OBJECT POSITION DETECTOR WITH EDGE MOTION FEATURE AND GESTURE RECOGNITION

RELATED APPLICATIONS

This application is a continuation-in-part of co-pending application Ser. No. 08/320,158, filed Oct. 7, 1994, which is a continuation-in-part of application Ser. No. 08/300,387, filed Sep. 2, 1994, now abandoned which is a continuation-in-part of application Ser. No. 08/115,743, filed Aug. 31, 1993, now U.S. Pat. No. 5,374,787, which is a continuation-in-part of application Ser. No. 07/895,934, filed Jun. 8, 1992, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to object position sensing transducers and systems. More particularly, the present invention relates to object position recognition useful in applications such as cursor movement for computing devices and other applications, and especially to cursor movement with enhanced edge-motion and gesture-recognition features.

2. The Prior Art

Numerous devices are available or have been proposed for use as object position detectors for use in computer systems and other applications. The most familiar of such devices is the computer "mouse". While extremely popular as a position indicating device, a mouse has mechanical parts and requires a surface upon which to roll its position ball. Furthermore, a mouse usually needs to be moved over long distances for reasonable resolution. Finally, a mouse requires the user to lift a hand from the keyboard to make the cursor movement, thereby upsetting the prime purpose, which is usually typing on the computer.

Trackball devices are similar to mouse devices. A major difference, however is that, unlike a mouse device, a trackball device does not require a surface across which it must be rolled. Trackball devices are still expensive, have moving parts, and require a relatively heavy touch as do the mouse devices. They are also large in size and doe not fit well in a volume-sensitive application like a laptop computer.

There are several available touch-sense technologies which may be employed for use as a position indicator. Resistive-membrane position sensors are known and used in several applications. However, they generally suffer from poor resolution, the sensor surface is exposed to the user and is thus subject to wear. In addition, resistive-membrane touch sensors are relatively expensive. A one-surface approach requires a user to be grounded to the sensor for reliable operation. This cannot be guaranteed in portable computers. An example of a one-surface approach is the UnMouse product by MicroTouch, of Wilmington, Mass. A two-surface approach has poorer resolution and potentially will wear out very quickly in time.

Resistive tablets are taught by U.S. Pat. No. 4,680,430 to Yoshikawa, U.S. Pat. No. 3,497,617 to Ellis and many others. The drawback of all such approaches is the high power consumption and the high cost of the resistive membrane employed.

Surface Acoustic Wave (SAW) devices have potential use as position indicators. However, this sensor technology is expensive and is not sensitive to light touch. In addition, SAW devices are sensitive to residue buildup on the touch surfaces and generally have poor resolution.

Strain gauge or pressure plate approaches are an interesting position sensing technology, but suffer from several drawbacks. This approach may employ piezo-electric transducers. One drawback is that the piezo phenomena is an AC phenomena and may be sensitive to the user's rate of movement. In addition, strain gauge or pressure plate approaches are somewhat expensive because special sensors are required.

Optical approaches are also possible but are somewhat limited for several reasons. All would require light generation which will require external components and increase cost and power drain. For example, a "finger-breaking" infra-red matrix position detector consumes high power and suffers from relatively poor resolution.

There have been numerous attempts to provide a device for sensing the position of a thumb or other finger for use as a pointing device to replace a mouse or trackball. Desirable attributes of such a device are low power, low profile, high resolution, low cost, fast response, and ability to operate reliably when the finger carries electrical noise, or when the touch surface is contaminated with dirt or moisture.

Because of the drawbacks of resistive devices, many attempts have been made to provide pointing capability based on capacitively sensing the position of the finger. U.S. Pat. No. 3,921,166 to Volpe teaches a capacitive matrix in which the finger changes the transcapacitance between row and column electrodes. U.S. Pat. No. 4,103,252 to Bobick employs four oscillating signals to interpolate x and y positions between four capacitive electrodes. U.S. Pat. No. 4,455,452 to Schuyler teaches a capacitive tablet wherein the finger attenuates the capacitive coupling between electrodes.

U.S. Pat. No. 4,550,221 to Mabusth teaches a capacitive tablet wherein the effective capacitance to "virtual ground" is measured by an oscillating signal. Each row or column is polled sequentially, and a rudimentary form of interpolation is applied to resolve the position between two rows or columns. An attempt is made to address the problem of electrical interference by averaging over many cycles of the oscillating waveform. The problem of contamination is addressed by sensing when no finger was present, and applying a periodic calibration during such no-finger-present periods. U.S. Pat. No. 4,639,720 to Rympalski teaches a tablet for sensing the position of a stylus. The stylus alters the transcapacitance coupling between row and column electrodes, which are scanned sequentially. U.S. Pat. No. 4,736,191 to Matzke teaches a radial electrode arrangement under the space bar of a keyboard, to be activated by touching with a thumb. This patent teaches the use of total touch capacitance, as an indication of the touch pressure, to control the velocity of cursor motion. Pulsed sequential polling is employed to address the effects of electrical interference.

U.S. Pat. Nos. 4,686,332 and 5,149,919, to Greanias, teaches a stylus and finger detection system meant to be mounted on a CRT. As a finger detection system, its X/Y sensor matrix is used to locate the two matrix wires carrying the maximum signal. With a coding scheme these two wires uniquely determine the location of the finger position to the resolution of the wire stepping. For stylus detection, Greanias first coarsely locates it, then develops a virtual dipole by driving all lines on one side of the object in one direction and all lines on the opposite side in the opposite direction. This is done three times with different dipole phases and signal polarities. Assuming a predetermined matrix response to the object, the three measurements present a set of simultaneous equations that can be solved for position.