forms an action based on the touch event. Touch surfaces are constructed in basically the same manner as a touch screen, except the surfaces need not be substantially transparent.

[0100] By way of example, the touch sensitive housing may generally correspond to the touch sensitive housing described in greater detail U.S. patent application Ser. No. 11/115,539, titled "Hand-Held Electronic Device with Multiple Touch Sensing Devices," filed Apr. 26, 2005.

C. Display Actuator

[0101] A hand-held multi-functional electronic device may also include a display actuator, which is an input device that mechanically uses the display of the hand-held device to provide inputs into the device (rather than electrically as with a touch screen). The display actuator may be used separately or in combination with the touch screen. The display actuator may include a movable display that causes one or more input signals to be generated when moved. The input signals then can be used to initiate commands, make selections, or control motion in a display.

[0102] The movable display may be configured to translate, slide, pivot, and/or rotate relative to the frame. The display is typically movable relative to a frame or housing that movably supports the display in its various positions. In some cases, the display is movably coupled to the frame, and in other cases the frame movably restrains a floating display.

[0103] The input signals may be generated by movement indicator(s) that monitor the movements of the display and produces signals indicative of such movements. The detection mechanism may, for example, one or more switches, sensors, encoders, and/or the like. Any suitable mechanical, electrical and/or optical switch, sensor or encoder may be used. For example, tact switches, force sensitive resistors, pressure sensors, proximity sensors, infrared sensors, mechanical or optical encoders and/or the like may be used. The movement indicators may be placed underneath the display or at the sides of the display as appropriate. Alternatively or additionally, these movement indicators may be attached to the display or some component of the display.

[0104] An exemplary display actuator is disclosed in U.S. patent application Ser. No. 11/057,050, titled "Display Actuator," filed on Feb. 11, 2005.

D. Pressure or Force Sensing Devices

[0105] The multi-functional hand-held electronic device described above may further include force or pressure sensing devices such as a force sensing display or housing.

1. Force Sensitive Display

[0106] A force sensitive display causes one or more input signals to be generated when pressure is exerted on the display screen of the device. The input signals can be used to initiate commands, make selections, or control motion in a display. Such displays generally provide a slight amount of flex (unnoticeable to the user) so, that any forces exerted thereon can be measured by a force detection arrangement generally provided underneath the display. The force detection arrangement monitors the forces exerted on the display and produces signals indicative thereof. The force detection arrangement may include one or more force sensors such as force sensitive resistors, force sensitive capacitors, load cells, pressure plates, piezoelectric transducers, strain gauges, etc. The force sensors may be attached to the back of the display or to a structural platform located within the housing of the device. When a force is applied to the display, it is transmitted through the display to the force sensor located underneath the display.

[0107] **FIG. 19** is a side elevation view, in cross section, of a hand-held device **300** incorporating a force sensitive display **302**. The force sensitive display **302** includes a display **308** and one or more force sensors **310** disposed underneath the display **308** (between the display and a structural platform **306**). In most cases, the force sensitive display **302** includes a plurality of sensors **310** that are laid out in an array. For example, the sensors **310** may be positioned side by side in rows and columns. The force sensors **310** measure the amount of force being applied to the display and when a desired force threshold is reached a control signal is generated. In some cases, an elastomer **312** is placed between the display and the structural platform to help transmit the force being exerted on the surface of the display to the force sensors disposed below the display.

[0108] Force sensing may be provided in conjunction with a touch screen to differentiate between light and hard touches. The determination of whether a touch is a light touch or a hard touch may be made by monitoring the force with the force sensors and comparing the force to a predetermined threshold. When the force threshold is not exceeded, the touch is considered a light touch. When the force threshold is exceeded, the touch is considered a hard touch. Each type of touch may be used to control different aspects of the device. Light touches may be associated with passive events such as navigation (e.g., cursor control scrolling, panning, zoom, rotation, etc.) and hard touches may be associated with active events such as selections or commands (e.g., button click).

[0109] **FIG. 20** illustrates an input device **320** that combines touch sensing and force sensing devices to provide x, y and z components when touched. The touch sensing device provides position sensing in the x and y directions, and the force sensing device provides force sensing in the z direction. These devices cooperate to output x, y location and z pressure information whenever there is a touch on the touch surface.

[0110] **FIG. 21** is a side elevation view of an I/O device **330** that combines a display **332** with touch screen **334** and a force sensing mechanism **336**. The touch screen **334** provides high resolution touch locations, and the force sensing mechanism **336** provides a measure of where the force is coming from as well the total force. Touch screen **334** is disposed over the display **332**, and the force sensing mechanism **336** is disposed below the display **332** although other arrangements are possible.

[0111] Force sensing mechanism **336** may also be widely varied. In the illustrated embodiment, the force sensing mechanism **336** is based on capacitance, and more particularly, self capacitance. The illustrated force sensing mechanism **336** is formed from various layers including an electrode layer **338**, an elastomer layer **340** and a conductive layer **342**.

[0112] Electrode layer **338** includes a plurality of spatially separated electrodes **339** that are positioned across the bottom of the display **332**. Electrodes **339** are typically