deformable part **104***c* of the flexible display **104** maintains its curved shape.

[0258] FIGS. **28**A through **28**C illustrate a procedure of controlling the flexible display **104** of the flexible device **10** including the shape maintaining part **165** of FIG. **21**, the procedure performed by the flexible device **10**, according to another exemplary embodiment.

[0259] As illustrated in FIG. **28**A, the flexible device **10** may include the shape maintaining part **165** including the shape maintaining devices **117** that are arranged in some areas of the shape maintaining part **165**.

[0260] The shape maintaining part **165** that is tightly attached to a rear surface of the deformable part **104***c* of the flexible display **104** may receive an electrical signal from the electrical signal applier **330** and thus may be activated. In more detail, an area from among an entire area of the shape maintaining part **165** in which the shape maintaining devices **117** having received the electrical signal from the electrical signal applier **330** are arranged may become an active area, and another area of the entire area may become an inactive area. The inactive area may include areas in which the shape maintaining devices **117** are not arranged and areas in which the shape maintaining devices **117** to which the electrical signal is blocked are arranged.

[0261] The active area of the shape maintaining part **165** may maintain a preset shape and thus may maintain a shape of the deformable part **104***c* that is tightly attached to the active area. The inactive area of the shape maintaining part **165** may be in a flexible state, and may be deformed according to a shape of the deformable part **104***c* that is attached to the inactive area.

[0262] The flexible device **10** may allow the electrical signal applier **330** to apply an electrical signal to some areas of the shape maintaining part **165**, and thus may control the shape of the deformable part **104***c* attached to the shape maintaining part **165**. The flexible device **10** may control the shape of the deformable part **104***c* to be flat, or may control the flexible display **104** to be smoothly unfolded or folded according to an unfolding angle of the flexible display **104** while the deformable part **104***c* maintains a curved shape.

[0263] In more detail, FIGS. **28**B and **28**C illustrate examples of an active area and an inactive area of the shape maintaining part **165** according to unfolding angles of the flexible display **104**.

[0264] When the flexible display **104** is unfolded, the flexible device **10** may apply an electrical signal to a wider area of the shape maintaining part **165**. In more detail, the flexible device **10** may measure unfolding angles of the flexible display **104**, may determine, according to the unfolding angles, whether or not to apply an electrical signal to each of areas in which the shape maintaining devices **117** in the form of bars are arranged, and may apply the electrical signal.

[0265] For example, as the unfolding angle of the flexible display **104** is increased, the flexible device **10** may apply an electrical signal to the shape maintaining devices **117** in wider areas.

[0266] When the unfolding angle of the flexible display **104** is less than 45 degrees, the flexible device **10** may block an electrical signal with respect to the entire area of the shape maintaining part **165**, and when the unfolding angle of the flexible display **104** is equal to or greater than 45 degrees, the flexible device **10** may apply the electrical signal to some shape maintaining devices **117** in the shape maintaining part **165**.

[0267] Referring to (a) of FIG. **28**B, when the unfolding angle of the flexible display **104** is 45 degrees, the flexible device **10** may apply an electrical signal to some shape maintaining devices **117** that are close to fixed parts of the flexible display **104**. Some areas in which the shape maintaining devices **117** that received the electrical signal are arranged become active areas, and other areas become inactive areas. In this regard, the active areas may be symmetrical with respect to a folding axis of the flexible display **104**.

[0268] Referring to (b) of FIG. **28**B, when the unfolding angle of the flexible display **104** is 90 degrees, the flexible device **10** may apply an electrical signal to the increased number of the shape maintaining devices **117** in the shape maintaining part **165**, and the active areas may be enlarged. Referring to (c) of FIG. **28**B, when the unfolding angle of the flexible display **104** is 135 degrees, the flexible device **10** may apply an electrical signal to the further-increased number of the shape maintaining devices **117**, and the active areas may be further enlarged.

[0269] Referring to (d) of FIG. **28**B, when the flexible display **104** is completely unfolded and thus the unfolding angle of the flexible display **104** is 180 degrees, the flexible device **10** may apply an electrical signal to all of the shape maintaining devices **117** in the shape maintaining part **165**, and all areas in which the shape maintaining devices **117** are arranged may become the active areas. The active areas may maintain a preset shape and thus may control the shape of the deformable part **104***c* so as to maintain flatness and flexibility of an attached area of the deformable part **104***c*.

