

and disposed such that an upper surface of the piezoelectric beam vibrator is spaced apart from a lower surface of the display part, a predetermined portion of the piezoelectric beam vibrator being connected to the lower surface of the display part.

[0020] In yet another aspect, there is provided a haptic display apparatus having a vibration isolating structure, the apparatus comprising a display part, a plurality of piezoelectric beam vibrators disposed under edges of the vibration display part, and a housing supporting ends of the piezoelectric beam vibrators, each of the piezoelectric beam vibrators being adjacent to an inner wall of the housing to be parallel to the inner wall, wherein each of the piezoelectric beam vibrators is spaced apart from the inner wall of the housing.

[0021] In another aspect, there is provided a haptic display apparatus having a plurality of excitation points, the apparatus comprising a housing, a display part defining an upper surface of the housing, forming an image, and receiving input through touch; and a plurality of piezoelectric beam vibrators, each of the piezoelectric beam vibrators taking a shape of a long rectangular plate and being connected at a predetermined portion thereof to a lower surface of each of edges of the display part.

[0022] In another aspect, there is provided a vibration panel, the vibration panel comprising a panel configured to input a command through touch and to sense vibration on an upper surface thereof; and a plurality of vibrators disposed under the panel to excite each center of edges of the vibration panel.

[0023] In another aspect, there is provided a vibration panel, the vibration panel comprising a panel configured to input a command through touch and to sense vibration on an upper surface thereof; and a plurality of vibrators disposed under the panel to excite corners of the vibration panel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] FIG. 1 is a graph showing a natural frequency of a panel of a haptic apparatus in accordance with an embodiment of the present invention;

[0025] FIGS. 2a to 2c are views schematically showing movement of a vibrating region of a locally vibrating haptic apparatus in accordance with the present invention;

[0026] FIG. 3 is a view schematically showing a vibrating region when a vibrator is disposed on a corner of a panel of the locally vibrating haptic apparatus in accordance with the present invention;

[0027] FIG. 4 is a view schematically showing a vibrating region when the vibrator is disposed on an edge of the panel of the locally vibrating haptic apparatus in accordance with the present invention;

[0028] FIGS. 5a to 5c are plan views showing examples of locations of vibrators of the locally vibrating haptic apparatus in accordance with the present invention;

[0029] FIG. 6 is a graph showing a case where a square input waveform is in a time domain;

[0030] FIG. 7 is a graph showing a case where a square input waveform is in a frequency domain, through a spectrum analysis;

[0031] FIG. 8 is a graph showing a case where a perfectly asymmetric input waveform is in a time domain;

[0032] FIG. 9 is a graph showing a case where a perfectly asymmetric triangle input waveform is in a frequency domain, through a spectrum analysis;

[0033] FIG. 10 is a graph showing a case where an asymmetric triangle input waveform is in a time domain;

[0034] FIG. 11 is a graph showing a case where an asymmetric triangle input waveform is in a frequency domain, through a spectrum analysis;

[0035] FIG. 12 is a plan view showing movement of a vibrating position in a vertical direction from bottom to top of the locally vibrating haptic apparatus in accordance with the present invention;

[0036] FIG. 13 is a plan view showing movement of a vibrating position in a horizontal direction from left to right of the locally vibrating haptic apparatus in accordance with the present invention;

[0037] FIG. 14 is a plan view showing movement of a vibrating position in upward and horizontal directions of the locally vibrating haptic apparatus in accordance with the present invention;

[0038] FIG. 15 is a plan view showing movement of a vibrating position in a circular shape on the locally vibrating haptic apparatus in accordance with the present invention;

[0039] FIGS. 16a and 16b are side sectional views showing examples of piezoelectric beam vibrators that may be disposed on a display apparatus in accordance with the present invention;

[0040] FIG. 17 is a plan view showing a haptic display apparatus having the piezoelectric beam vibrators;

[0041] FIG. 18 is a side sectional view showing a second vibrator disposed on the haptic display apparatus of FIG. 17;

[0042] FIG. 19 is a front sectional view showing arrangement of a first vibrator;

[0043] FIG. 20 is a detailed view showing a vibration isolating structure of the haptic display apparatus;

[0044] FIG. 21 is a perspective view showing a haptic display apparatus having the vibration isolating structure; and

[0045] FIG. 22 is a perspective view showing a housing of the haptic display apparatus in accordance with the present invention.

DETAILED DESCRIPTION

[0046] A locally vibrating haptic apparatus and a method for locally vibrating the haptic apparatus in accordance with a preferred embodiment of the present invention will be described in detail with reference to the accompanying drawings.

[0047] FIG. 1 is a graph showing a natural frequency of a panel disposed on a haptic apparatus in accordance with the present invention.

[0048] In the present invention, the haptic apparatus includes a panel that transmits vibration feedback or outputs vibration through touch. Hereinafter, the panel of the haptic apparatus according to the present invention may be applied to various display types of touch screens or a simple display panel, as long as the panel is a panel to which a vibration type of haptic technology is applied. Further, it is noted that the present invention may be applied to various types of panels which transmit tactility by vibration according to the haptic technology, even if the panels do not form images. Further, the panel generally comprises a flat plate, but may have various shapes such as a curved surface or a three-dimensional shape according to an entire shape of the haptic apparatus.

[0049] The panel of the haptic apparatus is shaped like a flat plate in appearance. Since the panel is manufactured using various materials and parts, the panel generally has a plurality of resonant frequencies.