DEPRESSABLE TOUCH SENSOR

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Abstract

An input device and a method for providing an input device are provided. The input device assembly includes a base, a sensor support, and a guide mechanism attached to the base and the sensor support. The guide mechanism allows for only substantially uniform translation of the sensor support towards the base in response to a force biasing the sensor support substantially towards the base.
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PRIORITY DATA

[0001] This application claims priority of U.S. Provisional Patent Application Ser. No. 61/181,888, which was filed on May 28, 2009, Ser. No. 61/253,944, which was filed on Oct. 22, 2009, and Ser. No. 61/295,068, which was filed on Jan. 14, 2010, and are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] This invention generally relates to electronic devices, and more specifically relates to sensor devices and using sensor devices for producing user interface inputs.

BACKGROUND OF THE INVENTION

[0003] Proximity sensor devices (also commonly called touchpads or touch sensor devices) are widely used in a variety of electronic systems. A proximity sensor device typically includes a sensing region, often demarked by a surface, which uses capacitive, resistive, inductive, optical, acoustic and/or other technology to determine the presence, location and/or motion of one or more fingers, stylus, and/or other objects. The proximity sensor device, together with finger(s) and/or other object(s), may be used to provide an input to the electronic system. For example, proximity sensor devices are used as input devices for larger computing systems, such as those found integral within notebook computers or peripheral to desktop computers. Proximity sensor devices are also used in smaller systems, including handheld systems such as personal digital assistants (PDAs), remote controls, digital cameras, video cameras, communication systems such as wireless telephones and text messaging systems. Increasingly, proximity sensor devices are used in media systems, such as CD, DVD, MP3, video or other media recorders or players.

[0004] Many electronic systems include a user interface (UI) and an input device for interacting with the UI (e.g., interface navigation). A typical UI includes a screen for displaying graphical and/or textual elements. The increasing use of this type of UI has led to a rising demand for proximity sensor devices as pointing devices. In these applications, the proximity sensor device may function as a value adjustment device, cursor control device, selection device, scrolling device, graphics/character/handwriting input device, menu navigation device, game input device, button input device, keyboard and/or other input device. One common application for a proximity sensor device is as a touch screen. In a touch screen, the proximity sensor is combined with a display screen for displaying graphical and/or textual elements. Together, the proximity sensor and display screen function as the user interface.

[0005] In recent years, “click touchpad” or “click pad” technology has been developed which allows touchpads, touch screens, and other touch sensors to provide tactile feedback by being at least partially depressable or “clickable.” The “click” may be purely for tactile feedback or may be used to generate a signal that is used by the electronic system in which the click pad is installed.

[0006] There is a continuing need for improvements in input devices, including those using click pad technology. In particular, there is a need for a robust and inexpensive input device assembly that allows for the use of click pad technology.

BRIEF SUMMARY OF THE INVENTION

[0007] The embodiments of the present invention provide a device and method that facilitates improved sensor device usability. Specifically, the device and method provide improved usability by facilitating the substantially uniform translation or depression of a sensor support in a “click touch pad” or “click pad” input device in a reliable and inexpensive manner.

[0008] In one embodiment, an input device assembly is provided. The input device assembly includes a base, a sensor support, and a guide mechanism attached to the base and the sensor support. The guide mechanism allows for only substantially uniform translation of the sensor support towards the base in response to a force biasing the sensor support substantially towards the base.

[0009] In another embodiment, an input device assembly is provided. The input device assembly includes a base, a sensor support configured to support a touch sensor, and a flexure assembly. The flexure assembly includes a first flexure member affixed to the base and having a first substantially planar portion, a second flexure member affixed to the sensor support and having a second substantially planar portion and, at least one spacing structure interconnecting the first and second flexure members and forming a space between the first and second substantially planar portions such that the first and second substantially planar portions are substantially parallel and overlap. The flexure assembly is configured to generate an opposing force in response to a displacement of the sensor support towards the base.

[0010] In a further embodiment, a depressable touch pad device configured to sense objects in a sensing region is provided. The depressable touch pad device includes a base, a sensor support, a capacitive touch sensor configured to detect input objects in the sensing region physically coupled to the sensor support, and a flexure assembly positioned within a combined footprint of the base, the sensor support, and the capacitive touch sensor. The capacitive touch sensor includes a sensor substrate, a plurality of sensor electrodes disposed on the sensor substrate, and a processing system communicatively coupled to the plurality of sensor electrodes. The flexure assembly includes a first flexure member affixed to the base at a first interface, the first flexure member having a first substantially planar portion, a second flexure member affixed to the sensor support at a second interface, the second flexure member having a second substantially planar portion, wherein the first and second interfaces do not overlap, and first and second spacing structures interconnecting the first and second flexure members such that the first and second planar portions are separated by a separation distance, are substantially parallel to each other, and overlap each other. The first spacing structure is adjacent to the first interface and the second spacing structure is adjacent to the second interface. In response to a displacement of the capacitive touch sensor towards the base, the first and second flexure members flex and generate an opposing force and the first and second spacing structures keep the separation distance substantially constant and the first and second substantially planar portions substantially parallel.

[0011] In another embodiment, a method for providing an input device assembly is provided. A base is provided. A
sensor support is provided. A flexure assembly is provided, which is designed to bend in a bending region and attached to the base and the sensor support, wherein the flexure assembly allows for only substantially uniform translation of the sensor support towards the base in response to a force biasing the sensor support substantially towards the base.