[0270] Referring to FIG. **28**C, when an unfolding angle of the flexible display **104** is equal to or greater than 45 degrees, the flexible device **10** may apply an electrical signal to some shape maintaining devices **117** that are close to fixed parts of the flexible display **104**. Some areas in which the shape maintaining devices **117** that received the electrical signal are arranged become active areas, and in this regard, the active areas may be symmetrical with respect to a folding axis of the flexible display **104**.

[0271] As shown in (b) and (c) of FIG. **28**C, when unfolding angles of the flexible display **104** are increased to 90 degrees and 135 degrees, the flexible device **10** may apply an electrical signal to the shape maintaining devices **117** in wider areas.

[0272] Referring to (d) of FIG. FIG. **28**C, when the flexible display **104** is completely unfolded and thus the unfolding angle of the flexible display **104** is 180 degrees, the flexible device **10** may apply an electrical signal to all of the shape maintaining devices **117** in the shape maintaining part **165**, so that all areas in which the shape maintaining devices **117** are arranged may become active areas. Here, areas in which the shape maintaining devices **117** are not arranged may become inactive areas. The active areas may maintain a preset shape and thus may control the shape of the deformable part **104***c* so as to maintain flatness and flexibility of an attached area of the deformable part **104***c*. In this regard, since the inactive areas having flexibility exist between the active areas, the flexible display **104** may be smoothly unfolded or folded while the deformable part **104***c* of the flexible display **104** maintains its curved shape.

[0273] FIGS. **29**A and **29**B illustrate a procedure of controlling the flexible display **104** of the flexible device **10** including the shape maintaining part **145** of FIG. **22**, the procedure performed by the flexible device **10**, according to another exemplary embodiment.

[0274] As illustrated in FIG. **29**A, the flexible device **10** may include the shape maintaining part **145** at a portion of the flexible display **104** that is asymmetrical with respect to a folding axis of the flexible display **104**. The shape maintaining part **145** that is tightly attached to a rear surface of the deformable part **104***c* of the flexible display **104** may be arranged at only one of a first housing and a second housing.

[0275] The shape maintaining part **145** may include the shape maintaining device **147** that is seamlessly arranged in an entire area of the shape maintaining part **145**.

[0276] FIG. **29**B illustrates an example of an active area and an inactive area of the shape maintaining part **145** according to unfolding angles of the flexible display **104**.

[0277] When the flexible display **104** is unfolded, the flexible device **10** may apply an electrical signal to a wider area of the shape maintaining part **145**. In more detail, the flexible device **10** may measure an unfolding angle of the flexible display **104**, may determine a position and area of an active area of the shape maintaining part **145** according to the unfolding angle, and may apply the electrical signal to the determined active area.

[0278] Referring to (a) of FIG. **29**B, when the unfolding angle of the flexible display **104** is 45 degrees, the flexible device **10** may apply an electrical signal to some areas of the shape maintaining part **145** that are close to a folding axis of the flexible display **104**. Some areas of the shape maintaining part **145** to which the electrical signal was applied may become active areas, and other areas of the shape maintaining part **145** may become inactive areas.

[0279] Referring to (b) of FIG. **29**B, when the unfolding angle of the flexible display **104** is 90 degrees, the flexible device **10** may apply an electrical signal to some wider areas of the shape maintaining part **145**, and thus active areas may be enlarged. Referring to (c) of FIG. **29**B, when the unfolding angle of the flexible display **104** is 135 degrees, the flexible device **10** may apply an electrical signal to some wider areas of the shape maintaining part **145**, and thus active areas may be further enlarged.

[0280] Referring to (d) of FIG. **29**B, when the flexible display **104** is completely unfolded and thus the unfolding angle of the flexible display **104** is 180 degrees, the flexible device **10** may apply an electrical signal to the entire area of the shape maintaining part **145**, so that the entire area of the shape maintaining part **145** may become a whole active area. The active area may maintain a preset shape and thus may control the shape of the deformable part **104***c* so as to maintain flatness and flexibility of an attached area of the deformable part **104***c*.

