

(upward on the page) will cause deformation of the member 60 against the touch screen 12, as shown in FIG. 12B. As in other embodiments, the spring may simply secure the mass 68 against the deformable member 60 such that deformation indicates acceleration in the +Z direction, or the spring may normally cause a first degree of deformation in order to indicate acceleration in the +Z direction by an increase in deformation and indicate acceleration in the -Z direction by a decrease in deformation.

[0055] FIG. 12C is a partial cross-sectional view of an embodiment for detecting acceleration in the +Y or -Y direction (as shown) or even in the +X or -X direction by orienting the mechanism at 90 degrees. Whereas the mechanisms of FIGS. 8A-C use a pivot to convert a force parallel to the touch sensitive device to a force perpendicular to the touch sensitive device, this mechanism 150 uses a fluid in the tubular chamber to enable the direction of the force to be changed as desired. Accordingly, acceleration of the module 50 in the +Y direction (to the right of the page) causes a high mass hydraulic piston 152 to move to the left, pushing the fluid 154 against the low mass piston 156, which in turn deforms the member 60 against the touch screen 12. The hydraulic tube is bent 90 degrees so that movement of the higher mass piston 152 in a direction parallel to the plane of the touch sensitive device 12 is converted to movement of the low mass piston 156 perpendicular to the touch sensitive device 12. Optionally, the low mass piston could be replaced with a membrane or bellows to cover the end of the tube 158 and contain the fluid 154. Hydraulic pressure would deform the membrane or bellows. This would enable the membrane or bellows to also function as the deformable member 60. Again, the spring may be used to deform the member 60 so that acceleration in both the +Y and -Y direction (or both the +X and -X direction) can be detected by sensing an increase or decrease in deformation.

[0056] FIGS. 13A-B provide a flow diagram of a method 100 for detecting accelerations that are applied to the accelerometer module. The user may select to enter an accelerometer mode of operation on a touch screen device (step 102), such as by pressing an accelerometer mode icon. When the accelerometer module is physically installed, the touch screen detects contact in certain predetermined regions to indicate that an accelerometer module has been properly coupled relative to the touch screen (step 104). During use of the accelerometer, the method monitors the contact area of the deformable member associated with each of three components of acceleration in a Cartesian coordinate system (step 106).

[0057] If a change is detected in the contact area associate with the "X" axis (step 108), then it is determined whether the contact area increased or decreased (step 110). If the contact area increased, then there is an indication of an acceleration in the positive X direction (+X) in an amount that is proportional to the extent of increase in the contact area (step 112). However, if the contact area decreased, then there is an indication of an acceleration in the negative X direction (-X) in an amount that is proportional to the extent of decrease in the contact area (step 114). The function of this proportionality may be stored in the application software.

[0058] If a change is detected in the contact area associate with the "Y" axis (step 118), then it is determined whether the contact area increased or decreased (step 120). If the contact area increased, then there is an indication of an acceleration in the positive Y direction (+Y) in an amount that is proportional to the extent of increase in the contact area (step 122). How-

ever, if the contact area decreased, then there is an indication of an acceleration in the negative Y direction (-Y) in an amount that is proportional to the extent of decrease in the contact area (step 124). The function of this proportionality may be stored in the application software.

[0059] Furthermore, if a change is detected in the contact area associate with the "Z" axis (step 128), then it is determined whether the contact area increased or decreased (step 130). If the contact area increased, then there is an indication of an acceleration in the positive Z direction (+Z) in an amount that is proportional to the extent of increase in the contact area (step 132). However, if the contact area decreased, then there is an indication of an acceleration in the negative Z direction (-Z) in an amount that is proportional to the extent of decrease in the contact area (step 134). The function of this proportionality may be stored in the application software.

[0060] Having detected whether there was any acceleration in the X, Y or Z directions, and having determined the extent of the acceleration where detected, the method provides the resulting X, Y and Z components of acceleration to an application program for further use (step 136). If the user wants to exit the accelerometer mode (step 138), then the process ends. Otherwise, the method continues in the accelerometer mode and returns to step 106 to continue monitoring the contact areas on the touch screen. Application programs, such as pedometers or video games, may use the output of the method in a wide variety of ways.

[0061] The terms "comprising," "including," and "having," as used in the claims and specification herein, shall be considered as indicating an open group that may include other elements not specified. The terms "a," "an," and the singular forms of words shall be taken to include the plural form of the same words, such that the terms mean that one or more of something is provided. The term "one" or "single" may be used to indicate that one and only one of something is intended. Similarly, other specific integer values, such as "two," may be used when a specific number of things is intended. The terms "preferably," "preferred," "prefer," "optionally," "may," and similar terms are used to indicate that an item, condition or step being referred to is an optional (not required) feature of the invention.

[0062] While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

What is claimed is:

1. An apparatus for sensing acceleration, comprising:
 - an electronic device having a touch sensor input to a processor; and
 - a module selectively securable to the electronic device adjacent the touch sensor, the module including one or more acceleration-responsive mechanisms, each acceleration-responsive mechanism including a deformable member that contacts the touch sensor over a contact area that varies in response to acceleration.
2. The apparatus of claim 1, wherein the module includes three acceleration-responsive mechanisms, wherein each acceleration-responsive mechanism detects acceleration in a different axis of a Cartesian coordinate system.