TOUCH SENSITIVE MEMBRANE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of the filing date of Canadian patent application No. 2,353,697 filed on 24 Jul. 2001. This application is a continuation of application Ser. No. 10/200295 filed on 23 Jul. 2002.

TECHNICAL FIELD

[0002] This invention relates to apparatus for locating and/or measuring the magnitudes of forces applied to a surface. The apparatus includes pressure sensors for detecting forces applied to a surface. Outputs from the pressure sensors may be used as inputs for computers or other types of electronic equipment. The invention relates to input devices comprising surfaces equipped with pressure sensors which can measure the location(s) and magnitude(s) of a force (or several forces) applied to the surfaces. The pressure sensors comprise electronic components.

EXAMPLE APPLICATIONS OF THE INVENTION

[0003] Surfaces as described herein have practical application in a number of fields. Implemented in a small form factor, they may be used in mobile devices such as hand-held telephones, remote control units, hand-held computers, musical instruments, or "personal digital assistants." Implemented on a larger scale, such surfaces may be used as wall-mounted electronic "white-boards," or as an interactive table- or desk-top surface. In preferred implementations, this invention combines a touch-sensitive membrane with an electronic display.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] In Figures which illustrate non-limiting embodiments and applications of the invention:

[0005] **FIG. 1** shows one application of this invention in a device which has a flat surface upon which a person applies a force by means of a stylus. A touch-sensitive membrane is used to detect the location and magnitude of the force applied by the stylus as described in this disclosure.

[0006] **FIG. 2** shows a second application of this invention in a device which is flexible and which detects the location and force applied by each of a user's fingers simultaneously.

[0007] **FIG. 3** shows a third application of this invention whereby a wall-mounted touch-sensitive membrane is integrated with a flexible digital display. The touch-sensitive membrane measures the location and force applied by a user's hands and/or other objects (such as a stylus or eraser-shaped block).

[0008] **FIGS. 4***a* and **4***b* show cross-sections through a touch-sensitive membrane according to an embodiment of the invention.

[0009] **FIG. 5** is a cross section through a touch-sensitive membrane which illustrates a means of measuring the deflection of the membrane using "optical cavities."

[0010] **FIG. 6** is a plan view which illustrates an arrangement of sensors in a touch-sensitive membrane.

[0011] **FIGS. 7***a* and **7***b* illustrate another means of measuring the deflection of the membrane by measuring the proximity of the membrane to a substrate.

[0012] **FIG. 7***c* illustrates touch-sensitive apparatus having strain gauges for detecting forces applied to a membrane.

[0013] **FIG. 8** is a cross-section which illustrates a variation of the invention.

DESCRIPTION

[0014] Throughout the following description specific details are set forth in order to provide a more thorough understanding of the invention. However, the invention may be practiced without these particulars. In other instances, well known elements have not been shown or described in detail to avoid unnecessarily obscuring the present invention. Accordingly, the specification and drawings are to be regarded in an illustrative, rather than a restrictive, sense.

[0015] **FIGS. 1, 2**, and **3** show applications (i.e. example implementations) of the invention. **FIG. 1** shows a touch-sensitive apparatus **5**. A user is using a stylus **6** to press on a flexible surface **12** of apparatus **5**. **FIG. 2** shows a touch-sensitive apparatus having an integrated display. A user is pressing on the touch-sensitive surface with his fingers. **FIG. 3** shows a large touch-sensitive surface having an integrated display screen. All of these implementations share common features.

[0016] **FIG. 4***a* shows a cross-section through a touch-sensitive device **10**. A flexible membrane **12** overlies a compressible elastic material **14**. Material **14** could comprise, for example, a polyurethane foam. Flexible membrane **12** is preferably (but not necessarily) adhered to material **14**. Flexible membrane **12** may comprise a surface of a membrane disposed adjacent to elastic material **14**. Flexible membrane **12** could be integral with elastic material **14**. Elastic material **14** sits on a base **16**.

[0017] When a force is applied to flexible membrane **12**, as shown in **FIG. 4***b*, flexible membrane **12** is deflected downward in a locality where the force is applied. The underlying elastic material **14** is compressed. The greater the applied force, the greater the deflection of flexible membrane **12**.

[0018] Measuring the magnitude of downward displacement of flexible membrane **12** at a sufficient number of locations provides a means for identifying the locations at which one or more forces are applied to flexible membrane **12** and determining the magnitude of the force applied at each such location.

[0019] Recently, techniques have been developed for creating micro-electronic circuits on thin, flexible, plastic substrates. The circuits do not significantly affect the flexibility of the substrates and remain functional as the substrates flex. These techniques can be used to create integrated circuits including components such as transistors, light emitting diodes, and photo-transistors, for example. It has previously been necessary to fabricate such components on hard inflexible substrates (such as silicon or glass). Given the availability of these techniques, this invention provides a novel means for detecting and measuring the deflection of a surface membrane.