LIGHT-BASED TOUCH SCREEN

CROSS REFERENCES TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of assignee's pending application U.S. Ser. No. 10/494,055, filed on Apr. 29, 2004, entitled ON A SUBSTRATE FORMED OR RESTING DISPLAY ARRANGEMENT.

FIELD OF THE INVENTION

[0002] The field of the present invention is touch screens for computers.

BACKGROUND OF THE INVENTION

[0003] Conventional touch screens are capacitance-based or resistance-based. These touch screens provide user interfaces through which a user enters input to a computing device by touching a screen at a selected location, with a stylus or with his finger.

[0004] Conventional touch screens are generally large. When space is at a premium, such as with small handheld electronic devices, conventional touch screens are limited to only a few user inputs. Moreover, these inputs are not accurately interpreted when the user does not use a stylus.

[0005] Conventional touch screens are also limited as to the types of user inputs that they can recognize. For example, conventional touch screens are unable to distinguish between a soft tap and a hard press. Conventional touch screens are unable to recognize fast repeated tapping on the same screen locations. Conventional touch screens are unable to recognize gestures made by a finger or stylus that moves continuously across a touch screen.

[0006] It would thus be of advantage to produce touch screens that recognize single soft taps, repeated soft taps, presses, and gestures, for both large and small screens.

SUMMARY OF THE DESCRIPTION

[0007] Aspects of the present invention relate to touch screens that operate by measuring light intensities emitted by infra-red light emitting diodes (LEDs). In distinction from prior art touch screens, which are resistance-based or capacitance-based, embodiments of the present invention use light beams.

[0008] LEDs and photodiode (PD) receivers are distributed around the perimeter of a touch screen. The LEDs are controlled by a microprocessor to selectively emit light, and the PD receivers are controlled by the microprocessor to selectively measure light intensities. The light emitted by the LEDs is projected by a lens assembly over the touch screen. An object crossing into the projected light obstructs some of the light from reaching the PD receivers. The corresponding decrease in light intensities measured by the PD receivers enables determination of the object's position.

[0009] In accordance with embodiments of the present invention, the lens assembly projects light onto parallel planes at multiple heights over the touch screen. In turn, the light intensities measured by the PD receivers enable detection of objects that touch the screen and also objects that are above the screen and nearly touching the screen. By measuring light intensities over time, the motion over time of objects that are nearly touching the screen is also determined. Moreover, determination of motion over time enables derivation of objects' velocity vectors.

[0010] The touch screen of the present invention is able to recognize and distinguish still user inputs and motion-based user inputs made by a user's finger, including inter alia a single soft tap on the screen, multiple soft taps on the screen, a hard press on the screen, multiple hard presses on the screen, a directional gesture, such as a rightward moving swipe on the screen, and a figurative gesture such as sliding a finger over the screen in the shape of an "s" or an asterisk "*". The touch screen of the present invention is also able to recognize positions and motions of more than one object simultaneously touching the screen.

[0011] The touch screen of the present invention may be used as both an input device and an output display device. In some embodiments of the present invention, paths of motion made by an object on the touch screen are converted to corresponding motion of a mouse, and input as such to a computer.

[0012] The user touch-based inputs may be logged and post-processed by a data processor. An application of this is a touch-based storefront window, whereby touch-based inputs from passersby are logged and analyzed to derive information about consumer interest in a storefront showcase display.

[0013] In some embodiments of the present invention, LEDs are arranged along two adjacent edges of the touch screen, and PD receivers are arranged along the other two adjacent edges. In other embodiments of the present invention, four LEDs are positioned at the corners of the touch screen, and PD receivers are arranged along the edges.

[0014] In some embodiments of the present invention, the LEDs are connected as a matrix to LED row drivers that select rows and LED column drivers that select columns. As such, a designated LED is activated by appropriately setting its corresponding row and column drivers. Such a connection significantly reduces the number of IO connectors required, thereby reducing the cost of materials for the touch screen. Similarly, the PD receivers may be connected as a matrix to PD row selectors and PD column selectors.

[0015] Thus the present invention provides touch screens suitable for both small and large electronic devices. Devices that use touch screens of the present invention, such as mobile phones, do not required keypads since the touch screens themselves may serve as keypads.

[0016] There is thus provided in accordance with an embodiment of the present invention a light-based touch screen, including a housing for a display screen, a plurality of infra-red light emitting diodes (LEDs), fastened on the housing, for generating light beams, at least one LED selector, fastened on the housing and connected with the plurality of LEDs, for controllably selecting and deselecting one or more of the plurality of LEDs, a plurality of photodiode (PD) receivers, fastened on the housing, for measuring light intensity, at least one PD selector, fastened on the housing and connected with the plurality of PD receivers, for controllably selecting and deselecting one or more of the plurality of PD receivers, an optical assembly, fastened on the housing, for projecting light beams emitted by the plurality of LEDs in substantially parallel planes over the housing, and a controller, fastened on the housing and coupled with the plurality of PD receivers, (i) for controlling the at least one LED selector, (ii) for controlling the at least one PD selector, and (iii) for determining therefrom position and velocity of an object crossing at least one of the substantially parallel planes, based on output currents of the plurality of PD receivers.