[0281] Even if the shape maintaining part **145** is arranged at only one side of the flexible display **104** with respect to a central axis of the flexible display **104**, the flexible device **10** may maintain flatness and flexibility by controlling the shape of the flexible display **104** by using the shape maintaining part **145**, or may allow, by controlling the shape of the flexible display **104**, the flexible display **104** to be smoothly unfolded or folded while the deformable part **104***c* of the flexible display **104** maintains its curved shape.

[0282] FIG. **30** is an exploded perspective view of the flexible device **10**, according to an exemplary embodiment.

[0283] Referring to FIG. **30**, the flexible device **10** may include the flexible display **104**, the shape maintaining part **105**, and the housing **100**.

[0284] The housing **100** that corresponds to a body of the flexible device **10** may include the first housing **101**, the second housing **102**, and the connecting part **103**. The first housing **101** may include an exterior case **101***a* and a support plate **101***b* for supporting internal devices and a display (i.e. a display panel). Likewise, the second housing **102** may include an exterior case **102***a* and a support plate **102***b*. In addition, the housing **100** may include, in the first housing **101** or the second housing **102**, the sensing unit **320**, the electrical signal applier **330**, a controller (not shown), etc. that correspond to internal configurations of the flexible device **10**.

[0285] The connecting part **103** that connects the first housing **101** and the second housing **102** may be variously embodied. For example, the connecting part **103** may include the hinge **113***a* including a cylindrical axis and thus may be embodied to be foldable with respect to the axis of the hinge **113***a*.

[0286] The first part **104***a* and the second part **104***b* of the flexible display **104** may be supported by the first housing **101** and the second housing **102**, respectively, in a manner that the first part **104***a* and the second part **104***b* are bonded to the first housing **101** and the second housing **102** by using a bonding element such as a bonding material.

[0287] The deformable part **104***c* of the flexible display **104** may not be supported by the housing **100**. The deformable part **104***c* may be neither attached to the first housing **101** and the second housing **102** nor attached to the connecting part **103** but may only depend on its connection with the first part **104***a* and the second part **104***b* of the flexible display **104**. Alternatively, the deformable part **104***c* of the flexible display **104** may be supported by the shape maintaining part **105** arranged on a rear surface of the deformable part **104***c*.

[0288] The shape maintaining part **105** may be bonded to a rear surface of the deformable part **104***c*. A shape of the shape maintaining part **105** that does not receive an electrical signal from the electrical signal applier **330** may be changed according to a shape of the bonded deformable part **104***c*. When the flexible display **104** is folded, the shape maintaining part **105** may receive an electrical signal from the electrical signal applier **330** and thus may maintain a preset shape.

[0289] FIG. **31** is a block diagram illustrating a configuration of the flexible device **10** of FIG. **30**, according to an exemplary embodiment.

[0290] Referring to FIGS. **31** and **30**, the flexible device **10** may include a flexible display **310**, the sensing unit **320**, the electrical signal applier **330**, and a controller **340**. With reference to FIG. **31**, elements related to one or more exemplary embodiments are described so as to prevent the inventive concept from being obscured. In this regard, it is obvious to one of ordinary skill in the art that the flexible device **10** may further include general-use hardware elements as well as hardware elements shown in FIG. **31**.

[0291] The flexible display **310** is a hardware element that displays information processed in the flexible device **10**. The flexible device **10** may provide a user interface screen to a user via the flexible display **310**. The flexible display **310** according to one or more exemplary embodiments may be

one of different displays such as a foldable display, a bendable display, a rollable display, etc., that are deformable due to an external force.

[0292] The flexible display **310** may include a first part and a second part that are non-deformable fixed parts, and a deformable part that is foldable. For example, the first part and the second part may be supported by a first housing and a second housing, respectively.

[0293] When the flexible device **10** is folded, the deformable part is deformed and thus allows the flexible display **310** to be folded. The deformable part may not be sharply bent but may be deformed with a gently-curved shape so as to prevent damage to the flexible display **310**. The deformable part may be deformed while maintaining the curved shape by using an enclosure space formed by the housing **100**.