BRIEF DESCRIPTION OF DRAWINGS

[0012] The preferred exemplary embodiment of the present invention will hereinafter be described in conjunction with the appended drawings, where like designations denote like elements, and wherein:

[0013] FIG. 1 is a block diagram of an exemplary system that includes an input device in accordance with an embodiment of the invention;

[0014] FIG. 2 is an exploded isometric view of an exemplary input device in accordance with an embodiment of the invention;

[0015] FIGS. 3 and 4 are isometric views of the input device of FIG. 2 shown partially constructed;

[0016] FIG. 5 is a plan view of the input device of FIG. 4;

[0017] FIG. 6 is an exploded isometric view of a base and a guide mechanism of the input device of FIG. 2;

[0018] FIGS. 7, 8, and 9 are cross-sectional views of the input device taken along line 7-7 in FIG. 5 illustrating the operation thereof;

[0019] FIG. 10 is a cross-sectional view of a portion of the input device of FIGS. 7-9 including a switch;

[0020] FIGS. 11 and 12 are cross-sectional views of an input device according to another embodiment of the present invention; and

[0021] FIG. 13 is a cross-sectional view of an input device according to a further embodiment of the present invention.

DETAILS DESCRIPTION OF THE INVENTION

[0022] 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.

[0023] Various aspects of the present invention provide input devices and methods that facilitate improved usability. Specifically, the input devices and methods relate user input to the input devices and resulting actions on displays. As one example, user input in sensing regions of the input devices and methods of processing the user input allow users to interact with electronic systems, thus providing more enjoyable user experiences and improved performance.

[0024] Turning now to the figures, FIG. 1 is a block diagram of an exemplary electronic system 100 that is coupled to an input device 116, shown as a proximity sensor device (also often referred to as a touch pad, a touch sensor, or a “click pad”). As used in this document, the terms “electronic system” and “electronic device” broadly refers to any type of system capable of processing information. An input device associated with an electronic system can be implemented as part of the electronic system, or coupled to the electronic system using any suitable technique. As a non-limiting example, the electronic system may comprise another input device (such as a physical keypad or another touch sensor device). Additional non-limiting examples of the electronic system include personal computers such as desktop computers, laptop computers, portable computers, workstations, personal digital assistants, video game machines. Examples of the electronic system also include communication devices such as wireless phones, pagers, and other messaging devices. Other examples of the electronic system include media devices that record and/or play various forms of media, including televisions, cable boxes, music players, digital photo frames, video players, digital cameras, video camera. In some cases, the electronic system is peripheral to a larger system. For example, the electronic system could be a data input device such as a remote control, or a data output device such as a display system, that communicates with a computing system using a suitable wired or wireless technique.

[0025] The elements communicatively coupled to the electronic system, and the parts of the electronic system, may communicate via any combination of buses, networks, and other wired or wireless interconnections. For example, an input device may be in operable communication with its associated electronic system through any type of interface or connection. To list several non-limiting examples, available interfaces and connections include Ethernet, USB, Bluetooth, RF, IR, and any other type of wired or wireless connection.

[0026] The various elements (e.g., processors, memory, etc.) of the electronic system may be implemented as part of the input device associated with it, as part of a larger system, or as a combination thereof. Additionally, the electronic system could be a host or a slave to the input device. Accordingly, the various embodiments of the electronic system may include any type of processor, memory, or display, as needed.

[0027] Returning now to FIG. 1, the input device 116 includes a sensing region 118. The input device 116 is sensitive to input by one or more input objects (e.g. fingers, stylus, etc.), such as the position of an input object 114 within the sensing region 118. “Sensing region” as used herein is intended to broadly encompass any space above, around, in and/or near the input device in which sensor(s) of the input device is able to detect user input. In a conventional embodiment, the sensing region of an input device extends from a surface of the sensor of the input device in one or more directions into space until signal-to-noise ratios prevent sufficiently accurate object detection. The distance to which this sensing region extends in a particular direction may be on the order of less than a millimeter, millimeters, centimeters, or more, and may vary significantly with the type of sensing technology used and the accuracy desired. Thus, embodiments may require contact with the surface, either with or without applied pressure, while others do not. Accordingly, the sizes, shapes, and locations of particular sensing regions may vary widely from embodiment to embodiment.

[0028] Sensing regions with rectangular two-dimensional projected shape are common, and many other shapes are possible. For example, depending on the design of the sensor array and surrounding circuitry, shielding from any input objects, and the like, sensing regions may be made to have two-dimensional projections of other shapes. Similar approaches may be used to define the three-dimensional shape of the sensing region. For example, any combination of sensor design, shielding, signal manipulation, and the like may effectively define a sensing region 118 that extends some distance into or out of the page in FIG. 1.

[0029] In operation, the input device 116 suitably detects one or more input objects (e.g. the input object 114) within the sensing region 118. The input device 116 thus includes a
sensor (not shown) that utilizes any combination sensor components and sensing technologies to implement one or more sensing regions (e.g. sensing region 118) and detect user input such as presences of object(s). Input devices may include any number of structures, such as one or more sensor electrodes, one or more other electrodes, or other structures adapted to detect object presence. As several non-limiting examples, input devices may use capacitive, resistive, inductive, surface acoustic wave, and/or optical techniques. Many of these techniques are advantageous to ones requiring moving mechanical structures (e.g. mechanical switches) as they may have a substantially longer usable life.

