DETAILED DESCRIPTION OF THE INVENTION

[0048] The present invention will now be described in detail with reference to a few preferred embodiments thereof as illustrated in the accompanying drawings. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be apparent, however, to one skilled in the art, that the present invention may be practiced without some or all of these specific details. In other instances, well known process steps have not been described in detail in order not to unnecessarily obscure the present invention.

[0049] Likewise, the drawings showing embodiments of the system are semi-diagrammatic and not to scale and, particularly, some of the dimensions are for the clarity of presentation and are shown greatly exaggerated in the drawing figures.

[0050] Similarly, although the views in the drawings for ease of description generally show similar orientations, this depiction in the figures. is arbitrary for the most part. Generally, the invention can be operated in any orientation. In addition, where multiple embodiments are disclosed and described having some features in common, for clarity and ease of illustration, description, and comprehension thereof, similar and like features one to another will ordinarily be described with like reference numerals.

[0051] Referring now to FIG. **1**, a generic electronic device **10** is shown. Device **10** could be, for example, a laptop computer, a media device, a remote control, a game player, or any other device that requires a button or switch. Device **10** features an invisible button or switch **20**, whose location is shown in phantom. Button **20** is used to control some function associated with electronic device **10**. Device **10** has a metal frame **30**, which may be, for example, aluminum. Button **20** is invisible because it is made from and integral with the same metal as frame **30**. Button **20** is flush with and does not bulge out or otherwise protrude into or out of frame **30**. Therefore, it is not visible from the exterior of device **10**. Frame **30** may have markings (e.g., paint, texture) to indicate the location of button **20**.

[0052] FIG. **2** shows a side cross sectional view of device **10**, taken along line **2-2** shown in FIG. **1**. Metal frame **30** has a face **40**. Inside of device **10**, there is an interior wall **50** below face **40**. In between face **40** and wall **50** is a dielectric medium **60**, such as air. In another implementation, dielectric medium **60** can be foam or rubber. In these implementations, supports **70** could be unnecessary and therefore removed. Supports **70** are disposed between face **40** and interior wall **50**. Dielectric medium **60** can be a dielectric gel (instead of air).

[0053] In the vicinity of invisible button **20**, a capacitor plate **80** is disposed on an inner surface of face **40**, and another capacitor plate **85** is disposed on a top surface of interior wall **50** opposite plate **80**. Capacitor plates **80** and **85** may be attached to, for example, printed circuit boards (PCBs) which are disposed on face **40** and/or wall **50**. In one embodiment, wall **50** is a PCB. In another embodiment, capacitor plates **80** and/or **85** can comprise conductive paint printed on face **40** and wall **50**. As used herein, a "capacitor plate" could be any conducting material which is separated from another conducting material. In the illustrated embodiment, capacitor plates **80** and **85** are shown as discrete objects attached to face **40** and wall **50**. In another embodiment (not shown) the face **40** and wall **50** themselves may function as capacitor plates.

[0054] There is a fixed separation between capacitor plates **80** and **85** when button **20** is not being depressed. This is important because the capacitance, C, between separated plates **80** and **85** is a function of their separation. When button **20** is not depressed, the zero-pressure capacitance, C_0, is related to the initial separation of plates **80** and **85**. Departures from the initial separation will cause a change in capacitance, $\Delta C \equiv C - C_0$, which can be detected and processed by device **10**. In practice, C_0 may not be strictly a function of separation. Other factors, such as changes in temperature, humidity, age of components, and the like can cause minor fluctuations in C_0. Therefore, a new estimate or baseline for the zero-pressure C_0 may be updated. In one embodiment, this update can be done each time device **10** starts up. In another embodiment, this update can be done during certain time intervals (for example every few minutes). Updating C_0 helps to ensure higher sensitivity and lower occurrences of false triggers.

[0055] When a user presses down on invisible button **20**, face **40** deflects between supports **70**, as shown in FIG. **3**. This causes the distance between capacitor plates **80** and **85** to decrease, creating an associated change in capacitance, ΔC. A capacitive sensor (not shown) associated with device **10** detects this change, and if the change is above some preset threshold, T, a button function is activated. In other words if $\Delta C \geqq T$ the button function is activated. For example, when the user presses down on button **20**, device **10** may turn on or off. Since both capacitor plates **80** and **85** are internal to device **10**, it is not necessary to push button **20** with a conducting material, e.g., a finger or stylus, as is the case with traditional capacitive sensing technology (e.g, glass touch screens). In contrast to traditional capacitive sensing surfaces, a user could successfully activate button **20** wearing a non-conductive glove, for example.

[0056] The on/off, or "binary," mode of operation described above is the simplest mode. In other embodiments, the change in capacitance ΔC could be correlated to a "continuous" output functionality. In this implementation, a larger ΔC could be associated with a command to full intensity. A very small ΔC could be associated with a command to low intensity. For example, how far the user presses down could correlate to how bright to make a light, for example, how loud to play music, or how fast to go forward or backward in a movie. In this continuous functionality mode, the correlation between capacitor plate distance and change in capacitance ΔC must be found through routine experiment, theory, calculation or combinations thereof. In other embodiments, button **20** could have three levels of functionality. This is a compromise between the binary and continuous modes. For example, before the user presses down, device **10** is "off," when the user presses down a certain amount, device **10** operates at 50%, and when the user presses down a certain amount more, device **10** operates at 100%. This could mean that device **10** could be used to turn a light from off, to 50% intensity, to 100% intensity depending on user input. Of course, many variations of this multi-level functionality mode are possible (e.g., 4 or more levels).

[0057] Supports **70** limit the area where a user can activate button **20**. In the illustrated embodiment, if a user presses down to the left of the left support **70**, for example, capacitor plates **80** and **85** will not appreciably move towards each other. Therefore, a change in capacitance (if any) will not exceed the threshold required to register a button depression, i.e., $\Delta C < T$. The supports can be closely spaced, thereby making the effective area of button **20** small, or the supports can be