[0294] The deformable part may be supported by the shape maintaining part **105** shown in FIG. **30**. In more detail, by using the controller **340**, the flexible device **10** may control a shape of the shape maintaining part **105** and may control a shape of the deformable part of the flexible display **310** tightly attached to the shape maintaining part **105**.

[0295] The sensing unit **320** is formed of sensors and senses a level of deformation of the flexible device **10** or the flexible display **310** that is foldable. The sensing unit **320** may sense a deformation scale of the flexible device **10** or the flexible display **310** while the flexible device **10** or the flexible display **310** is deformed. Since the flexible display **310** is deformed to conform to a shape of the flexible device **10**, the level of deformation of the flexible device **10** may correspond to a level of deformation of the flexible display **310**.

[0296] The sensing unit **320** may sense conversion from a folding state of the flexible device **10** or the flexible display **310** to an unfolding state of the flexible device **10** or the flexible display **310**, and may sense an unfolding angle or an unfolding curvature of the flexible device **10** or the flexible display **310**. That is, the sensing unit **320** may sense an unfolding motion of the flexible device **10** or the flexible display **310**. Likewise, the sensing unit **320** may sense shape conversion from the folding state of the flexible device **10** or the flexible display **310** to the unfolding state of the flexible device **10** or the flexible display **310**. That is, the sensing unit **320** may sense a folding motion of the flexible device **10** or the flexible display **310**. Here, for convenience of description with respect to one or more exemplary embodiments, only the unfolding angle is described, but even when the unfolding curvature is sensed by the sensing unit **320**, one or more exemplary embodiments may be applied thereto and may operate, likewise to the unfolding angle.

[0297] When the flexible display **310** is a bendable display, the sensing unit **320** may sense a bending curvature indicating a bending level of the bendable display. When the flexible display **310** is a rollable display, the sensing unit **320** may sense a rolling level of the rollable display. That is, according to types of the flexible display **310**, the sensing unit **320** may sense various deformation states corresponding to the types of the flexible display **310**.

[0298] The electrical signal applier **330** applies an electrical signal to the shape maintaining part **105** shown in FIG. **30**, and thus makes all or some areas of the shape maintaining part **105** as an active state or an inactive state.

[0299] The electrical signal applier **330** may apply the electrical signal to all or some areas of the shape maintaining part **105** that are determined by the controller **340**. All or some areas of the shape maintaining part **105** to which the electrical signal is applied become an active area, and the active area of the shape maintaining part **105** may maintain a preset shape.

[0300] The controller **340** is a hardware configuration embodied at least one processor such as a central processing unit (CPU), an application processor (AP), or the like, and controls general operations of the flexible device **10**.

[0301] The controller **340** may receive, from the sensing unit **320**, an unfolding angle of the flexible display **310** that indicates a deformation state of the flexible display **310**. Based on the received unfolding angle, the controller **340** may determine an area of the shape maintaining part **105** to which an electrical signal is to be applied and that corresponds to the unfolding angle.

[0302] For example, the controller **340** determines whether the unfolding angle is equal to or greater than a preset reference angle. When the unfolding angle is less than the preset reference angle, the controller **340** may determine to block the electrical signal with respect to the shape maintaining part **105**, and when the unfolding angle is equal to or greater than the preset reference angle, the controller **340** may determine to apply the electrical signal to all or some areas of the shape maintaining part **105**.

[0303] As the unfolding angle is increased, the controller **340** may determine to apply the electrical signal to a wider area of the shape maintaining part **105**. The controller **340** may determine positions and an area of some areas of the shape maintaining part **105** that correspond to the unfolding angle.

[0304] The controller **340** may control the electrical signal applier **330** to apply an electrical signal to all or some determined areas of the shape maintaining part **105**.

[0305] Likewise, when the flexible display **310** is a bendable display or a rollable display, the controller **340** may determine some areas of the shape maintaining part **105** that correspond to a bending curvature or a rolling curvature.

[0306] FIG. **32** is a block diagram illustrating a configuration of the flexible device **10**, according to another exemplary embodiment.

[0307] Referring to FIG. **32**, the flexible device **10** may include a user input unit **3210**, an output unit **3220**, a communication unit **3230**, a sensing unit **3240**, a memory **3250**, a controller **3260**, and an electrical signal applier **3270**.

