SUMMARY OF THE INVENTION

[0018] A method and apparatus for identifying user gesture includes a touch sensor for determining contact information that describes locations at which a user contacts a touch sensitive surface corresponding to a display. The touch sensor provides the contact information to a gesture identification module which uses state information to identify a user gesture and, responsive thereto issues an associated display command to a display control module. The display control module updates the display based on display commands received from the gesture identification module.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. **1** shows several users operating an exemplary touch detecting interactive display;

[0020] FIG. **2** shows a flow chart summarizing the state-based gesture identification;

[0021] FIG. **3** shows a schematic representation of the gesture identification module behavior; and

[0022] FIG. **4** shows the classification of contact motion as aligned or opposed.

DETAILED DESCRIPTION

[0023] To address the above noted deficiencies, a novel state-based approach to identifying user gestures is proposed. Gestures are identified in a manner that more accurately reflects user intent, thereby facilitating more natural interaction with the display.

[0024] FIG. **2** shows a flow chart summarizing the state-based gesture identification. A touch sensor **500** determines contact information describing the locations at which a user contacts the touch sensitive surface corresponding to the display. The touch sensor provides the contact information **750** to a gesture identification module **1000**. The gesture identification module identifies a user gesture, and issues an associated display command **1500** to a display control module **2000**. The display control module updates the display **2500** based on the display command received from the gesture identification module.

[0025] In the preferred embodiment of the invention the touch sensor is physically coincident with the display, as shown in FIG. **1**. This may be achieved, for example, by projecting imagery onto a horizontal touch sensor with an overhead projector. However, in alternative embodiments of the invention, the touch sensor and display are physically separate.

[0026] The touch sensor of FIG. **2** may determine contact information using any one of a number of different approaches. In the preferred embodiment of the invention, a set of infrared emitters and receivers is arrayed around the perimeter of the projection surface, oriented such that each emitter emits light in a plane a short distance above the projection surface. The location where the user is touching the projection surface is determined by considering which emitters are and are not occluded, as viewed from each of the receivers. A configuration incorporating a substantially continuous set of emitters around the perimeter and three receivers, each positioned in a corner of the projection surface, is particularly effective in resolving multiple locations of contact.

[0027] Alternatively, a resistive touch pad, such as those commonly used in laptop computers, may be placed beneath a flexible display surface. The resistive touch pad comprises two layers of plastic that are separated by a compressible insulator, such as air, with a voltage differential maintained across the separated layers. When the upper layer is touched with sufficient pressure, it is deflected until it contacts the lower layer, changing the resistive characteristics of the upper to lower layer current pathway. By considering these changes in resistive characteristics, the location of the contact can be determined. Capacitive touch pads may also be used, such as the Synaptics TouchPad™ (www.synaptics.com/products/touchpad.cfm).

[0028] As shown in FIG. **2**, contact information is provided from the touch sensor to the gesture identification module. Typically, the contact information is updated over time at discrete, regular intervals. In the preferred embodiment of the invention, the touch sensor provides contact information for up to two contacts at each update, and the gesture identification module identifies gestures based on the initiation, termination, position, and motion of the up to two contacts. For touch sensors providing information for more than two contacts, the gesture identification module may simply ignore additional contacts initiated when two current contacts are presently reported by the touch sensor.

[0029] Preferably, the touch sensor explicitly indicates within the contact information that a contact has been initiated or terminated. Alternatively, the gesture identification module may infer an initiation or termination of a contact from the inception, continuation, and ceasing of position information for a particular contact. Similarly, some touch sensors may explicitly report the motion of a contact point within the contact information. Alternatively, the gesture identification module may store the contact information reported by the touch sensor at successive updates. By comparing the position for each contact point over two or more updates, motion may be detected. More specifically, a simple difference between two consecutive updates may be computed, or a more complicated difference scheme incorporating several consecutive updates, e.g. a moving average, may be used. The later approach may be desirable contact positions reported by touch sensor exhibit a high level of noise. In this case, a motion threshold may also be employed, below which motion is not detected.

[0030] Herein, the first and second contact are referred to as C**1** and C**2**. The initiation of the first contact, as either reported by the sensor or determined by the gesture identification module, is referred to as D**1** ("Down-**1**"), and the initiation of a second contact is referred to as D**2**. Similarly, the termination of the first and second contact is referred to as U**1** ("Up-**1**") and U**2**, respectively. The presence of motion of the first and second contacts is termed M**1** and M**2**, respectively. More specifically, M**1** and M**2** are computed as the difference between the position of C**1** and C**2** at the current update and the position of C**1** and C**2** at the previous update.

[0031] Often, a user may briefly lose contact with the touch sensor, or the touch sensor itself may briefly fail to register a persistent contact. In either case, the software monitoring the contact information registers the termination of one contact and the initiation of a new contact, despite the fact that the user very likely considers the action as a