[0030] For example, sensor(s) of the input device 116 may use arrays or other patterns of capacitive sensor electrodes to support any number of sensing regions 118. As another example, the sensor may use capacitive sensing technology in combination with resistive sensing technology to support the same sensing region or different sensing regions. Examples of the types of technologies that may be used to implement the various embodiments of the invention may be found in U.S. Pat. Nos. 5,543,591, 5,648,642, 5,815,091, 5,841,078, and 6,249,234.

[0031] In some resistive implementations of input devices, a flexible and conductive top layer is separated by one or more spacer elements from a conductive bottom layer. A voltage gradient is created across the layers. Pressing the flexible top layer in such implementations generally deforms it sufficiently to create electrical contact between the top and bottom layers. These resistive input devices then detect the position of an input object by detecting the voltage output due to the relative resistances between driving electrodes at the point of contact of the object.

[0032] In some inductive implementations of input devices, the sensor picks up loop currents induced by a resonating coil or pair of coils, and use some combination of the magnitude, phase and/or frequency to determine distance, orientation or position.

[0033] In some capacitive implementations of input devices, a voltage is applied to create an electric field across a sensing surface. These capacitive input devices detect the position of an object by detecting changes in capacitance caused by the changes in the electric field due to the object. The sensor may detect changes in voltage, current, or the like.

[0034] As an example, some capacitive implementations utilize resistive sheets, which may be uniformly resistive. The resistive sheets are electrically (usually ohmically) coupled to electrodes that receive from the resistive sheet. In some embodiments, these electrodes may be located at corners of the resistive sheet, provide current to the resistive sheet, and detect current drawn away by input devices via capacitive coupling to the resistive sheet. In other embodiments, these electrodes are located at other areas of the resistive sheet, and drive or receive other forms of electrical signals. Depending on the implementation, sometimes the sensor electrodes are considered to be the resistive sheets, the electrodes coupled to the resistive sheets, or the combinations of electrodes and resistive sheets.

[0035] As another example, some capacitive implementations utilize transcapacitive sensing methods based on the capacitive coupling between sensor electrodes. Transcapacitive sensing methods are sometimes also referred to as “mutual capacitance sensing methods.” In one embodiment, a transcapacitive sensing method operates by detecting the electric field coupling one or more transmitting electrodes with one or more receiving electrodes. Proximate objects may cause changes in the electric field, and produce detectable changes in the transcapacitive coupling. Sensor electrodes may transmit as well as receive, either simultaneously or in a time multiplexed manner. Sensor electrodes that transmit are sometimes referred to as the “transmitting sensor electrodes,” “driving sensor electrodes,” “transmitters,” or “drivers”—at least for the duration when they are transmitting. Other names may also be used, including contractions or combinations of the earlier names (e.g. “driving electrodes” and “driver electrodes.” Sensor electrodes that receive are sometimes referred to as “receiving sensor electrodes,” “receiver electrodes,” or “receivers”—at least for the duration when they are receiving. Similarly, other names may also be used, including contractions or combinations of the earlier names. In one embodiment, a transmitting sensor electrode is modulated relative to a system ground to facilitate transmission. In another embodiment, a receiving sensor electrode is not modulated relative to system ground to facilitate receipt.

[0036] In FIG. 1, the processing system (or “processor”) 119 is coupled to the input device 116 and the electronic system 100. Processing systems such as the processing system 119 may perform a variety of processes on the signals received from the sensor(s) of input devices such as the input device 116. For example, processing systems may select or couple individual sensor electrodes, detect presence/proximity, calculate position or motion information, or interpret object motion as gestures. Processing systems may also determine when certain types or combinations of object motions occur in sensing regions.

[0037] The processing system 119 may provide electrical or electronic indicia based on positional information of input objects (e.g. input object 114) to the electronic system 100. In some embodiments, input devices use associated processing systems to provide electronic indicia of positional information to electronic systems, and the electronic systems process the indicia to act on inputs from users. One example system responses is moving a cursor or other object on a display, and the indicia may be processed for any other purpose. In such embodiments, a processing system may report positional information to the electronic system constantly, when a threshold is reached, in response criterion such as an identified stroke of object motion, or based on any number and variety of criteria. In some other embodiments, processing systems may directly process the indicia to accept inputs from the user, and cause changes on displays or some other actions occur without interacting with any external processors.

[0038] In this specification, the term “processing system” is defined to include one or more processing elements that are adapted to perform the recited operations. Thus, a processing system (e.g. the processing system 119) may comprise all or part of one or more integrated circuits, firmware code, and/or software code that receive electrical signals from the sensor and communicate with its associated electronic system (e.g. the electronic system 100). In some embodiments, all processing elements that comprise a processing system are located together, in or near an associated input device. In other embodiments, the elements of a processing system may be physically separated, with some elements close to an associated input device, and some elements elsewhere (such as near other circuitry for the electronic system). In this latter embodiment, minimal processing may be performed by the
processing system elements near the input device, and the majority of the processing may be performed by the elements elsewhere, or vice versa.

