APPARATUS AND METHOD FOR TOUCH SCREEN INTERACTION BASED ON TACTILE FEEDBACK AND PRESSURE MEASUREMENT

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a method of a user interface utilizing a touch screen and tactile feedback, and an apparatus that employs such a user interface method.

[0003] 2. Discussion of the Related Art

[0004] Japanese Patent Application Publication No. 2003-016502 discloses an example of such a user interface system for detecting a position of a user's finger or a pointing device on the touch screen of a display device. In this user interface system, the tactile feedback are provided by vibrating the touch screen when the user touches one of graphical user interface objects displayed on the touch panel. A functionality assigned to the selected graphical user interface object is actuated when the user releases or detouches the finger or pointing device from the touch screen.

[0005] Japanese Patent Application Publication No. 2005-190290 discloses another example of a user interface system capable of providing tactile feedbacks when a user touches on a touch screen. In this user interface system, the initial tactile feedback is provided when the user first touches the touch panel, and a different tactile feedback is provided when the touch position is moved to a region of the touch screen where a graphical user interface object is displayed. A function assigned to the selected graphical user interface object is actuated when the user detouches the finger or pointing device or presses for a longer period of time. The actuation of the selected graphical user interface object is notified to the user in a form of tactile feedback, color change of the graphical user interface object, sound or combination thereof.

[0006] Minsky, M., "Manipulating simulated objects with real-world gestures using force and position sensitive screen". Proceedings of SIGGRAPH'84. 1984: ACM: pp. 195-203 discloses still another example of a user interface system in which a pressure sensor is added to a touch screen for detecting pressure applied to the touch screen, allowing more flexibility in the user interface operation.

SUMMARY OF THE INVENTION

[0007] It is desirable to provide tactile notification when a user touches a user interface element on a touch screen without executing functionality of the user interface element. Furthermore, it is desirable to provide tactile notification to the user when the functionality of the user interface element is executed.

[0008] Furthermore, it is desirable to provide a method of user interface utilizing a touch screen display device capable of providing tactile feedback and measuring pressure applied to the touch screen, thereby allowing a user to have interactive operations similar to ones with physical operation means, such as pressing buttons or keys. Further, it is also desirable to provide an apparatus that employs such a user interface method.

[0009] The present invention is made in view of the forgoing issues described above.

[0010] In an embodiment of the present invention, there is provided an apparatus including a display section with a touch screen. The touch screen is configured to display at least one graphical user interface object and detect a touch position on the touch screen. The touch position is inputted with a user's finger or a pointing device. The apparatus includes: a haptic feedback generating unit attached to the touch screen and generating haptic feedback; a pressure sensing unit attached to the touch screen and detecting pressure applied to the touch screen; and a controller section configured to control and drive the display section. The graphical user interface object displayed on the touch screen has a plurality of logical states. The controller section determines a current logical state of the graphical user interface object using a history of detected touch positions and a history of detected pressure values. The controller section determines a form of the haptic feedback to be generated depending on (i) the detected touch position, (ii) the detected pressure value and (iii) the determined current logical state of the graphical user interface object.

[0011] In another embodiment of the present invention, the haptic feedback generating unit may generate different tactile feedback for different logical states of the GUI object.

[0012] In another embodiment of the present invention, the logical states of the GUI object may include at least a selected state and an actuated state. The controller section may determine that the graphical user interface object is in the actuated state if a pressing event is recognized. The controller section may recognize the pressing event using a history of the detected pressure value. Alternatively, the controller section may determine that the GUI object is in the actuated state if: (i) the touch position is inside of the GUI object; and (ii) the detected pressure is more than a preset actuation threshold value. In another example, the controller section may determine that the GUI object is in the actuated state if: (i) the touch position is inside of the GUI object; and (ii) a history of the detected pressure satisfies a preset actuation condition. In the present embodiment, the logical state of GUI object is allowed to change to the actuated state only after the selected state.

[0013] In another embodiment of the present invention, the haptic feedback generating unit may include a single or plurality of piezoelectric elements. At least one of the piezoelectric elements may be used for generating the haptic feedback and detecting the pressure applied by the user. Alternatively, the at least one of the piezoelectric elements may generate the haptic feedback and detect the pressure in time sharing manner.

[0014] In another embodiment of the present invention, the haptic feedback is controlled in either a frequency, an amplitude or both amplitude and frequency simultaneously.

[0015] In another embodiment of the present invention, the haptic feedback generating unit may generate a continuous haptic feedback as long as the touch position is inside of the GUI object. Further, the continuous tactile feedback is changed in response to a change of the pressure applied to the touch screen. The change of the continuous tactile feedback depends on the current logical state of the graphical user interface object.

[0016] In another embodiment of the present invention, the haptic feedback generating unit may generate a single burst of the haptic feedback when the touch position crosses over a hotspot predefined within the GUI object. Alternatively, the haptic feedback generating unit may generate a