## CLAIMS

1. A flexible device comprising:

a flexible body;

a first plurality of piezoelectric materials disposed on the flexible body, the first plurality of piezoelectric materials arranged in rows on the flexible body in a horizontal direction of the flexible device, each of the rows comprising piezoelectric materials of elongated shape in the horizontal direction connected in series;

a second plurality of piezoelectric materials disposed the flexible body, the second plurality of piezoelectric materials arranged in columns on the flexible body in a vertical direction of the flexible device, each of the columns comprising piezoelectric materials of elongated shape in the vertical direction connected in series; and

a controller configured to apply a drive signal selectively to one or more rows of the first plurality of piezoelectric materials or one or more columns of the second plurality of piezoelectric materials in response to detecting an event, causing the one or more rows of the first plurality of piezoelectric materials to deform in the horizontal direction of the flexible device or the one or more columns second plurality of piezoelectric materials to deform in the vertical direction of the flexible device.

2. The flexible device of claim 1, wherein the drive signal comprises a first drive signal and a second drive signal,

wherein the first drive signal drives the one or more rows of the first plurality of piezoelectric materials and the second drive signal drives the one or more columns of the second plurality of piezoelectric materials,

wherein the one or more rows of the first plurality of piezoelectric materials deform in the horizontal direction of the flexible device, in response to application of the first drive signal to the first plurality of piezoelectric materials and the one or more columns of the second plurality of piezoelectric materials deform in the vertical direction of the flexible device, in response to application of the second drive signal to the second plurality of piezoelectric materials.

3. The flexible device of claim 2, wherein the controller divides the first plurality of piezoelectric materials and the second plurality of piezoelectric materials into a plurality of groups based on the rows in which the first plurality of piezoelectric materials and the columns in which the second plurality of piezoelectric materials are disposed, and applies different ones of the first drive signal and the second drive signal to the respective groups to cause the grouped first plurality of piezoelectric materials and the second plurality of piezoelectric materials to locally deform.

4. The flexible device of claim 3, further comprising a display,

wherein the first plurality of piezoelectric materials and the second plurality of piezoelectric materials are disposed on a lower portion of the display,

wherein the controller selectively applies the first drive signal and the second drive signal to the one or more rows of the first plurality of piezoelectric materials and the one or more columns of the second plurality of piezoelectric materials based on a type of the event, and

wherein the controller controls the display to display a user interface (UI) corresponding to a deformation state of the flexible body corresponding to the deformation of the first plurality of piezoelectric materials and the second plurality of piezoelectric materials on the display.

5. The flexible device of claim 1, further comprising

a display; and

at least one biosensor configured to detect a touch of a user arranged on lower side of the display;

wherein the first plurality of piezoelectric materials and the second plurality of piezoelectric materials are disposed between the display and the at least one biosensor, and

wherein the controller selectively applies the first drive signal and the second drive signal to the one or more rows of the first plurality of piezoelectric materials and the one or more columns of the second plurality of piezoelectric materials and controls the display to display a user interface on the display, in response to the at least one biosensor detecting the touch of the user.

6. The flexible device of claim 1, further comprising a non piezoelectric intermediate layer of flexible elastic material disposed on the first plurality of piezoelectric materials,

wherein the first plurality of piezoelectric materials, the intermediate layer, and the second plurality of piezoelectric materials are stacked sequentially on one side of the flexible body.

7. The flexible device of claim 1, wherein a magnitude of the drive signal corresponds to a degree of deformation of the at least one of the first plurality of piezoelectric materials and the second plurality of piezoelectric materials.

8. The flexible device of claim 1, further comprising a detector configured to detect an electric signal generated from one or more piezoelectric materials of the first plurality of piezoelectric materials and the second plurality of piezoelectric materials in response to a deformation of the flexible body,

wherein the controller determines a deformation state of the flexible body based on a change in the electric signal and performs a control operation corresponding to the determined deformation state.

9. A method for operating a flexible device, comprising:

detecting, by a controller of the flexible device, occurrence of an event; and

selectively applying drive signals to a first plurality of piezoelectric materials of a lower piezoelectric layer disposed on a flexible body of the flexible device and a second plurality of piezoelectric materials of upper piezoelectric layer disposed on the first plurality of piezoelectric materials based on the event, the first plurality of piezoelectric materials arranged in rows on the flexible body in a horizontal direction of the flexible device, each of the rows comprising piezoelectric materials of elongated shape in the horizontal direction connected in series and the second plurality of piezoelectric materials arranged in columns on the flexible body in a vertical direction of the flexible device, each of the columns comprising piezoelectric materials of elongated shape in the vertical direction connected in series,

wherein the selectively applied drive signals cause independently controlled deformation of the one or more rows of the first plurality of piezoelectric materials in the horizontal direction of the flexible device or the one or more columns of the second plurality of piezoelectric materials in the vertical direction of the flexible device.

