

[0044] FIG. 11 is a graph showing changes of pressure applied by a user with time during a pressing event of a user interface method according to another embodiment of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0045] Below embodiments of the present invention will be described with reference to the accompanying figures. In the following description, some terminology is used to describe certain characteristics of the present invention.

[0046] The term “touch screen” is a transparent screen-type position sensing device capable of detecting a touch position on the screen surface, at which a user’s finger or any pointing device is touching.

[0047] The term “logical states of a graphical user interface object” means distinct states of a graphical user interface object, by which different corresponding operations or processing are triggered. The logical states includes at least a selected state which indicates the graphical user interface object is selected by a user but none of the corresponding operation or operation is triggered, and an actuated state in which the corresponding operations or processing is performed.

[0048] FIG. 1 shows an example of an apparatus to which a user interface method according to an embodiment of the present invention is applied. The apparatus 1 includes a display/input section 10, a controller section 20 and an application section 30.

[0049] The display/input section 10 displays on a touch screen thereof images of buttons, keys, switches or any other Graphic User Interface (GUI) objects to prompt a user 2 to interact with the apparatus 1. The display/input section 10 further detects a touch position of a user’s finger or a pointing device on the screen and pressure applied when the finger or pointing device touches the screen. The display/input section 10 further provides different types of tactile feedback in response to the user’s input operation.

[0050] It should be noted, in this specification, that the word “tactile” and “haptic” indicate the same sensory effect and are used interchangeably.

[0051] The control section 20 dynamically correlates: (i) the touch position on the screen or a GUI object selected by the user’s input operation; (ii) the pressure applied on the screen by the user’s input operation; and (iii) a current logical state of the selected GUI object; with the type of tactile feedback to be presented to the user 2.

[0052] The application section 30 performs various operations or functions in response to the user’s input operation detected by the display/input section 10. The application section 30 may include various applications and software units or hardware.

(1) Display/Input Section

[0053] The display/input section 10 includes a haptic feedback generating unit 102, a visual display unit 103, a two-dimensional (2D) position sensing unit 104 and a pressure sensing unit 105.

[0054] The visual display unit 103 presents visual information to the user 2. Such visual information may include various predefined GUI objects that user can interact with, such as images of buttons, sliders, drawing, scroll bars, hyper links and etc. The visual display unit 103 may be

formed with any type of display as long as it can be used with the tactile feedback generating unit 102, the 2D position sensing unit 104 and the pressure sensing unit 105. For example, a Liquid Crystal Display (LCD), a Organic Light Emitting Diode (OLED) display or the like may be employed as the visual display unit 103.

[0055] The haptic feedback generating unit 102 may be formed with piezoelectric bimorph actuators with single or multiple layer structure. Examples of such actuators for generating the tactile feedback are disclosed in Japanese Patent Application Publication No. 2006-48302. Alternatively, various types of mechanical or electrical or electromagnetic actuators/motors may be employed to generate the tactile feedback depending on a size/mass of the display and/or available power.

[0056] The pressure sensing unit 104 allows to measure pressure applied to the touch screen by the user’s input operation. In the present embodiment, various types of pressure sensing units may be employed as long as such devices can measure the pressure of the user’s touch with a predetermined resolution and be incorporated in the display/input section 10 with other units 102-104. For example, a force sensitive circuit elements such as strain gauges or pressure sensitive resistors may be used to sense the force which the touch screen member exerts on each support of the touch screen when finger pressure is applied to the member.

[0057] Alternatively, the piezoelectric actuators may be used to measure the pressure applied to the touch screen. For example, the piezoelectric actuators may be connected with a driver circuit and a detector circuit so as to use some of the actuators for generating the tactile feedback and the others for measuring the pressure applied thereon, respectively. An example of such a pressure sensing unit formed with the piezoelectric actuators is disclosed in Japanese Patent Application Publication No. 2006-48302. Alternatively, the driving of the actuators and measuring of the pressure may be performed time sharing manner. More specifically, a single actuator may be used with a switching circuit for measuring pressure and generating the feedback.

[0058] The 2D position sensing unit 105 detects where the user is touching on the touch screen. Any type of a touch screen or touch panel technology may be used as the 2D position sensing unit 105 as long as the touch screen/panel can measure two-dimensional position of the user’s finger or pointing device. For example, a resistive touch screen, a capacitive touch screen, a surface acoustic wave touch screen, or the like may be used.

(2) Controller Section

[0059] The controller section 20 drives and controls subsections of the display/input section 10 in response to the user’s input operation detected by the display/input section 10. The controller section 20 controls the display/input section 10 to change the tactile feedback depending on the position, pressure of the user’s touch on the screen and the current logical state of GUI object, attempting to simulate the interactive operations with physical interface objects. Accordingly, the apparatus of the present embodiment allows the user to easily and intuitively perform input operations even without the physical user interface objects.

[0060] The control section 20 and the application section 30 may be embodied with a computer (not shown in the figure), which may include a CPU, a memory, an external data storage, and an input/output interface. Various functions