ELECTROACTIVE POLYMER ACTUATOR BRAILLE CELL AND BRAILLE DISPLAY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority from U.S. provisional application Ser. No. 60/449,143 entitled: "Fabrication of Full Page Braille Display Using the Self Supporting and Hydraulic (SSH) System in the Braille Cell Based on the Bending Mechanism of Electroactive Polymer Actuator", filed Feb. 24, 2003.

BACKGROUND OF INVENTION

The present invention relates to Braille and graphic displays for providing individuals with visual impairments a means to access media through the use of tactile devices.

Prior art in the field of Braille displays for computer interfaces utilize various mechanisms to actuate the Braille dots and refresh the text. Actuators known in the art comprised of piezoelectric materials, shape memory alloys and solenoids control the Braille dots. These actuators serve to raise and lower the individual pins to represent the Braille characters. The Braille cell displays utilizing these actuator technologies are limited to the display of one or two lines. The size and complexity of the actuators and the tight tolerance requirements for the Braille dots limits the number of Braille characters that can be presented simultaneously. These Braille cell devices known in the art also exhibit high power requirements, slow refresh rates and complex manufacturing processes.

Due to the limitations inherent in the Braille cells available to construct Braille cell displays, current technology provides for Braille displays that are limited to a few lines as displayed on a computer screen at one point in time. It is advantageous to be able to provide a reader with a full-page Braille display representing an entire screen. The fabrication of a full-page Braille display will allow the reader to access both character and graphic information.

Electroactive polymers are known in the art. These polymers respond to external electrical stimulation by displaying a significant shape or size displacement. Electroactive polymers have the ability to induce strains that are as high as two orders of magnitude greater than the movements possible with rigid and fragile electroactive ceramics, such as piezoelectric materials. Electroactive polymers inherently exhibit quicker response times, lower densities and improved resilience when compared to shape memory alloys. Two major categories of electroactive polymers are identifiable based on their driving mechanism. Electronic electroactive polymers are driven by the Coulomb forces resulting from the electric field applied, while ionic electroactive polymers are driven by the mobility or diffusion of ions.

A need exists for a refreshable Braille display that overcomes the prior art limitations by providing a tactile array that can give readers access to full computer generated screens of text and graphical information in real time. Accordingly, an improved Braille cell is needed that will allow the construction of a full Braille cell display. The Braille cell needs to have a quick response time, be compact in size, operate under low power, and be lightweight while still providing the necessary tactile response to the reader.

However, in view of the prior art considered as a whole at the time the present invention was made, it was not obvious to those of ordinary skill in the pertinent art how the identified need could be fulfilled.

SUMMARY OF INVENTION

The longstanding but heretofore unfulfilled need for a Braille cell that exhibits desired characteristics superior to Braille cells known in the art is now met by a new, useful, and nonobvious invention.

The present invention provides a Braille cell being of compact design and having low power consumption. The novel Braille cell is based on the bending characteristics of electroactive polymers to provide hydraulic actuation of a Braille dot. As such, the bending mechanism of the electroactive polymer actuator is transferred to the linear motion of the Braille dot. Additionally, to reduce power consumption, a latching and support mechanism is provided.

In accordance with the present invention is provided a Braille cell having a substantially fluid-tight housing, the fluid-tight housing further comprising a tactile member cover, a tactile member in the housing, the tactile member being movable between a neutral position at which the tactile member is substantially flush with the tactile member cover and is not palpable and a reading position at which the tactile member is extended beyond the tactile member cover and is palpable, a support member in the housing for supporting the tactile member when the member is in the reading position, and an actuator integrally connected to the support member for moving the tactile member between a neutral position and a reading position through the displacement of fluid within the substantially fluid-tight housing. The actuator is actuated by an electrical voltage and further includes an electroactive polymer, which bends upon application of an electrical voltage, the bending of the electroactive polymer, to displace a fluid volume within the housing is sufficient to move the tactile member between a neutral position and a reading position. Additionally, the bending of the electroactive polymer is sufficient to move the support member to support the tactile member when in the reading position.

In an embodiment of the present invention, the novel Braille cell includes a substantially fluid-tight housing having a top end and a bottom end, an opening in the top end of the housing is fluidly sealed with a flexible diaphragm, the flexible diaphragm has a topside and an underside. Additionally, at least two support blocks and a stabilizer block are positioned at the bottom end of the housing. The stabilizer block is positioned between the two support blocks. An actuator rod having a top end and a bottom end is provided, whereby the top end of the actuator rod is secured to the underside of the flexible diaphragm and the bottom end of the rod is secured to the stabilizer block. At least two electroactive polymer bending elements are included, each element having a top edge and a bottom edge. The bottom edge of each of the electroactive polymer bending elements is secured to one of the two support blocks and the top edge of each of the electroactive polymer bending elements is secured to the housing.

In an additional embodiment, the housing of the novel Braille cell further includes, two substantially continuous sides and two windowed sides, the windowed sides further having a support strip positioned to establish a top aperture and a bottom aperture. In one embodiment, the two continuous sides are positioned opposite each other and the two windowed sides are positioned opposite each other in the housing, thereby providing a substantially rectangular housing. Additionally, four electroactive polymer bending elements are provided, each of the four electroactive polymer bending elements are positioned to cover one of each of the top aperture and the bottom aperture of the two windowed