[0039] Furthermore, a processing system (e.g. the processing system 119) may be physically separate from the part of the electronic system (e.g. the electronic system 100) that it communicates with, or the processing system may be implemented integrally with that part of the electronic system. For example, a processing system may reside at least partially on one or more integrated circuits designed to perform other functions for the electronic system aside from implementing the input device.

[0040] In some embodiments, the input device is implemented with other input functionality in addition to any sensing regions. For example, the input device 116 of FIG. 1 may be implemented with buttons or other input devices near the sensing region 118. The buttons may be used to facilitate selection of items using the proximity sensor device, to provide redundant functionality to the sensing region, or to provide some other functionality or non-functional aesthetic effect. Buttons form just one example of how additional input functionality may be added to the input device 116. In other implementations, input devices such as the input device 116 may include alternate or additional input devices, such as physical or virtual switches, or additional sensing regions. Conversely, in various embodiments, the input device may be implemented with only sensing region input functionality.

[0041] Likewise, any positional information determined a processing system may be any suitable indicia of object presence. For example, processing systems may be implemented to determine “zero-dimensional” 1-bit positional information (e.g. near/far or contact/no contact) or “one-dimensional” positional information as a scalar (e.g. position or motion along a sensing region). Processing systems may also be implemented to determine multi-dimensional positional information as a combination of values (e.g. two-dimensional horizontal/vertical axes, three-dimensional horizontal/vertical/depth axes, angular/radial axes, or any other combination of axes that span multiple dimensions), and the like. Processing systems may also be implemented to determine information about time or history.

[0042] Furthermore, the term “positional information” as used herein is intended to broadly encompass absolute and relative position-type information, and also other types of spatial-domain information such as velocity, acceleration, and the like, including measurement of motion in one or more directions. Various forms of positional information may also include time history components, as in the case of gesture recognition and the like. As will be described in greater detail below, positional information from processing systems may be used to facilitate a full range of interface inputs, including use of the proximity sensor device as a pointing device for cursor control, scrolling, and other functions.

[0043] In some embodiments, an input device such as the input device 116 may be adapted as part of a touch screen interface. Specifically, a display screen is overlapped by at least a portion of a sensing region of the input device, such as the sensing region 118. Together, the input device and the display screen provide a touch screen for interfacing with an associated electronic system. The display screen may be any type of electronic display capable of displaying a visual interface to a user, and may include any type of LED (including organic LED (OLED)), CRT, LCD, plasma, EL or other display technology. When so implemented, the input devices may be used to activate functions on the electronic systems. In some embodiments, touch screen implementations allow users to select functions by placing one or more objects in the sensing region proximate an icon or other user interface element indicative of the functions. The input devices may be used to facilitate other user interface interactions, such as scrolling, panning, menu navigation, cursor control, parameter adjustments, and the like. The input devices and display screens of touch screen implementations may share physical elements extensively. For example, some display and sensing technologies may utilize some of the same electrical components for displaying and sensing.

[0044] It should be understood that while many embodiments of the invention are to be described herein the context of a fully functioning apparatus, the mechanisms of the present invention are capable of being distributed as a program product in a variety of forms. For example, the mechanisms of the present invention may be implemented and distributed as a sensor program on computer-readable media. Additionally, the embodiments of the present invention apply equally regardless of the particular type of computer-readable medium used to carry out the distribution. Examples of computer-readable media include various discs, memory sticks, memory cards, memory modules, and the like. Computer-readable media may be based on flash, optical, magnetic, holographic, or any other storage technology.

[0045] In one embodiment, the input device 116 utilizes a “click pad” technology. The touch sensor(s) used may be based on any type of touch-related technology, including resistive, capacitive, inductive, surface acoustic wave (SAW), optical, and the like. The depressing of the touch sensor, or the “click,” may be purely for tactile feedback. However, in the depicted embodiment described below, the click provides input information used to provide other responses in the electronic system 100. For example, the click may involve actuation of a binary or multi-stage switch, change a reading of a digital or analog force sensor, change a reading of a displacement sensor, or the like. The response to the switch actuation or force change can be non-varying or variable. Examples of non-varying responses include selection, emulation of specific mouse button clicks, confirmation of a command, and the like. Variable responses may be dependent on context such as such as which window is active in an associated GUI, which software application is active, which function is active, options then available to the user, the amount of force or displacement sensed, displays shown, position(s) of one or more input objects in the sensing region of the touch sensor, a combination thereof, or the like. The click pad may be integral or peripheral to computing devices, including terminals, desktops, laptops, PDAs, cell phones, remote controls, etc. The click pad may communicate via any wired or wireless protocols.

[0046] Examples of switches that may be used include snap dome buttons (which may be enabled with a Belleville spring or some other mechanism) and various types of microswitches. The switches may be binary or have multiple positions or switch levels. Any variety of switch technology, including electrical contact, resistive, or capacitive, may be used.

[0047] Examples of other sensors (aside from switches) include force sensors (e.g. strain gauges) or displacement sensors (e.g. linear position sensors). These sensors may supply finer resolution information. Finer resolution information may be used to provide multiple different levels of actuation
(even continuous changes akin to analog readings) for controlling various parameters (e.g. volume, speed, etc). For force sensors, the force sensed may not be the applied force (since the force transmitted to sensor may be a fraction or an amplification of the applied force, depending on the click pad design and potentially the location(s) of the input(s)). Since the touch sensor may be used to supply input location information, the actual force applied may be determined using the force reading as well as the location(s) of the input.