10. The method of claim 10, wherein the selectively applying drive signals comprises:

determining drive signals to apply to the one or more rows of the first plurality of piezoelectric materials and the one or more columns of the second plurality of piezoelectric materials based on the type of the event; and

applying the determined drive signals to the one or more rows of the first plurality of piezoelectric materials and the one or more columns of the second plurality of piezoelectric materials,

wherein the first plurality of piezoelectric materials deform in the horizontal direction of the flexible device in response to application of a first drive signal to the first plurality of piezoelectric materials of the lower piezoelectric layer and the one or more columns of the second plurality of piezoelectric materials deform in the vertical direction of the flexible device, in response to application of the second drive signal to the second plurality of piezoelectric materials of the upper piezoelectric layer.

11. The method of claim 10, wherein the selectively applying comprises:

dividing the first plurality of piezoelectric materials and the second plurality of piezoelectric materials into a plurality of groups based on the rows in which the first plurality of piezoelectric materials and the columns in which the second plurality of piezoelectric materials are disposed; and

applying different ones of the drive signals to the respective groups to cause the grouped first plurality of piezoelectric materials and the second plurality of piezoelectric materials to locally deform.

12. The method of any of claims 10, further comprising displaying a user interface (UI) corresponding to a deformation state of the flexible device corresponding to deformation of the first plurality of piezoelectric materials and the second plurality of piezoelectric materials on a display of the flexible device.

13. The method of claim 10, further comprising

detecting a touch of a user through a biosensor provided on the flexible device;

selectively applying the drive signals to the one or more rows of the first plurality of piezoelectric materials and the one or more columns of second plurality of piezoelectric materials and displaying a user interface on a display of the flexible device, in response to the detecting.

# Claims

[Claim 1] A flexible device comprising:

a flexible body;

a first plurality of piezoelectric materials disposed on the flexible body, the first plurality of piezoelectric materials arranged in rows on the flexible body in a horizontal direction of the flexible device, each of the rows comprising piezoelectric materials of elongated shape in the horizontal direction arranged in series;

a second plurality of piezoelectric materials disposed on the flexible body, the second plurality of piezoelectric materials arranged in columns on the flexible body in a vertical direction of the flexible device, each of the columns comprising piezoelectric materials of elongated shape in the vertical direction arranged in series; and

a flexible display panel supported by the flexible body; and

a controller configured to apply a drive signal selectively to one or more rows of the first plurality of piezoelectric materials or one or more columns of the second plurality of piezoelectric materials in response to detecting an event, causing the one or more rows of the first plurality of piezoelectric materials to deform in the horizontal direction of the flexible device or the one or more columns second plurality of piezoelectric materials to deform in the vertical direction of the flexible device.

[Claim 2] The flexible device of claim 1, wherein the drive signal comprises a first drive signal and a second drive signal,

wherein the first drive signal drives the one or more rows of the first plurality of piezoelectric materials and the second drive signal drives the one or more columns of the second plurality of piezoelectric materials,

wherein the one or more rows of the first plurality of piezoelectric materials deform in the horizontal direction of the flexible device, in response to application of the first drive signal to the first plurality of piezoelectric materials and the one or more columns of the second plurality of piezoelectric materials deform in the vertical direction of the flexible device, in response to application of the second drive signal to the second plurality of piezoelectric materials.

[Claim 3] The flexible device of claim 2, wherein the controller divides the first plurality of piezoelectric materials and the second plurality of piezoelectric materials into a plurality of groups based on the rows in which the first plurality of piezoelectric materials and the columns in which the second

plurality of piezoelectric materials are disposed, and applies different ones of the first drive signal and the second drive signal to the respective groups to cause the grouped first plurality of piezoelectric materials and the second plurality of piezoelectric materials to locally deform.

[Claim 4] The flexible device of claim 3, further comprising a display, wherein the first plurality of piezoelectric materials and the second plurality of piezoelectric materials are disposed on a lower portion of the display,

wherein the controller selectively applies the first drive signal and the second drive signal to the one or more rows of the first plurality of piezoelectric materials and the one or more columns of the second plurality of piezoelectric materials based on a type of the event, and

wherein the controller controls the display to display a user interface (UI) corresponding to a deformation state of the flexible body corresponding to the deformation of the first plurality of piezoelectric materials and the second plurality of piezoelectric materials on the display.