[0308] The user input unit **3210** may include a touch recognition module **3211**, a motion recognition module **3212**, a key recognition module **3213**, and a voice recognition module **3214**, the output unit **3220** may include a display unit **3221**, a sound output module **3222**, and an alarm unit **3223**, and the communication unit **3230** may include a short-distance communication module **3231**, a wireless internet module **3232**, a mobile communication module **3233**, a wired internet module **3234**. With reference to FIG. **32**, hardware elements related to one or more exemplary embodiments are described so as to prevent the inventive concept from being obscured. In this regard, it is obvious to one of ordinary skill in the art that the flexible device **10** may further include general-use hardware elements as well as hardware elements shown in FIG. **32** or may exclude some of the hardware elements shown in FIG. **32**, according to a type of the flexible device **10**.

[0309] The user input unit **3210** may indicate a hardware configuration used by a user to input information to control the flexible device **10**. For example, the user input unit **3210** may be embodied a key pad, a dome switch, a touch pad, a jog wheel, a jog switch, or the like.

[0310] The touch recognition module **3211** may sense a touch gesture or a touch input by the user, and may deliver information about the sensed touch gesture or the sensed touch input to the controller **3260**.

[0311] The touch recognition module **3211** may include various sensors so as to sense a touch or a proximity touch. In order to sense the touch gesture or the touch input, the touch recognition module **3211** may be embodied as a touch capacitive type sensor, a pressure resistive type sensor, an infrared beam sensing type sensor, a surface acoustic wave type sensor, an integral strain gauge type sensor, a piezo effect type sensor, etc.

[0312] The touch recognition module **3211** may sense the proximity touch by using a proximity sensor. The proximity sensor senses the existence of an object that approaches a predetermined detection surface or that exists nearby, by using a force of an electro-magnetic field or an infrared ray, instead of a mechanical contact. Examples of the proximity sensor include a transmission-type photoelectric sensor, a direction reflection-type photoelectric sensor, a mirror reflection-type photoelectric sensor, a high frequency oscillation-type proximity sensor, a capacity-type proximity sensor, a magnetic proximity sensor, an infrared-type proximity sensor, or the like.

[0313] The touch gesture or the touch input by the user may include a tap gesture, a touch & hold gesture, a double tap gesture, a drag gesture, a panning gesture, a flick gesture, a drag & drop gesture, or the like.

[0314] The touch recognition module **3211** and the display unit **3221** may form a mutual layer structure and then may be formed as a touch screen. That is, the flexible display **310** described with reference to FIG. **31** may be embodied as a touchscreen hardware structure including the touch recognition module **3211** and the display unit **3221**.

[0315] The motion recognition module **3212** may recognize a motion of the flexible device **10**, and may deliver information about the motion of the flexible device **10** to the controller **3260**. The motion recognition module **3212** may not recognize deformation of the flexible device **10** but may recognize a motion such as three-dimensional (3D) movement or rotation of the flexible device **10**.

[0316] The motion recognition module **3212** may include various sensors to recognize the motion of the flexible device **10**. For example, the motion recognition module **3212** may include an acceleration sensor, a tilt sensor, a gyro sensor, a 3-axis magnetic sensor, etc.

[0317] Examples of a motion input that is recognizable to the motion recognition module **3212** may include a 3D motion input by which the flexible device **10** is moved in X, Y, and Z-axes, a rotational motion input by which the flexible device **10** is rotated in at least one direction in a 3D space, a shaking motion input by which the flexible device **10** is shaken in at least one direction, a tilting motion input by which the flexible device **10** tilts in a preset direction, or the like.

[0318] The key recognition module **3213** may recognize a user's command input via a hardware key (e.g., a directional key, a letter key, a mouse, etc.). The voice recognition module **3214** may recognize a user's voice by using a voice recognition engine and may deliver a recognized voice to the controller **3260**.

[0319] The output unit **3220** indicates a hardware configuration to output an audio signal, a video signal, or an alarm signal.