In some embodiments, sensors such as switches may be placed behind a touch sensor that is constrained in some way to move substantially repeatably in response to force applied to the touch sensor. For example, the substrate may be constrained to translate, rotate, or translate and rotate in such a way that it can activate the switch (or other sensor) used.

Some embodiments may implement keypads using touch sensors. A keypad may be demarcated by a dynamic display (e.g. an LCD) or statically imprinted on a surface of the touch sensor device. In response to user pressure applied on the surface, the associated touch sensor may relay the location(s) of the user input to a host processor that determines which key(s) should be activated in response. Criteria such as a minimum amount of force or a minimum duration of user contact may be applied to qualify the actuation. The system may respond to the activated key by passing the key information to another system or another part of the system, by entering the associated input (e.g. a letter, number, or function), by displaying visual feedback, or by taking any other appropriate action (e.g. by dialing a phone number if the keypad is that of a phone).

Motion of the touch sensor may be implemented in various ways. For example, the system may be designed to provide substantially uniform translation in response to actuation force applied to different locations across a surface of the touch sensor. A linear slide may be used to constrain the motion of the substrate such that the substrate does not tilt, twist, or slide (e.g. toward actuation of a switch or interaction with a force or displacement sensor).

FIG. 2 illustrates, in an exploded manner, an exemplary input device assembly 120 which utilizes “click touch-pad” or “click pad” technology and may be implemented in the input device 116. The input device assembly 120 includes a base (or lower bracket) 122, a guide mechanism (or flexure assembly) 124, a sensor support 126, and a touch sensor (e.g., a capacitive touch sensor) 128. As shown, all of the components of the input device assembly 120 are substantially rectangular and arranged such that the guide mechanism is positioned between (and intersects) the base 122 and the sensor support 126, and the touch sensor 128 is positioned over the sensor support 126. In the example shown, the input device assembly 120 also includes an upper bracket 130, a cover sheet (e.g., made of Mylar) 132, and various adhesive layers or films 134, which are arranged as shown. The input device assembly 120 further includes a switch (e.g., a snap dome button) 136 connected to a central portion of the base 122 on a side adjacent to the guide mechanism 124. Still referring to FIG. 2, as will be described in greater detail below, the base 122 has a lower guide mechanism opening 138, and the sensor support 126 has an upper guide mechanism opening 140.

FIGS. 3, 4, and 5 illustrates the input device assembly 120 partially assembled. As shown in FIG. 3, the touch sensor 128 is centered on and mounted to the sensor support 126. Referring to FIGS. 4 and 5, which show the assembly 120 without the touch sensor 128, the guide mechanism 124 and the sensor support 126 are arranged relative to the base 122 such that the guide mechanism 124 is aligned with the upper guide mechanism opening 140, as well as the lower guide mechanism opening 138, as described in greater detail below. Although not specifically shown, when the input device assembly 120 is assembled, the upper bracket 130 may be secured to a frame of the input device 116 such that it is aligned with a periphery of the touch sensor 128, the sensor support 126, and the base 122, as is suggested with the alignment of the components show in FIG. 1.

FIG. 6 illustrates the base 122, along with the guide mechanism 124 in an exploded view. In the depicted embodiment, the guide mechanism, or flexure assembly, 124 includes a first (or lower) flexure member (or spring) 142, a second (or upper) flexure member 144, and two spacing structures 146 and 148. In one embodiment, the first and second flexure members 142 and 144 are substantially rectangular, planar pieces of stainless steel with a thickness of, for example, between 0.002 and 0.004 inches. The spacing structures 146 and 148 are, in the depicted embodiment, “J” shaped channels that interconnect the first and second flexure members 142 and 144 along opposing edges thereof. In some embodiments, the flexure members 142 and 144 and the spacing structures 146 and 148 may be made of a single, integral planar piece of material (e.g., stainless steel) that is “wrapped” or folded into a “torsion box” configuration. In some embodiments, the shape of the flexure member can be adjusted for performance and response to user input, for example, holes, notches or apertures pattered in the flexure member.

It should be understood that the flexure members 142 and 144 may be constructed of a variety of different materials (e.g., other metals, composite materials, and plastics) and made to form various different shapes (e.g. wavy, rippled, perforated or otherwise shaped) as to provide substantially uniform actuation force across a surface of the touch sensor. It should also be understood that the spacing structures 146 and 148 may be constructed of a variety of different materials (e.g., other metals, composite materials, and plastics) and made to form a variety different shapes (e.g., “C” brackets, “I” shaped channels, solid blocks, or hollow channels, etc).

Referring again to FIG. 5, the guide mechanism 124 (and/or the flexure members 142 and 144 and/or the spacing structures 146 and 148) has a length 150 that is at least half a length 152 of the touch sensor 128 (shown with a dashed line in FIG. 5) and a width 154 that is less than half a width 156 of the touch sensor 128 (or the sensor support 126). Additionally, the guide mechanism 124 does not increase the “footprint” (i.e., lateral surface area covered) of the input device assembly 120. That is, the guide mechanism 124 is sized and arranged relative to the base 122, the sensor support 126, and the touch sensor 128 such that the guide mechanism 124 is contained within the outermost perimeter of the other components. In the example shown, the footprint of the input device assembly 120 is defined solely by the base 122, as the base 122 extends laterally further than the other components in all directions.

