

SUMMARY OF THE INVENTION

[0010] The present invention provides a touch screen system for discerning between user interaction states. The inventive touch screen system can approximate tracking and dragging states, regardless of the user's orientation and without reliance on direct sensing of touch pressure or area. The touch screen system includes a touch screen, at least two detectors in proximity to the touch screen and a signal processor. The detectors may be line scan camera, area scan cameras or phototransistors. The touch screen system will typically include a light source for illuminating the object. The detectors will detect illumination level variations caused by an object interacting with the touch screen.

[0011] A first detector generates a first signal representing a first image of an object interacting with the touch screen. A second detector generates a second signal representing a second image of the object interacting with the touch screen. The signal processor for executing computer-executable instructions for processing the first signal to determine approximated coordinates of a first pair of outer edges of the object and processing the second signal to determine approximated coordinates of a second pair of outer edges of the object. For example, the approximated coordinates may be determined using slope line calculations.

[0012] The signal processor then calculates an approximated touch area based on the approximated coordinates of the first pair of outer edges and the approximated coordinates of the second pair of outer edges of the object. If the approximated touch area is less than or equal to a threshold touch area, the signal processor determines that the object interacting with the touch screen indicates a tracking state. If the approximated touch area is greater than the threshold touch area, the signal processor determines that the object interacting with the touch screen indicates a selection state. The threshold touch area may be established by calibrating the touch screen system when the object interacting with the touch screen is known to indicate the tracking state.

[0013] If the object interacting with the touch screen indicates the selection state, the signal processor monitors subsequent signals from the detectors to determine whether the object moves relative to the touch screen. If the object moves relative to the touch screen, the signal processor re-calculates the approximated touch area and determines whether the re-calculated touch area remains greater than or equal to the threshold touch area. If so, the signal processor determines that the object interacting with the touch screen indicates a dragging state. If not, the signal processor determines that the object interacting with the touch screen indicates the tracking state. If the object interacting with the touch screen indicates either the selection state, the dragging state or the tracking state, the signal processor determines whether the object becomes undetected by the first detector and the second detector. If so, the signal processor determines that the object interacting with the touch screen indicates an out-of-range state.

[0014] The object interacting with the touch screen may be a finger, stylus or other object capable of producing a first touch area and a relatively larger second touch area. For example, the object may comprise a stylus having a spring loaded plunger protruding from a tip of the stylus, where the plunger produces a relatively small touch area when interacting with the touch screen. The plunger collapses into the tip of the stylus when sufficient compression is applied to the spring, causing the tip of the stylus to contact the touch screen

and producing a relatively larger touch area. These and other aspects and features of the invention will be described further in the detailed description below in connection with the appended drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. 1 is an illustration of a touch screen system, in accordance with certain exemplary embodiments of the present invention.

[0016] FIG. 2 is a block diagram of touch screen system components, including a computing device, in accordance with certain exemplary embodiments of the present invention.

[0017] FIG. 3, comprising FIG. 3A and FIG. 3B, is an illustration of a finger interacting with a touch screen in tracking mode, in accordance with certain exemplary embodiments of the present invention.

[0018] FIG. 4, comprising FIG. 4A and FIG. 4B, is an illustration of a finger interacting with a touch screen in selection mode, in accordance with certain exemplary embodiments of the present invention.

[0019] FIG. 5 is a reference diagram shown to provide an understanding of exemplary trigonometric calculations that can be used to approximate touch area in accordance with certain exemplary embodiments of the present invention.

[0020] FIG. 6, comprising FIG. 6A and FIG. 6B, is an illustration of a specialized stylus, which may be used in accordance with certain exemplary embodiments of the present invention.

[0021] FIG. 7 is a flow chart illustrating an exemplary method for discerning between a tracking state and a selection in a touch screen system, in accordance with certain exemplary embodiments of the present invention.

[0022] FIG. 8 is a state diagram showing the operation sequence of certain exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS OF THE INVENTION

[0023] The present invention provides touch screen systems and methods for approximating at least four interaction states: (1) out-of-range; (2) tracking; (3) selection; and (4) dragging. The systems and methods of the present invention provide functionality for discerning between the various interaction states regardless of the orientation of the user's finger, stylus or other touch object and without reliance on direct sensing of touch pressure or area. Exemplary embodiments of the present invention will hereinafter be described with reference to the drawings, in which like reference numerals represent like elements throughout the several figures.

[0024] FIG. 1 is an illustration of an exemplary touch screen system 100. As used herein, the term "touch screen system" is meant to refer to a touch screen 110 and the hardware and/or software components that provide touch detection functionality. The exemplary touch screen system 100 is shown adjacent to a display device (i.e., video monitor) 190. The display device 190 may be interfaced to a personal computer or other computing device (see FIG. 2), which may execute software for detecting touches on or near the touch screen 110. The illustration in FIG. 1 of the touch screen system 100 adjacent to the display device 190 represents an exemplary application of the touch screen system 100. For