[0320] The display unit **3221** is a display interfacing unit for displaying, to a user, various types of information such as information that is processed in the flexible device **10** or information that is to be processed in the flexible device **10**. The display unit **3221** may display a graphical user interface (GUI) for visually and intuitionally providing the user with a plurality of pieces of information processed in the flexible device **10**. The flexible display **310** described with reference to FIG. **31** has a function of the display unit **3221**. Alternatively, the flexible display **310** of FIG. **31** may be embodied as a touchscreen hardware structure including the touch recognition module **3211** and the display unit **3221**.

[0321] The sound output module **3222** may output audio data that is received from the communication unit **3230** or is stored in the memory **3250**. The sound output module **3222** may include a speaker, a buzzer, or the like.

[0322] The alarm unit **3223** may generate a signal for notifying the user about an occurrence of an event in the flexible display **310**. The alarm unit **3223** may output the signal for notifying the user about the occurrence of the event by using at least one of an audio signal, a video signal, and a vibration signal.

[0323] The communication unit **3230** indicates a hardware configuration to communicate with an external network or an external device.

[0324] The short-distance communication module **3231** indicates a module for short-distance communication. Examples of a short-distance communication technology may include Bluetooth, Ultra Wideband (UWB), ZigBee, near field communication (NFC), Wi-Fi Direct (WFD), infrared Data Association (IrDA), or the like.

[0325] The wireless internet module **3232** indicates a module for accessing wireless internet. The mobile communication module **3233** indicates a module for communicating with a mobile communication network. The wired internet module **3234** indicates a module for accessing wired internet.

[0326] The sensing unit **3240** may sense a deforming motion of the flexible device **10** or the flexible display **310**, and may deliver information about a sensed deforming motion to the controller **3260**. The sensing unit **3240** may sense a deformation state of the flexible device **10** or the flexible display **310** which occurs after the flexible device **10** is opened for use. The sensing unit **3240** may sense the deforming motion of the flexible device **10** by collecting and analyzing the information about the sensed deforming motion by using at least one sensor. In this regard, as described above, the deforming motion may include a folding motion, a bending motion, an unfolding motion, an unbending motion, a rolling motion, or the like. The sensing unit **3240** corresponds to the sensing unit **320** of FIG. **31**.

[0327] Regarding the deforming motion, the sensing unit **3240** may obtain information about a deformation position (a coordinates value and a deformed line), a deformation direction, a deformation angle, a deformation curvature, a deformation strength, a deformation speed, a number of times of deformation, an occurrence time of the deforming motion, a maintaining time period of the deforming motion,

or the like. The sensing unit **3240** may be embodied as a load cell, a bending sensor, an infrared sensor, a pressure sensor, an electromagnetic sensor, or the like.

[0328] The sensing unit **3240** may sense a folding motion and a folding angle of the flexible display **310** via procedures described with reference to FIGS. **24**A through **25**B.

[0329] The memory **3250** may indicate a hardware configuration to store a plurality of pieces of information processed in the flexible device **10**, and may be embodied as a hard disk drive (HDD), a solid-state drive (SDD), a random-access memory (RAM), a read-only memory (ROM), or the like. For example, the memory **3250** may store a plurality of pieces of general information about a user interface to be displayed via the flexible display **310**.

[0330] The controller **3260** may indicate a hardware configuration to control general operations and functions of the flexible device **10**, and may be embodied as at least one processor such as a CPU, an AP, or the like. The controller **340** of FIG. **31** may correspond to the controller **3260**.

[0331] The electrical signal applier **3270** may control a shape of the shape maintaining part **105** in a manner that the electrical signal applier **3270** applies an electrical signal to the shape maintaining part **105** of FIG. **30** and thus makes all or some areas of the shape maintaining part **105** as an active state or an inactive state.

[0332] FIG. **33** is a flowchart of a method of controlling flexibility of the flexible display **104**, the method performed by the flexible device **10** of FIG. **30**, according to an exemplary embodiment.

[0333] Referring to FIGS. **30** and **33**, in operation **3301**, the flexible device **10** may sense a deformation state of the flexible display **104**.

[0334] The flexible device **10** may sense the deformation state of the flexible display **104** by referring to an unfolding angle of the flexible display **104** that is sensed by a sensing unit.