FIGS. 7-10 are side views of the input device assembly 120 illustrating the relationships between the base 122, the guide mechanism 124, the sensor support 126, and the switch 136, along with the operation thereof. The first flexure
member 142 is connected (or affixed) to the base 122 at a first interface 158 that is position along an edge of the lower guide mechanism opening 138, and the second flexure member 144 is connected to the sensor support 126 at a second interface 160 that is positioned along an edge of the upper guide mechanism opening 140. That is, guide mechanism 124 (and/or the interfaces 158 and 160) interconnects the base 122 and the sensor support 126 on opposing sides of the lower and upper guide mechanism openings 138 and 140. As such, the interface 158 and 160 do not overlap in the sense that, as shown in FIG. 7, first interface 158 is not directly below the second interface 160. More particularly, the first and second interfaces 158 and 160 are separated by a distance as measured across the base 122 and/or the sensor support 126. It should be understood that the interfaces 158 and 160 may simply refer to the interconnected portions of the base 122, the guide mechanism 124, and the sensor support 126 that are joined using, for example, rivets, screws, welding, laser welding, caulking (or a caulking joint), adhesive (e.g., glue), or any combination thereof.

In one embodiment, the interfaces 158 and 160 extend the entire length 150 of the guide mechanism 124. In other embodiments, the interfaces 158 and 160 may be broken into multiple, smaller segments, in which may be beneficial to have the segments spread across a part of the length 150 of the guide mechanism. Still referring to FIG. 7, the spacing structures 146 and 148 are arranged such that the spacing structure 146 is adjacent to (or directly above, as seen in FIG. 7) the first interface 158 and spacing structure 148 is adjacent to (or directly below, as seen in FIG. 7) the second interface 160. The spacing structures are arranged in a way such that the first and second flexure members 142 and 144 are substantially parallel. More particularly, the first and second flexure members 142 and 144 have respective planar portions 162 and 164 on opposing sides of a gap 166 formed between the spacing structures 146 and 148, which are substantially parallel. As described below, the planar portions may jointly form a bending or flexing portion of the guide mechanism 124. The gap 166 may have a height 168 of, for example, between 0.5 and 2.0 mm, which may be similar to the distance between the base 122 and the sensor support 126 (not accounting for the thickness of the flexure members 142 and 144). It should be noted that the use of the "J" shaped spacing structures 146 and 148 allows the size of the sensor support 126 to be maximized. An example of this is shown in FIG. 7, as an inner edge of the upper guide mechanism opening 140 partially extends over (i.e., overlaps) interface 158.

The switch 136 is affixed to the base 122 on a side of the lower guide mechanism opening 138 opposing the first interface 158. Referring ahead to FIG. 10, the switch 136 is coupled to the base 122 through an adjustment mechanism 170. In the depicted embodiment, the adjustment mechanism 170 is a set screw (or screw) that is inserted through a threaded hole (not explicitly shown) in the base 122 and connected to the switch 136. As such, rotation of the adjustment mechanism (or screw) 170 causes the switch 136 to move towards or away from the base 122. It should be understood that a variety of attachment and adjustment mechanisms for the switch may be used. For example, the switch 136 may be attached to the sensor support 126 (or the touch sensor 128) and be "facing" down with the dome in contact with the base 122. As shown in FIGS. 7-10, the switch (e.g., the dome) 136 is in contact with the sensor support 126. However, in some embodiments, the switch 136 may extend through an opening in the sensor support 126 and be in contact with a different component, such as the touch sensor 128 (FIG. 2).

FIG. 7 illustrates the assembly 120 when no additional force is being applied to the touch sensor 128 by user input. However, it should be noted that when the assembly is constructed, the upper bracket 130 (FIG. 2) may be positioned relative to the base 122 such that the upper bracket 130 applies a slight force to the touch sensor 128 and/or the sensor support 126 towards the base 122. In other words, the guide mechanism 124 may be slightly “pre-loaded” to ensure that the touch sensor 128 remains in contact with the upper bracket 130 (and/or the frame of the electronic system 100 or the input device 116) when the click pad functionality is not in use.

In normal operation, the touch sensor 128 is used to receive user input in the manner described above. To use the “click pad” functionality, the user simply applies a force onto, or into, the touch sensor 128, using the input object 114 (e.g., a finger or a stylus).

Referring to FIGS. 8 and 9, the force applied by the user causes the sensor support 126 to move towards the base, while the planar portions 162 and 164 of the first and second flexure members 142 and 144 bend or flex, thus applying a force that opposes the movement of the sensor support 126. Also, as the sensor support 126 (and/or the touch sensor 128) is moved downward, the switch 136 may be actuated (e.g., the dome portion of the snap down button collapses). It should also be noted that as the sensor support 126 is moved towards the base 122, the portion of the guide mechanism 124 near spacing structure 146 enters the upper guide mechanism opening 140, and the portion of the guide mechanism 124 near spacing structure 148 enters the lower guide mechanism opening 138.

