vide strong tactile feedback of each key location without impeding pointing, gestures, or related lateral sliding motions on the same touch surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The invention may best be understood by reference to the following description taken in conjunction with the accompanying drawings in which:

[0014] FIG. **1** is a top view of a surface keyboard employing a tactile feedback mechanism.

[0015] FIG. **2** is a cross-section view of the surface keyboard depicted in FIG. **1**.

[0016] FIG. **3** is a top view of a surface keyboard employing a variation of the tactile feedback mechanism depicted in FIGS. **1** and **2**.

[0017] FIG. **4** is a cross-section view of the surface keyboard depicted in FIG. **3**.

[0018] FIG. **5** is a cross-section view of a surface keyboard employing an alternative tactile feedback arrangement including an articulating frame (shown in an extended position).

[0019] FIG. **6** is a cross-section view of the surface keyboard illustrated in FIG. **5** with the articulating frame shown in a retracted position.

[0020] FIG. **7** is a plan view of the surface keyboard illustrated in FIGS. **5** and **6**.

[0021] FIGS. **8**A and **8**B illustrate a cross-section view of a surface keyboard tactile feedback arrangement for simulating concave key cap centers.

[0022] FIG. **9** illustrates a cross-section view of a surface keyboard employing a deformable material beneath the keys to provide tactile feedback.

DETAILED DESCRIPTION

Braille-Like Dot Pairs or Bars at Key Centers

[0023] With reference now to FIGS. **1** and **2**, one technique for providing tactile feedback in a surface keyboard is depicted. FIG. **1** is a vertical view of a surface keyboard **100**. FIG. **2** is a cross-section view of surface keyboard **100**. Surface keyboard **100** includes numerous key regions **101**. As used herein, the term "key" may also refer to the key regions **101**, although in a surface keyboard there is actually no mechanical key. Rather, sensing circuitry **111** disposed beneath the surface cover **112** detects an object, such as a user's finger, in contact or close proximity with the key regions **101** and outputs the corresponding letter, number, or symbol to a host computer or other device (not shown). The key layout shown in FIG. **1** is a slightly modified QWERTY layout, which has been ergonomically designed to provide a more comfortable typing position.

[0024] Key regions **101** are arranged in a plurality of rows. As known to touch typists, the row of keys containing the letters "ASDF" on the left-hand side and "JKL;" on the right-hand side are known as the home row **102**. The home row is so called because a touch typist will keep the four fingers of each hand over these characters when a finger is not reaching for a key in another row. Adjacent rows **103** are the rows immediately adjacent, for example, the rows containing "QWER" and "ZXCV." The remaining rows are known as peripheral rows **104**, for example, the row of number keys.

[0025] One mechanism to provide more robust tactile feedback for a user of a surface keyboard is to stamp two horizontally aligned dots **105** at the center of each home row key **106**. Similarly, two vertically aligned dots **107** may be stamped on each adjacent key **108**. Finally, a single dot **109** may be stamped on peripheral keys **110**. Because the home row keys feel different than all other keys, home row **102** may be easily found without looking when sliding hands over the surface. The two vertical dots **107** on adjacent keys **108** in turn help distinguish their feel from peripheral number and punctuation keys having only one raised dot **110**.

[0026] It will be appreciated that the particular arrangement of dots could vary from that described. For example, a single dot could be used to mark home row keys **102**, with two horizontal dots used for adjacent keys **103** and two vertical dots used for peripheral keys **104**. All that is required is that one unique tactile feedback mechanism, such as raised dots, be used for home row keys, while another is used for adjacent and/or peripheral keys. It is not required that the adjacent keys and peripheral keys employ different tactile feedback mechanisms, although it may be preferable to do so.

[0027] Moreover, the tactile feedback mechanism need not be limited to raised dots. In a variation of this technique, shown in plan-view in FIG. **3** and in cross-section in FIG. **4**, the a raised dot pair is replaced with a raised "hyphen," i.e., a short bar **113**. The short bars **113** may be, for example, arranged horizontally (**113***a*) at the centers of home row keys **106** and vertically (**113***b*) on keys adjacent to home row **102**. Peripheral keys **110** may include a single raised dot **109**. Other shapes, such as squares, circles, triangles, etc. could also be used so long as the arrangements used for home row keys **102** are distinct from those used for the adjacent keys **103** and/or peripheral keys **104**. These embodiments may be less desirable than a raised dot pair in terms of efficient tactility and minimizing sensor distortion. However, these raised bars or other shapes may be more aesthetically pleasing than raised dot pairs.

[0028] It should also be noted that, although the tactile feedback arrangement described above has particular applicability to surface keyboards, it could also be used in conjunction with traditional mechanical/electromechanical keyboards. Additionally, although described in terms of the traditional QWERTY keyboard, the techniques may also be applied to other keyboard layouts, such as Dvorak keyboard, foreign language keyboards, court reporting machine keyboards, and other keyboard-like input devices.

Articulating Frame Protrudes at Key Edges During Typing

[0029] An alternative technique for providing tactile feedback in a surface keyboard will now be described with respect to FIGS. **5**, **6**, and **7**. FIGS. **5** and **6** depict a cross-section view of the keyboard, while FIG. **7** depicts a plan view. As illustrated in FIGS. **5** and **6**, the surface keyboard **200** comprises a plurality of layers including an enclosure base **201**, the electrode circuit board **202**, and the surface cover **203**. Details of the construction of these devices are described in the various incorporated references and are not repeated here.

[0030] Additionally, the keyboard **200** includes an articulating frame **204**, which is disposed beneath the circuit board **202**. The articulating frame **204** may be raised and lowered by actuators **205**, which preferably take the form of electromagnetic actuators. Raising and lowering the articulating frame extends and withdraws key edge ridges **206**, which are dots or bars that poke through the keyboard surface when extended. Electromagnetic actuators **205** would raise the frame when operating in a typing mode such that the tops of the key edge ridges **206** are about 1 mm above the surface cover **203**. The