CAPACITIVE SENSOR PANEL HAVING DYNAMICALLY RECONFIGURABLE SENSOR SIZE AND SHAPE

FIELD OF THE INVENTION

[0001] This relates to capacitive sensor panels, and more particularly to capacitive sensor panels having dynamically reconfigurable sensor size and shape for proximity and/or distance to enable hover and gesture detection.

BACKGROUND OF THE INVENTION

[0002] Many types of input devices are presently available for performing operations in a computing system, such as buttons or keys, mice, trackballs, joysticks, touch sensor panels, touch screens and the like. Touch sensor panels and touch screens, in particular, are becoming increasingly popular because of their ease and versatility of operation as well as their declining price. Touch screens can include a touch sensor panel, which can be a clear panel with a touch-sensitive surface, and a display device such as a liquid crystal display (LCD) that can be positioned partially or fully behind the panel so that the touch-sensitive surface can cover at least a portion of the viewable area of the display device. Touch screens can allow a user to perform various functions by touching the touch sensor panel using a finger, stylus or other object at a location dictated by a user interface (UI) being displayed by the display device. In general, touch sensor panels and touch screens can recognize a touch event and the position of the touch event on the touch sensor panel, and the computing system can then interpret the touch event in accordance with the display appearing at the time of the touch event, and thereafter can perform one or more actions based on the touch event.

[0003] Capacitive touch sensor panels can be formed from a matrix of drive and sense lines of a substantially transparent conductive material such as Indium Tin Oxide (ITO), often arranged in rows and columns in horizontal and vertical directions on a substantially transparent substrate. U.S. Pat. application Ser. No. 11/649,998 filed on Jan. 3, 2007 and entitled "Proximity and Multi-Touch Sensor Detection and Demodulation" (also incorporated by reference herein in its entirety) teaches a capacitive touch sensor array of uniform granularity capable of detecting multiple simultaneous touch events and a limited amount of proximity (or hover) events (near-field proximity sensing). In addition, that application discloses a proximity sensor array of fixed granularity capable of detecting multiple simultaneous proximity events (far-field proximity sensing). However, these fixed or uniform granularity proximity sensor arrays are incapable of being selectively configurable in real time to optimize their sensing capabilities, especially with regard to the detection of hovering objects whose distance to the touch sensor panel or touch screen may vary greatly.

SUMMARY OF THE INVENTION

[0004] This relates to a capacitive sensor panel that is able to dynamically reconfigure its sensor size and shape for proximity and/or distance to enable hover and gesture detection. Thus, the size and/or shape of the sensors in the panel can differ according to present needs. Hover and gesture detection may become more effective and efficient.

[0005] In some embodiments, a sensor panel may dynamically reconfigure its sensor size and shape based on an object's proximity to the panel. The sensors may have an initial size and shape. When the sensors sense an object, a determination may be made as to whether the object is within a certain distance of the panel. If so, the size and/or shape of the sensors in the panel may be dynamically reconfigured accordingly.

[0006] In some embodiments, a sensor panel may dynamically reconfigure its sensor size and shape based on a gesture detected by the panel. The sensors may have an initial size and shape. When the sensors sense a touch or proximity event, the event may be recognized as a gesture. Based upon recognized characteristics of the gesture, the size and/or shape of the sensors in the panel may be dynamically reconfigured.

[0007] In some embodiments, a sensor panel may dynamically reconfigure its sensor size and shape based on an application executing on a device in communication with the panel. The sensors may have an initial size and shape. When the device selects an application to execute, the application may have functions which require certain gestures from a user in order to interact with the application. Accordingly, the size and/or shape of the sensors in the panel may be dynamically reconfigured for the selected application based on the expected gestures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** illustrates an exemplary computing system including a capacitive sensor panel having dynamically reconfigurable sensor size and shape according to embodiments of the invention.

[0009] FIG. **2** illustrates an exemplary capacitive sensor panel according to embodiments of the invention.

[0010] FIG. **3***a* illustrates an exemplary mutual capacitance scheme for dynamically reconfiguring sensor size and shape using intersecting composite drive lines and sense lines to form a composite electrode according to embodiments of the invention.

[0011] FIG. **3***b* illustrates an exemplary mutual capacitance scheme for dynamically reconfiguring sensor size and shape using a composite drive electrode formed from one group of parallel sense lines and a composite sense electrode formed from another group of parallel sense lines according to embodiments of the invention.

[0012] FIG. **4***a* illustrates an exemplary self capacitance scheme for dynamically reconfiguring sensor size and shape using composite columns of electrodes to form a composite electrode according to embodiments of the invention.

[0013] FIG. **4***b* illustrates an exemplary self capacitance scheme for dynamically reconfiguring sensor size and shape using composite rows of electrodes to form a composite electrode according to embodiments of the invention. FIG. **4***c* illustrates an exemplary self capacitance scheme for dynamically reconfiguring sensor size and shape using composite rows and columns of electrodes to form a composite loop electrode according to embodiments of the invention.

[0014] FIG. **5** illustrates an exemplary method for dynamically reconfiguring sensor size and shape of a sensor panel based on an object's proximity to the panel according to embodiments of the invention.

[0015] FIGS. **6***a*, **6***b*, and **6***c* are exemplary illustrations of a sensor panel having dynamically reconfigurable sensor size and shape based on an object's proximity to the panel according to embodiments of the invention.

[0016] FIG. **7** illustrates an exemplary method for dynamically reconfiguring sensor size and shape of a sensor panel