[0335] In operation **3302**, based on the sensed deformation state, the flexible device **10** may apply an electrical signal to the shape maintaining part **105** that controls flexibility of the deformable part **104***c* of the flexible display **104**.

[0336] The flexible device **10** may determine, based on the sensed deformation state, all or some areas of the shape maintaining part **105** to which the electrical signal is to be applied, and may apply the electrical signal to at least one determined area of the shape maintaining part **105**.

[0337] For example, when the flexible device **10** is completely folded, the flexible device **10** may block an electrical signal with respect to all areas of the shape maintaining part **105**, so that a shape of the shape maintaining part **105** may be deformed according to a shape of the deformable part **104***c*. When the flexible device **10** is completely unfolded, the flexible device **10** may apply an electrical signal to all areas of the shape maintaining part **105**, so that the shape maintaining part **105** may maintain a preset shape of the shape maintaining part **105**. The flexible device **10** may control, by using the shape maintaining part **105**, a shape and flexibility of the deformable part **104***c* tightly attached to the shape maintaining part **105**.

[0338] According to an unfolding angle indicating the deformation state of the flexible device **10**, the flexible device **10** may vary a position and area of at least one area of the shape maintaining part **105** to which an electrical signal is applied, so that the flexible display **104** may be smoothly folded or unfolded.

[0339] FIG. **34** is a flowchart of a method of controlling flexibility of the flexible display **104**, the method performed by the flexible device **10** of FIG. **30**, according to another exemplary embodiment.

[0340] Referring to FIGS. **30** and **34**, in operation **3401**, the flexible device **10** may sense a deformation state of the flexible display **104**.

[0341] The flexible device **10** may sense the deformation state of the flexible display **104** by referring to an unfolding angle of the flexible display **104** that is sensed by a sensing unit.

[0342] In operation **3402**, the flexible device **10** may determine whether the unfolding angle of the flexible display **104** is equal to or greater than a reference angle.

[0343] In operation **3403**, when the unfolding angle of the flexible display **104** is less than the reference angle, the flexible device **10** may block an electrical signal with respect to the shape maintaining part **105**. In this case, the shape maintaining part **105** may have a flexible status and thus may be deformed according to a shape of the attached deformable part **104***c*.

[0344] In operation **3404**, when the unfolding angle of the flexible display **104** is equal to or greater than the reference angle, the flexible device **10** may determine all or some areas of the shape maintaining part **105** to which an electrical signal is to be applied and that correspond to the unfolding angle.

[0345] In more detail, the flexible device **10** may determine positions and an area of some areas of the shape maintaining part **105** that correspond to the unfolding angle. For example, the flexible device **10** may determine the positions and the area of some areas of the shape maintaining part **105** in such a manner that, as the unfolding angle is increased, an electrical signal may be applied to a wider area of the shape maintaining part **105**.

[0346] In operation **3405**, the flexible device **10** may apply the electrical signal to the determined areas of the shape maintaining part **105**. An active area of the shape maintaining part **105** to which the electrical signal is applied may maintain its preset shape, and thus may maintain a shape of the deformable part **104***c*.

[0347] According to the aforementioned descriptions, when a flexible display is folded, the flexible display may be prevented from being sharply bent and being damaged. When the flexible display is unfolded, flatness of the flexible display may be maintained by using a shape maintaining device. By varying a shape-maintained area according to an unfolding angle of the flexible display, the flexible display may be smoothly folded or unfolded while the flexible display maintains flatness. Since the flatness of the flexible display is maintained, readability for a user may be increased and an error with respect to a touch input by the user may be decreased, and thus, a more accurate user interface manipulation environment may be provided to the user.

[0348] The one or more exemplary embodiments can be written as computer programs and can be implemented in general-use digital computers that execute the programs using a computer readable recording medium. In addition, a data structure used in the one or more exemplary embodiments can be written in a computer readable recording medium through various means. Examples of the computer readable recording medium include magnetic storage media

(e.g., ROM, floppy disks, hard disks, etc.), optical recording media (e.g., CD-ROMs, or DVDs), etc.

[0349] It should be understood that exemplary embodiments described herein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each exemplary embodiment should typically be considered as available for other similar features or aspects in other exemplary embodiments.

