force sensor **140** may be disposed within the other touch sensor layer **88**. Integrating the force sensor **140** in a touch sensor layer **88**, **92** is an inexpensive way to implement a force sensor because the force sensor **140** may be formed of the same material during the same process without requiring separate discrete components that take up space outside the touch-sensitive display **33**. The same controller **35** or processor **22** may also be utilized to process the force sensor **140** and touch sensor **88**, **92** signals.

[0048] The touch sensors layers **88**, **92** advantageously comprise a material that is optically translucent or transparent, for example a thin film, such that light emitted from the display **32** is visible on the outside of the touch-sensitive display **33**. The touch sensor layers **88**, **92** may advantageously comprise, for example, piezoelectric or piezoresistive materials, such as ITO, ATO, ZAO, and so forth, which are advantageously optically translucent or transparent. Piezoresistive material at room temperature exhibits low sheet or layer resistivity, for example, in the range of 50 to 300 ohms/square, and relatively high (negative) gage factor, on the order of 5 to 10 gage factor or higher. ITO is a piezoresistive material with a gauge factor greater than known metal strain gauges. Although the material comprising the capacitive touch sensor and the force sensor may differ, for example, to optimize the capacitive and resistive properties, utilizing the same material for both sensors is beneficial because the second touch sensor layer **92**, including the force sensor **140**, may be formed during the same process.

[0049] A touch imparted on the touch-sensitive display **33** causes the force sensor **140**, for example, to undergo an electrical change in resistance that corresponds to a force imparted by the touch. The change in resistance may occur due to a change in geometry of the deflected or displaced material and the change in resistivity of the material arising from micro-changes in the structure of the material under pressure. Generally, between about 1 and 5 N of force may be applied by a user to the touch-sensitive display **33**, for example, in the general direction of arrow A shown in FIG. **3**. Under such force conditions, the total change in resistance may be, for example, on the order of about 0.01%.

[0050] The example pattern of the force sensor **140** shown in FIG. **6** occupies enough of the available area of the touch sensor layer **92** that force may be sensed for any location of a touch on the touch-sensitive display **33**. Various other patterns of the force sensor may be utilized, such as patterns of a single, continuous sensor or patterns of multiple discrete sensors electrically coupled to one another or in isolation, such as shown in FIG. **7**. Any suitable single force sensor pattern may be advantageously utilized because the force or the majority of the force of a touch is generally perpendicular to the plane of the cover **96** of the touch-sensitive display **33**, i.e., in the z direction. Other patterns, such as multiple force sensor patterns, e.g., bi-directional, multi-grid patterns, may provide increased sensing accuracy with less dependency on the width and orientation of the pattern or the direction of the touch. For example, planar or stacked rosette patterns, such as "tee", "delta," and "rectangular" rosettes, may be utilized.

[0051] Another example of a touch sensor layer **792** that facilitates determination of the y component of a touch location is illustrated in FIG. **7**. In this example, the touch-sensitive display **33** is divided into five zones **751**, **752**, **753**, **754**, **755**, with their area boundaries indicated by dashed lines in FIG. **7**. Ten discrete force sensors **740** are shown with two force sensors **740** located in each of the five zones **751**, **752**, **753**, **754**, **755**. Each zone **751**, **752**, **753**, **754**, **755** may include an actuator **37**, as indicated by dashed circles in FIG. **7**.

[0052] The force sensors **740** are shown in FIG. **7** in a rosette pattern, although any other suitable pattern may be utilized, including, for example, single force sensor patterns, multiple force sensor patterns, multi-directional patterns, stacked or planar configurations, patterns of other shapes, and so forth. The individual force sensors **740** may be electrically coupled to one another and to the controller **35** or the processor **22**, such that a change in resistance or force sensed at any one of the force sensors **740** may generate a signal to the electronic controller **35** or the processor **22** without differentiating which force sensor **740** sensed the force. The force sensors **740** are electrically isolated as shown in FIG. **7**, and separate conductors connect each individual force sensor to the controller **35** or the processor **22**.

[0053] The values from one or more individual force sensors **740** may be utilized, independently or by averaging, to actuate one or more associated actuators **37**. Tactile feedback may be provided corresponding to the specific zone or zones in which a touch is detected. Such tactile feedback may give the user greater accuracy and sense of control over input to the portable electronic device.

[0054] The force sensor(s) may additionally or optionally be located below the display, such as illustrated in FIG. **3**. The force sensors **77** shown in FIG. **3**, which may comprise one or more posts that may deflect as the touch-sensitive display **33** moves in response to a touch. Deflection of the force sensors **77** generates a force signal that is sent to the controller **35** and/or the processor **22**. The posts **77** may be composed of a piezoelectric material through which an electrical change in resistance may be detected to provide a force signal/force value corresponding to the force imparted on the touch-sensitive display.

[0055] The force sensor **140** sends a force signal to the controller **35** or the processor **22**, for example, in response to a change in resistance resulting from the application of force exerted on the touch-sensitive display **33**, for example, by a touch. The change in resistance results from the application of force, rather than due to an electrical coupling as with the capacitive touch sensor, such that touch by a non-conductive object may be detected by the force sensor **140**. The processor **22** determines whether the force signal corresponds to a touch and may perform a function associated with the detected touch location.

[0056] The portable electronic device **20** may be configured to perform functions when the force sensor **140** indicates that a touch of sufficient force has been imparted on the touch-sensitive display **33**. For example, a backlight (not shown) may be activated or a "home" screen may be displayed on the touch-sensitive display **33**. The portable electronic device **20** may determine whether a touch constitutes a command to perform a function. A "click" event is a touch that corresponds to a virtual button depressed with a sufficient force, e.g., a touch having a force exceeding a force threshold or any other input action that warrants feedback. Feedback may include tactile feedback, e.g., vibration, impulse, deflection, or other movement of the touch-sensitive display **33**, visual feedback, e.g., a flashing light, displaying a visual indicator such as a symbol on the touch-sensitive display **33**, and so forth, and/or audible feedback, e.g., emitting a beep, playing an audible media file, and so forth. One or more