Because of the arrangement of the guide mechanism 124, the sensor support 126 moves towards the base in a substantially “uniform” manner. That is, the use of two flexure members 142 and 144, along with the use of two separated spacing structures 146 and 148, minimizes any tilting and/or sliding experienced by the sensor support 126. Additionally, because of the length of the interfaces 158 and 160, the amount of twisting (i.e., rotation about an axis perpendicular to the touch sensor 128) experienced by the sensor support 126 is reduced. Of particular interest is that this sort of uniform motion occurs regardless of where on the touch sensor 128 the force is applied (e.g., in the middle vs. along an edge). It should also be noted that the uniformity of the motion is facilitated by the “non-overlapping” arrangement of the first and second interfaces 158 and 160, as the relative directions of motion of the interfaces 158 and 160 are controlled.

Referring specifically to FIG. 9, when the sensor support 126 is moved towards the base 122 by an actuation distance 172, the switch 136 is actuated to the point where it, in accordance with normal operation, generates a suitable signal which is sent to the processor 119 (FIG. 1). That is, the switch is “activated.” The particular magnitude of the actuation distance 172 is dependent on how much “travel” the switch 136 has (i.e., how much actuation is needed to activate the switch), the position of the switch 136 relative to the base 122 as determined by the adjustment mechanism 170 (FIG. 10) and the design of the guide mechanism 124. As such, the actuation distance 172 may be adjusted by utilizing a particular kind of switch and tuning the position of the switch with the adjustment mechanism 170. In some embodiments, the activation of the switch provides a particular tactile feel to the
user by, for example, providing a different amount of resistance to further actuating the switch 136. The activation of the switch 136 may also be accompanied by an audible sound, such as a “click.”

[0065] When the user releases or lifts the input object from the touch sensor 128, the force being applied by the flexure members 142 and 144 causes the sensor support 126 to return to the position shown in FIG. 7. This movement may also be substantially uniform, as little or no twisting, tilting, or sliding may be experienced, for the same reasons as those described above with respect to the sensor support 126 moving towards the base 122.

[0066] FIGS. 11 and 12 illustrate another embodiment of the input device assembly 120. Of particular interest in the assembly 120 shown in FIGS. 11 and 12 is the addition of an upper lip 174 on the sensor support 126 and a lower lip 176 on the base 122. The upper lip 174 extends downwardly (as drawn) from the sensor support 126 at opposing edges thereof (e.g., only along the two “longer” edges (or sides) of the sensor support 126). The lower lip 176 extends upwardly from the base 122 also at opposing edges thereof (e.g., only along the two “longer” edges (or sides) of the base 122). The upper lip 174 includes a series of protrusions 178 on an outer side thereof, while the lower lip 176 includes a matching series of slots 180 on an inner side thereof. In the depicted embodiment, the base 122, the upper bracket 130, and the lips 174 and 176, are configured such that when the assembly 120 is assembled, the upper lip 182 passes along the inner side of the lower lip 184. Additionally, the protrusions 186 and the openings 188 are arranged and sized such that the protrusions 186 “snap fit” into the openings 188 to attach the upper bracket 130 to the base 122, and thus “pre-loading” the guide mechanism, as has already been described.) In some embodiments, the upper bracket 130 may be secured to a frame of an electronic system, such as a laptop computer. In some embodiments, the upper lip 182 passes along the outer side of the lower lip 184.

The embodiment shown in FIG. 13 provides a simple and inexpensive manner for securing the input device assembly 120 to such an electronic system. It should also be noted that in the embodiment shown in FIG. 13 the spacing structures 146 and 148 are substantially solid blocks.

[0069] A sensor device is provided that comprises an array of capacitive sensing electrodes and a processing system coupled to the electrodes. The capacitive sensing electrodes are configured to generate sensing signals that are indicative of objects in a sensing region. The processing system is configured to receive sensing signals from the capacitive sensing electrodes and generate a plurality of sensing values, each of the plurality of sensing values corresponding to a sensing electrode in the first array of capacitive sensing electrodes. The processing system is further configured to produce a plurality of positional values corresponding to a plurality of groups of electrodes in the first array of capacitive sensing electrodes; analyze the plurality of positional values to determine if one or more clusters exist in the plurality of positional values; and determine a number of objects in the sensing region from the determined one or more clusters in the plurality of positional values. Thus, the sensor device facilitates the determination of the number of objects in the sensing region, and can thus be used to facilitate different user interface actions in response to different numbers of objects.

[0070] The embodiments and examples set forth herein were presented in order to best explain the present invention and its particular application and to thereby enable those skilled in the art to make and use the invention. However, those skilled in the art will recognize that the foregoing description and examples have been presented for the purposes of illustration and example only. The description as set forth is not intended to be exhaustive or to limit the invention to the precise form disclosed.

What is claimed is:
1. An input device assembly comprising:
   a. a base;
   b. a sensor support; and
   c. a guide mechanism attached to the base and the sensor support, wherein the guide mechanism allows for only substantially uniform translation of the sensor support towards the base in response to a force biasing the sensor support substantially towards the base.
2. The input device assembly of claim 1, wherein the guide mechanism comprises a flexure assembly designed to bend in a bending region, the flexure assembly having a first flexure spring with a first substantially planar portion in the bending region and a second flexure spring having a second substantially planar portion in the bending region, wherein the first and second substantially planar portions overlap, are substantially parallel to each other, and are separated by a distance.
3. The input device assembly of claim 2, wherein the flexure assembly is configured such that when the sensor support
translates towards the base in response to the force biasing the sensor support substantially towards the base, the first and second substantially planar portions remain substantially parallel to each other and the distance separating the first and second substantially planar portions remains substantially constant.

