# ELECTRONIC DEVICE HOUSING WITH INTEGRATED USER INPUT CAPABILITY

## CROSS-REFERENCE DATA

**[0001]** This application claims priority of the U.S. Provisional Patent Application No. 60/792,379 filed 14 Apr. 2006 with the same title and incorporated herein in its entirety by reference. It is also a continuation-in-part of the U.S. patent application Ser. No. 11/697,026 with the same title filed 5 Apr. 2007, now U.S. Pat. No. 7,595,788.

## FIELD OF THE INVENTION

**[0002]** The present invention generally relates to electronic devices with housings incorporating user input means based on contact force sensing. More specifically, the invention relates to a hand-held electronic device with a portion of a housing adapted to serve as a contact force-sensitive user input zone. In particular, the user input zone comprises a capacitance tactile sensor built using the housing itself as one of the electrodes thus obviating the need for separate input devices to protrude through the housing.

## BACKGROUND

**[0003]** There exist today many types of consumer electronic devices, each of which utilizes some sort of user input and interface. The user interface typically includes an output device in the form of a fixed display such as an LCD and one or more input devices, which can be mechanically actuated as for example, switches, buttons, keys, dials, joysticks, navigation pads, or electrically activated as for example touch pads and touch screens. The display is typically configured to present visual information such as text and graphics, and the input devices are typically configured to perform operations such as issuing commands, making selections or moving a cursor in the consumer electronic device. Each of these well known devices has considerations such as size and shape limitations, costs, functionality, complexity, etc. that must be taken into account when designing the consumer electronic device. In most cases, the user interface is positioned on the front face of the electronic device for easy viewing of the display and easy manipulation of the input devices. Examples of hand-held electronic devices include mobile phones, PDAs, remote controls, various media and game players, and other navigation and communication devices.

**[0004]** Modern seamless look is one of the desired marketing aspects of present-day electronic devices. Incorporation of user input into the design of such devices without resorting to traditional buttons and switches allows manufacturers to present their devices to consumers in the most positive light. Force-sensitive zones on the device housing may serve just such purpose. In comparison to similar input devices that sense electrical proximity of the person's finger, the present invention allows force-controlled proportional signal recognition that can be used to enhance the user operation of the electronic device. Examples of such enhancements include pressure-based scroll, zoom, and multiple activation levels: light touch+motion only moves a cursor while hard touch+motion grabs and moves an object simulating real world environments.

**[0005]** Conventional touch-sensitive proximity sensors include a conductive electrode covered with an insulating dielectric layer. Touching the proximity sensor by a finger causes a change in capacitance of the electrode because the finger serves as an electrical ground due to a slightly conductive nature of human tissue. That change and the location of the touch point are then detected by the control circuitry and used as an input signal for the electronic device. However, the level of signal does not correlate well with the actual amount of force applied to the sensor: a small finger can exert much higher force yet yield a smaller amount of signal when compared to a larger finger causing a larger contact area. Thus, using a conventional touch-sensitive proximity sensor for applications such as on an Iphone or Ipod is not suitable as a proportional force-sensitive input device.

**[0006]** Traditionally, touch-sensitive zones incorporated in the device housing are made using proximity sensors such as capacitance electrode on the inside surface of the housing. One additional limitation of such proximity sensors is that the user cannot wear gloves or use a non-conductive object like a pencil when interacting with the device. A glove insulates the finger from the sensor precluding the proper function of the device. The need exists therefore for a touch-sensitive input device capable of working with both conductive and non-conductive user input objects such as a gloved finger or a stylus.

**[0007]** Another known method of sensing the touch of the user through the housing is done by having a thin compressible portion of the housing placed in firm contact with the strain gauge sensor located inside the device. Piezoelectric strip can be used as such a sensor. Pressure from the finger of the user is transmitted as deflection through the deformable housing and sensed as a changed strain through the housing surface by the strain gauge sensor. The signal from the sensor is then used as an input command by the electronic circuitry of the device. This approach requires the device to incorporate several separate components that have to be assembled together to make it work, making manufacturing processes quite complicated and costly.

**[0008]** Examples of devices using this concept are disclosed in the U.S. Pat. Nos. 5,555,894; 6,040,823; 6,945,981; and US Patent Applications Nos. 2003/0076306; 2006/0197750; and 2006/0197753, all incorporated herein by reference in their entirety. The need exists for a simplified touch-sensitive housing that can inherently serve as an input device.

## SUMMARY OF THE INVENTION

**[0009]** Two fundamentally different types of touch sensors that are known to exist today can be described as follows:

- **[0010]** Deformation-based capacitive sensors that generate a signal responsive to deformation of at least one of the conductive layers whereby causing these layers to come closer together at the location of such deformation, and
- **[0011]** Non-deformation based proximity sensors detecting a presence in their vicinity of a ground electrode object such as a conductive pointing device or a finger of a user—a change in capacitance is detected at a location of such ground object without any physical deformation of the sensor itself.

**[0012]** On the one hand, operation of a proximity sensor of the second type independently of mechanical deformation of the sensor surface makes it easy for incorporating into a housing of an electronic device. On the other hand, using of a sensor of the first type in the same configuration is much more problematic and not obvious due to the reliance of this sensor on a repeatable and consistent deformation of at least one conductive layer to achieve satisfactory performance.