[0350] While one or more exemplary embodiments have been described with reference to the figures, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope as defined by the following claims.

1. A flexible device comprising:

a flexible display that has a foldable deformable part;

a housing that is foldable and forms an enclosure space in which the deformable part is enclosed when the flexible display is deformed;

a shape maintaining part that is arranged in the enclosure space so as to control flexibility of the deformable part; and

an electrical signal applier that applies an electrical signal to the shape maintaining part, based on a deformation state of the flexible display.

2. The flexible device of claim **1**, wherein the flexible display comprises a first part, a second part, and the deformable part between the first part and the second part, and

the first part and the second part are fixed to the housing, and the deformable part is not fixed to the housing.

3. The flexible device of claim **1**, wherein the shape maintaining part is arranged on a rear surface of the deformable part in the enclosure space.

4. The flexible device of claim **1**, wherein the shape maintaining part comprises a shape-maintaining device whose shape is deformed according to the electrical signal received from the electrical signal applier.

5. The flexible device of claim **1**, wherein

when the shape maintaining part receives the electrical signal from the electrical signal applier, the shape maintaining part maintains a preset shape, and

when the electrical signal is blocked, a shape of the shape maintaining part is deformed according to a deformed shape of the deformable part having the shape maintaining part arranged on its rear surface.

6. The flexible device of claim **1**, further comprising a sensing unit that senses the deformation state of the flexible display.

7. The flexible device of claim **6**, wherein the sensing unit senses the deformation state of the flexible display by sensing an unfolding angle or an unfolding curvature of the flexible display.

8. The flexible device of claim **1**, wherein the electrical signal applier applies the electrical signal to an area of the shape maintaining part that corresponds to the deformation state of the flexible display.

9. A flexible device comprising:

a flexible display that has a foldable deformable part;

a sensing unit that senses a deformation state of the flexible display;

an electrical signal applier that applies an electrical signal to a shape maintaining part that is arranged on a rear surface of the deformable part in an enclosure space in which the deformable part is enclosed when the flexible display is deformed; and

a controller that controls the electrical signal applier to apply the electrical signal to the shape maintaining part, based on the deformation state.

10. The flexible device of claim **9**, wherein

the sensing unit senses an unfolding angle or an unfolding curvature of the flexible display, and

the controller determines, based on the sensed unfolding angle or the sensed unfolding curvature, whether or not to apply the electrical signal to the shape maintaining part.

11. The flexible device of claim **9**, wherein the controller determines, based on the deformation state, an area of the shape maintaining part to which the electrical signal is to be applied.

12. The flexible device of claim **9**, wherein the controller determines, based on the deformation state, a magnitude of the electrical signal to be applied to an area of the shape maintaining part.

13. A method of controlling flexibility of a foldable deformable part of a flexible display, the method comprising:

sensing a deformation state of flexible display; and

applying, based on the deformation state, an electrical signal to a shape maintaining part that controls the flexibility of the deformable part,

wherein the shape maintaining part is arranged on a rear surface of the deformable part in an enclosure space in which the deformable part is enclosed when the flexible display is deformed.

14. The method of claim **13**, wherein the sensing comprises sensing the deformation state by sensing an unfolding angle or an unfolding curvature of the flexible display.

15. The method of claim **13**, wherein the applying comprises applying the electrical signal to an area of the shape maintaining part that corresponds to the deformation state.

16. The method of claim **13**, wherein the applying comprises:

based on the deformation state, determining whether or not to apply the electrical signal to the shape maintaining part; and

when it is determined to apply the electrical signal, applying the electrical signal to the shape maintaining part.

17. The method of claim **13**, wherein the applying comprises:

based on the deformation state, determining an area of the shape maintaining part to which the electrical signal is to be applied; and

applying the electrical signal to the determined area of the shape maintaining part.

18. The method of claim **13**, wherein the applying comprises:

based on the deformation state, determining a magnitude of the electrical signal to be applied to an area of the shape maintaining part; and

applying the electrical signal having the determined magnitude to the area of the shape maintaining part.

19. A non-transitory computer-readable recording medium having recorded thereon a program for executing the method of claim **13**, by using a computer.

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