4. The input device assembly of claim 2, wherein the flexure assembly further comprises a spacing structure interconnecting the first and second flexure springs.

5. The input device assembly of claim 2, further comprising a switch, wherein the switch is actuated when the sensor support translates towards the base by at least an actuation distance.

6. The input device assembly of claim 5, further comprising a switch adjustment mechanism, the switch adjustment mechanism configured to adjust the actuation distance.

7. An input device assembly comprising:
   a base;
   a sensor support configured to support a touch sensor; and
   a flexure assembly comprising:
   a first flexure member affixed to the base and having a first substantially planar portion;
   a second flexure member affixed to the sensor support and having a second substantially planar portion and;
   at least one spacing structure interconnecting the first and second flexure members and forming a space between the first and second substantially planar portions such that the first and second substantially planar portions are substantially parallel and overlap, wherein the flexure assembly is configured to generate an opposing force in response to a displacement of the sensor support towards the base.

8. The input device assembly of claim 7, wherein the first flexure member is connected to the base at a first interface, and the second flexure member is connected to the sensor support at a second interface, and wherein the first and second interfaces do not overlap.

9. The input device assembly of claim 7, wherein the entire flexure assembly is positioned within a combined footprint of the touch sensor, the sensor support, and the base.

10. The input device assembly of claim 7, further comprising a switch, and wherein the switch is actuated when the sensor support is displaced towards the base by an actuation distance.

11. The input device assembly of claim 10, wherein the base comprises an opening arranged such that when the sensor support is displaced towards the base by the actuation distance, the flexure assembly moves into the opening.

12. The input device assembly of claim 8, wherein at least one spacing structure comprises a first spacing structure and a second spacing structure, the first spacing structure being adjacent to the first interface and the second spacing structure being adjacent to the second interface, the first and second spacing structures configured such that a gap distance of the space between the first and second flexure members remains substantially constant when the sensor support is displaced towards the base by an actuation distance.

13. The input device assembly of claim 8, wherein a length of the first substantially planar portion is at least half of a length of the sensor support, and wherein a length of the second substantially planar portion is at least half of the length of the sensor support.

14. A depressable touch pad device configured to sense objects in a sensing region comprising:
   a base;
   a sensor support;
   a capacitive touch sensor configured to detect input objects in the sensing region physically coupled to the sensor support, the capacitive touch sensor comprising:
   a substrate;
   a plurality of sensor electrodes disposed on the substrate; and
   a processing system communicatively coupled to the plurality of sensor electrodes; and
   a flexure assembly positioned within a combined footprint of the base, the sensor support, and the capacitive touch sensor, the flexure assembly comprising:
   a first flexure member affixed to the base at a first interface, the first flexure member having a first substantially planar portion;
   a second flexure member affixed to the sensor support at a second interface, the second flexure member having a second substantially planar portion, wherein the first and second interfaces do not overlap; and
   first and second spacing structures interconnecting the first and second flexure members such that the first and second planar portions are separated by a separation distance, are substantially parallel to each other, and overlap each other, wherein the first spacing structure is adjacent to the first interface and the second spacing structure is adjacent to the second interface,
   wherein in response to a displacement of the capacitive touch sensor towards the base, the first and second flexure members flex and generate an opposing force and the first and second spacing structures keep the separation distance substantially constant and the first and second substantially planar portions substantially parallel.

15. The depressable touch pad device of claim 14, further comprising:
   a switch configured to be actuated when the touch sensor is moved an actuation distance towards the base; and
   a switch adjustment mechanism, the switch adjustment mechanism configured to adjust the actuation distance.

16. A method for providing an input device assembly, the method comprising:
   providing a base;
   providing a sensor support; and
   providing a flexure assembly designed to bend in a bending region and attached to the base and the sensor support, wherein the flexure assembly allows for only substantially uniform translation of the sensor support towards the base in response to a force biasing the sensor support substantially towards the base.

17. The method of claim 16, wherein the providing the flexure assembly designed to bend in the bending region and attached to the base and the sensor support comprises:
   attaching a first flexure spring to the base such that a substantially planar portion of the first flexure spring is in the bending region; and
   attaching a second flexure spring to the sensor support such that a substantially planar portion of the second flexure spring is in the bending region and overlaps the substantially planar portion of the of the first flexure spring.
wherein the second flexure spring is physically coupled to the first flexure spring, and wherein the substantially planar portion of the second flexure spring is substantially parallel to and is separated by a distance from the substantially planar portion of the first flexure spring.

18. The method of claim 17, wherein the attaching the first flexure spring to the base and the attaching the second flexure spring to the sensor support each comprises using a laser weld, a rivet, a screw, or an adhesive.

19. The method of claim 16, further comprising physically coupling a capacitive touch sensor to the sensor support, the capacitive touch sensor configured to detect input objects in a sensing region, the capacitive touch sensor comprising:

   a sensor substrate;

   a plurality of sensor electrodes disposed on the sensor substrate; and

   a processing system communicatively coupled to the plurality of sensor electrodes.

20. The method of claim 19, further comprising providing a switch communicatively coupled to the processing system and arranged such that the switch is actuated when the sensor support translates towards the base by at least an actuation distance.

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