

hopefully lowering the potential for fatigue and possible injury. In conventional button assemblies, a large-handed individual will activate the button assembly further away from the fulcrum compared to a small-handed individual. Due the nature of the cantilever design, it will take less force for the large-handed individual to activate the button assembly and electronic switch relative to the small-handed individual. This design may be contrary to the anatomical biomechanics related to stature and hand size. Smaller-handed and often weaker individuals are required to apply more force to the button assembly compared to the larger-handed and often stronger individuals.

[0019] 2. An Exemplary Computer Mouse

[0020] FIG. 1 is a simplified representation of a conventional mouse button 10 and electronic switch 12. Surrounding portions of the device are not shown for simplicity of illustration. The button assembly includes a fulcrum 14 about which the button moves in a slight arc, the external visible surface of the button assembly 16 extends away from the fulcrum (i.e. away from the user's hand) and a spring beam 18. The spring beam can be made of molded plastic or other suitable material with a molded plastic hinge joint serving as the fulcrum and connecting the button assembly to the housing 19 of the device. The electronic switch 12 beneath the button is configured to be electrically coupled to a computer or other device. Depressing the external surface of the button assembly 16 actuates the switch 12 by pushing the plunger 20 against a spring-loaded movable switch element 22, which returns to a default position and switch state after the actuating force has been removed from the button assembly 16.

[0021] The force required to actuate the button assembly 16 decreases with increasing distance from the fulcrum 14 because of the leverage obtained. Thus, the larger the user's hand, the further the point of force application on the button assembly 16 relative to the fulcrum 14, and the easier it is for the user to actuate the button. In contrast, individuals with smaller, weaker hands will have a point of force application on the button assembly 16 closer to the fulcrum 14 and will be required to apply more force relative to larger-handed individuals. The mechanics of this arrangement opposes the strength-related mechanics related to human stature and hand size. The difference in this force is significant and there is often an order of magnitude difference between the forces applied to the external surface the button assembly 16 nearest the fulcrum 14 and the external surface of the button assembly furthest away from the fulcrum to actuate the underlying electronic switch.

[0022] For example, the actuation force required to actuate a conventional mouse button was measured as a function of distance along the button. The button is 3.1 cm wide and 3.5 cm long (palm-finger direction). The measured forces (Newtons) versus distance (cm from the finger end) are provided in Table 1.

TABLE 1

Distance (cm)	Force (N)
0.5	1.0
1.0	0.8
1.5	0.65

TABLE 1-continued

Distance (cm)	Force (N)
2.0	0.55
2.5	0.5
3.0	0.45

[0023] FIG. 2 is a simplified representation of a reverse cantilever button assembly 26 and electronic switch 12 assembled into a housing 19' of a pointing device according to an embodiment of the present invention. Alternatively, the button assembly could be molded with the housing, rather than being attached to it by gluing, heat welding, mechanical fastening, or similar techniques. The reverse cantilever button assembly has a first fulcrum 28 at the point where the button assembly is attached to the device housing 19' or body and a second fulcrum 32 at the end of spring beam 30. The spring beam is a cantilevered beam, as is the button portion 36, which is attached to the spring beam through the second fulcrum. The button portion includes the external surface 37 of the button assembly, which is configured to be contacted by the finger, thumb, foot, or other portion of the user and will be referred to as the "switch button" for purposes of illustration. In this embodiment essentially the entire portion of the second cantilevered beam has an exposed external surface, but in other embodiments a portion or portions of the second cantilevered beam might not be exposed.

[0024] The second fulcrum can be implemented as a molded plastic flexible hinge or have a plurality of implementations using other materials. The button plunger 20' extends through a hole 40 in the spring beam 30 to actuate the electronic switch 12 when the switch button 22 is depressed. Extending the plunger through the spring beam provides a simple and compact configuration. Alternatively, the button plunger can be offset to either side of the spring beam, rather than extending through a hole in the beam. In either configuration, the movable switch element 22 is actuated with force from the finger to the external surface (finger portion) of the button assembly 38, and not the underlying spring beam 30.

[0025] The force applied by the finger to the external surface of the button assembly 38 to actuate the electronic switch button 22 can be the same or increase moving from the first fulcrum 28 to the second fulcrum 32, depending on the ratio of the spring constants between the two fulcrums. In one embodiment, the spring constant of the first fulcrum 28 can be higher than the spring constant of the second fulcrum 32 to achieve an increasing force profile when the force is applied to the external surface of the button assembly 26 moving from the first fulcrum 28 to the second fulcrum 32. In another embodiment, the spring constant of the first fulcrum 28 can be lower than the spring constant of the second fulcrum 32 to achieve an decreasing force profile when the force is applied to the external surface of the button assembly 38 moving from the first fulcrum 28 to the second fulcrum 32. In yet another embodiment, the spring constant of the first fulcrum 28 can be designed to be a proportion of the second fulcrum 32 to achieve an essentially constant force profile across the external surface of the button assembly 38 when moving from the first fulcrum 28 to the second