[Claim 5] The flexible device of claim 1, further comprising

a display; and

at least one biosensor configured to detect a touch of a user arranged on lower side of the display,

wherein the first plurality of piezoelectric materials and the second plurality of piezoelectric materials are disposed between the display and the at least one biosensor, and

wherein the controller selectively applies the first drive signal and the second drive signal to the one or more rows of the first plurality of piezoelectric materials and the one or more columns of the second plurality of piezoelectric materials and controls the display to display a user interface on the display, in response to the at least one biosensor detecting the touch of the user.

[Claim 6] The flexible device of claim 1, further comprising a non-piezoelectric intermediate layer of flexible elastic material disposed on the first plurality of piezoelectric materials;

wherein the first plurality of piezoelectric materials, the intermediate layer, and the second plurality of piezoelectric materials are stacked sequentially on one side of the flexible body.

[Claim 7] The flexible device of claim 1, wherein a magnitude of the drive signal corresponds to a degree of deformation of the at least one of the first plurality of piezoelectric materials and the second plurality of piezoelectric materials.

[Claim 8] The flexible device of claim 1, further comprising a detector configured to detect an electric signal generated from one or more piezoelectric materials of the first plurality of piezoelectric materials and the second plurality of piezoelectric materials in response to a deformation of the flexible body,

wherein the controller determines a deformation state of the flexible body based on a change in the electric signal and performs a control operation corresponding to the determined deformation state.

[Claim 9] A method for operating a flexible device, comprising:

detecting, by a controller of the flexible device, occurrence of an event; and

selectively applying drive signals to a first plurality of piezoelectric materials of a lower piezoelectric layer disposed on a flexible body of the flexible device and a second plurality of piezoelectric materials of an upper piezoelectric layer disposed on the first plurality of piezoelectric materials, based on the event, the first plurality of piezoelectric materials arranged in rows on the flexible body in a horizontal direction of the flexible device, each of the rows comprising piezoelectric materials of elongated shape in the horizontal direction arranged in series and the second plurality of piezoelectric materials arranged in columns on the flexible body in a vertical direction of the flexible device, each of the columns comprising piezoelectric materials of elongated shape in the vertical direction arranged in series,

wherein the selectively applied drive signals cause independently controlled deformation of the one or more rows of the first plurality of piezoelectric materials in the horizontal direction of the flexible device or the one or more columns of the second plurality of piezoelectric materials in the vertical direction of the flexible device.

[Claim 10] The method of claim 9, wherein the selectively applying drive signals comprises:

determining drive signals to apply to the one or more rows of the first plurality of piezoelectric materials and the one or more columns of the second plurality of piezoelectric materials based on the type of the event; and

applying the determined drive signals to the one or more rows of the first plurality of piezoelectric materials and the one or more columns of the second plurality of piezoelectric materials,

wherein the first plurality of piezoelectric materials deform in the horizontal direction of the flexible device in response to application of a first drive signal to the first plurality of piezoelectric materials of the lower

piezoelectric layer and the one or more columns of the second plurality of piezoelectric materials deform in the vertical direction of the flexible device, in response to application of the second drive signal to the second plurality of piezoelectric materials of the upper piezoelectric layer.

[Claim 11] The method of claim 9, wherein the selectively applying comprises:

dividing the first plurality of piezoelectric materials and the second plurality of piezoelectric materials into a plurality of groups based on the rows in which the first plurality of piezoelectric materials and the columns in which the second plurality of piezoelectric materials are disposed; and

applying different ones of the drive signals to the respective groups to cause the grouped first plurality of piezoelectric materials and the second plurality of piezoelectric materials to locally deform.

[Claim 12] The method of any of claims 9, further comprising displaying a user interface (UI) corresponding to a deformation state of the flexible device corresponding to deformation of the first plurality of piezoelectric materials and the second plurality of piezoelectric materials on a display of the flexible device.

[Claim 13] The method of claim 9, further comprising

detecting a touch of a user through a biosensor provided on the flexible device;

selectively applying the drive signals to the one or more rows of the first plurality of piezoelectric materials and the one or more columns of the second plurality of piezoelectric materials and displaying a user interface on a display of the flexible device, in response to the detecting.