MULTIPLE-TOUCH SENSOR

RELATED APPLICATIONS

[0001] The benefit of Provisional Application Ser. No. 60/653,893, filed Feb. 17, 2005 and entitled MULTIPLE-TOUCH SENSOR, is hereby claimed. The disclosure of this referenced provisional application is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The field of the present invention relates to touch sensor technology, and more particularly to resistive and capacitive touch sensor technology for multiple touches simultaneously.

BACKGROUND OF THE INVENTION

[0003] Technological advances are needed to connect man more effectively to machines of many types (such as computers, home appliances, and communication devices). The touch screen as conventionally developed enjoys wide use as a convenient device for providing finger contact as a "friendly" assistant that provides the user with a much easier access to the computer. Touch pads are also used to assist in communicating spatial and temporal data with computers and other programmed devices.

[0004] Touch sensors use an impressive array of technologies including acoustic, optical, resistive and capacitive and are typically coupled with display devices using transparent or translucent materials or are opaque structures when used independent of a computer. In nearly all cases, a single finger or single stylus contact is made with the sensor to input the data.

[0005] In this disclosure, a new design concept is introduced that provide a means to allow multiple contacts to a touch sensor, enabling the user to communicate more effectively and efficiently to other devices.

[0006] Touch screens have been developed over the past few decades and are widely used. Commonly a two-dimensional substrate is used, typically using glass coated with a transparent conductor, wherein electrical fields are applied sequentially in the x and y directions. To obtain electric fields that are uniform enough for touch screen uses, it is necessary to border the entire surface with various kinds of conducting frames to ameliorate the field distortions. In some cases a correction algorithm is used to achieve further accuracy and to make possible narrow inactive edges. For a recent summary of these methods, see U.S Pat. No. 6,650,319, by Hurst et al. In a resistive touchscreen, a flexible cover sheet allows electrical contact to be made with the substrate, and potential measurements are made to determine the contact position. In a capacitive touchscreen, capacitive coupling is made between a finger and an electrically activated touch sensor. Current, voltage, or resistance ratios are generally used to determine the contact position.

[0007] Generally, the touch screen acts to provide the coordinates of a single touch on the sensor surface, i.e. only one touch point is sensed at any one instant in time. Multiple touches cause erroneous data. However, a number of important needs cannot be met with the limitations of a single touch. Familiar operations such as the use of the "Shift" or "Ctrl" keys on a computer keyboard cannot be directly used on present touchscreens due to this limitation. The operation of a right-click of a computer mouse becomes a multi-stroke operation on conventional touchscreens. Chording for musical keyboards is not possible because of the limitation of single-touch screens. The gaming industry could enjoy increased flexibility in game design and operation with the advent of sensors that allow multiple touches. Thus there are possibly substantial markets for multi-touch devices where one or more fingers are used at the same time, thus there is a need for multiple-touch sensors. This document discloses a new concept for meeting these and other needs. Such sensors that allow multiple touches to be sensed and located are termed "MultiTouch."

[0008] Additional needs are not related to human touch, but rather to contact with some mechanical object placed on a sensor. For example, the identity and orientation of a component placed upon a sensor would be useful in a robotic manufacturing operation. The extension of MultiTouch to such an application is termed "TransTouch."

[0009] This document discloses a new concept for meeting these needs. The Digalog concept is one in which one Cartesian axis is measured with an analog method and the other axis is measured with a digital method. This concept yields very simple geometries for the layout of conductive areas onto insulating substrates. Very satisfactory spatial resolution, time resolution, and low energy consumption, are achieved with modest electronic controllers at moderate cost. While these sensors can be used to locate a single touch, a most significant advantage is that they can be used to measure many simultaneous touches. This general approach can be adapted to a variety of touch sensors for many kinds of applications. It is especially interesting to explore the applications of these multiple-touch sensors to areas where combinations of hand fingers can be used advantageously, e.g., home appliances, security, and stationary or portable computers. Additionally, these MultiTouch screens can be advantageously used in systems that connect encoded messages, such as Braille, to the Internet and email.

[0010] Other multiple-touch sensors have been described in the patent literature. For instance, U.S. Pat. No. 6,723,929 by Joel Kent is entitled, "Acoustic Condition Sensor Employing a Plurality of Mutually Non-Orthogonal Waves." In the standard Surface Acoustical Wave (SAW) technique, ambiguities arise when the sensor is touched at more than one point. These can be resolved for two or more points when using the non-orthogonal waves. SAW sensors have the advantage of high optical transparency, since the working surface is only glass but are known to be subject to errors caused by contamination.

[0011] The self capacity principle has also been used to achieve multi-touch capability. This type of multiple-touch sensor was pioneered for typing and handwriting primarily by Westerman (see U.S. Pat. Nos. 6,677,932, 6,570,557 and 6,323,846). These patents are assigned to Finger Works, Inc, founded by Westerman at the University of Delaware. Advanced typewriters are based on these capacitance touch screens and a form of Bayesian analysis is used to deal with typing errors. Multiple-finger strokes, called "gestures," are used to facilitate communications of a person with an associated processor. The system does not offer transparency for use with touch screens over display devices.