

METHODS AND SYSTEMS FOR DETECTING A POSITION-BASED ATTRIBUTE OF AN OBJECT USING DIGITAL CODES

TECHNICAL FIELD

[0001] The present invention generally relates to position or proximity sensors such as touchpads, and more particularly relates to devices, systems and methods capable of detecting a position-based attribute of a finger, stylus or other object using digital codes.

BACKGROUND

[0002] Position sensors are commonly used as input devices for computers, personal digital assistants (PDAs), media players, video game players, consumer electronics, wireless phones, payphones, point-of-sale terminals, automatic teller machines, kiosks and the like. One common type of sensor used in such applications is the touchpad sensor, which can be readily found, for example, as an input device on many notebook-type computers. A user generally operates the sensor by moving a finger, stylus or other stimulus near a sensing region of the sensor. The stimulus creates a capacitive, inductive or other electrical effect upon a carrier signal applied to the sensing region that can be detected and correlated to the position or proximity of the stimulus with respect to the sensing region. This positional information can in turn be used to move a cursor or other indicator on a display screen, scroll through text elements on the screen, or for any other user interface purpose. One example of a touchpad-type position sensor that is based on capacitive sensing technologies is described in U.S. Pat. No. 5,880,411, which issued to Gillespie et al. on Mar. 9, 1999.

[0003] While touchpad-type sensors have been in use for several years, engineers continue to seek design alternatives that reduce costs and/or improve sensor performance. In particular, significant attention has been paid in recent years to reducing the effects of noise generated by display screens, power sources, radio frequency interference and/or other sources outside of the sensor. Numerous sampling, filtering, signal processing, shielding, and other noise-reduction techniques have been implemented with varying levels of success.

[0004] Accordingly, it is desirable to provide systems and methods for quickly, effectively and efficiently detecting a position-based attribute of an object in the presence of noise. Other desirable features and characteristics will become apparent from the subsequent detailed description and the appended claims, taken in conjunction with the accompanying drawings and the foregoing technical field and background.

BRIEF SUMMARY

[0005] Methods, systems and devices are described for detecting a position-based attribute of a finger, stylus or other object with a touchpad or other sensor. According to various embodiments, the sensor includes a touch-sensitive region made up of any number of electrodes arranged in an appropriate fashion to detect user input. Modulation signals for one or more electrodes are produced as a function of any number of distinct discrete digital codes, which may be substantially orthogonal to each other. The modulation signals are applied to an associated at least one of the plurality

of electrodes to obtain a resultant signal that is electrically affected by the position of the object. The resultant signal is demodulated using the plurality of distinct digital codes to discriminate electrical effects produced by the object. The position-based attribute of the object is then determined with respect to the plurality of electrodes from the electrical effects.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Various aspects of the present invention will hereinafter be described in conjunction with the following drawing figures, wherein like numerals denote like elements, and

[0007] FIGS. 1A-B are block diagrams showing exemplary sensing devices;

[0008] FIG. 2 is a flowchart showing an exemplary process for detecting a position-based attribute of an object;

[0009] FIG. 3 includes two frequency domain plots for exemplary received and demodulated signals;

[0010] FIG. 4 is a depiction of an exemplary scenario for processing electrical images of sensed objects;

[0011] FIG. 5 is a block diagram of an exemplary sensing device capable of sensing multiple position-based attributes in two dimensions;

[0012] FIG. 6 includes two block diagrams of exemplary sensing devices with a filtering capacitor: one with simultaneous sensing of multiple signal channels on a common receive electrode, and the other with unified modulation and receive electrodes;

[0013] FIG. 7 is a block diagram of an exemplary sensing device formed on a single substrate; and

[0014] FIG. 8 is a block diagram of an exemplary sensing device formed on a flexible substrate.

DETAILED DESCRIPTION

[0015] The following detailed description is merely exemplary in nature and is not intended to limit the invention or the application and uses of the invention. Furthermore, there is no intention to be bound by any expressed or implied theory presented in the preceding technical field, background, brief summary or the following detailed description.

[0016] According to various exemplary embodiments, spread spectrum techniques can be applied within a position sensor such as a touchpad to improve noise immunity and/or to provide performance enhancements. Code division multiplexing (CDM), for example, can be used to create two or more distinct modulation signals that are applied to sensing electrode(s) within the sensor, thereby increasing the effective power of the applied signals. Coded spread spectrum modulation may refer to direct sequence, frequency hopping, time hopping or various hybrids of these or other techniques. Because the modulation frequencies applied to the sensitive region cover a wider spectrum than was previously received, narrow band noise occurring at a particular frequency or moderate wide band noise, uncorrelated with the coded modulation, has a minimal effect upon the narrower overall demodulated signal channels. The effect of noise on multiple signal channels may also be more uniform so that a minimum signal-to-noise ratio (SNR) is maintained for each useful signal channel. This concept can be exploited