

**REFRESHABLE BRAILLE DISPLAY SYSTEM**

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**BACKGROUND OF THE INVENTION****1. Field of the Invention**

This invention relates, generally, to refreshable Braille display systems for use as monitors in computer systems and, more particularly, to refreshable Braille display systems using microelectromechanical (MEMS) actuators.

**2. Description of the Related Art**

The flourishing computer and information revolution has left behind visually impaired and particularly visually and hearing impaired individuals. This is due to the fact that visual display units, typically cathode ray tubes (CRTs), are the heart of all modern communication and information systems including the Internet. This especially affects those impaired individuals in the technical fields. To remedy this situation and promote the mandates of the Americans with Disabilities Act that mandates equal access and opportunities be presented to all capable individuals, Congress has proposed a State Model Bill. The bill would provide materials in a computer-accessible format capable of Braille reproduction. It states, "the Legislature finds that:

- (1) the advent of the information age throughout the United States and around the world has resulted in lasting changes in information technology;
- (2) use of interactive visual display terminals by state and state-assisted organizations is becoming a widespread means of access for employees and the public to obtain information available electronically, but nonvisual access, whether by speech, Braille, or other appropriate means has been overlooked in purchasing and deploying the latest information technology;
- (3) presentation of electronic data solely in a visual format is a barrier to access by individuals who are blind or visually impaired, preventing them from participating on equal terms in crucial areas of life, such as education and employment;
- (4) alternatives, including both software and hardware adaptations, have been created so that interactive control of computers and use of the information presented is possible by both visual and nonvisual means; and
- (5) the goals of the state in obtaining and deploying the most advanced forms of information technology properly include universal access so that segments of society with particular needs (including individuals unable to use visual displays) will not be left out of the information age."

Prior art computer interfaced Braille devices use various mechanisms to actuate the Braille dots and "refresh" the text. The dots are controlled via macroscopic actuators comprised of piezoelectric materials, shape memory alloys, and solenoids to raise individual pins in the Braille characters. Most of these devices display one or two lines and up to 80 Braille characters per row. Ideally, more rows of Braille text are desired, however, the complexity of the actuators and the close spacing of the Braille dots limit the number of Braille characters. Such actuators also require a

very large "volume overhead" to accommodate this complex network of actuators and wires needed to operate the Braille dots. The result is that the foot print of the unit is much larger than the display surface and it is difficult to skin information based on the limited number of Braille characters.

Recently, a company in Cambridge Mass. called Braille Displays overcame the limitation of two rows of Braille cells. This company with the support of the National Science Foundation was able to produce a prototype 4 line by 40 column prototype refreshable Braille display. This 160 cell display is not commercially available. Telesensory produces an 80 character unit, PowerBraille 80 (PB80). This device has many user friendly features integrated into its device such as a cursor locator, a touch sensitive strip and scrolling toggle.

U.S. Pat. No. 5,685,721, to Decker, discloses a macro-sized shape-memory alloy based actuator enclosed in a series of tubes and housed in modules which are mounted into a multi-row display under ledges. U.S. Pat. No. 5,766,013, to Vuyk, discloses another macro-sized actuation technique utilizing an intrinsically conducting polymer sheet that expands when a charge is applied. Another macro-sized actuation technique, utilizing a rotary actuator with cams is disclosed by U.S. Pat. No. 5,453,012, to Hudecek. Also, Garner, U.S. Pat. No. 5,496,174 utilizes an electrorheological fluid that expands when a high voltage is applied. All of these devices suffer from the same fundamental problems: a large number of individual components needed for each Braille dot increasing assembly problems; high power requirements eliminating the potential for portability and creating problems dissipating the excess heat; responding fast enough to allow refresh rates appropriate for computer based communications; and, the difficulties in assembling the large number of Braille dots needed for true replication of computer display terminals.

Another approach to providing access to the visually impaired has been the development of optical recognition systems attached to voice synthesizers. Although these devices represent an enormous leap forward in access to both computerized and printed material, they are not appropriate for all tasks. Specifically, they cannot be used with detailed technical material which has a very specialized vocabulary. Medicine, law, accounting, engineering, and science careers are restricted by this limitation. Voice Synthesizing devices are not effective at dealing with tabular material. The voice synthesizing devices do not provide blind accountants and bookkeepers the access they require to spreadsheets and databases. Furthermore, voice synthesizers are not capable of limited document skimming, or provide a means to address accessing links otherwise known as sub-directories or complementary subject indicators. Perhaps most important, these reading devices provide limited ability to edit text or tables.

The devices currently available for the sight impaired are limited and have drawbacks in that they do not have fast enough refresh rate or sufficient Braille character ability to replicate a computer display, including memory capacity, readable area, and scanning and highlighting functions; are bulky and heavy; can not be adapted for different applications, i.e., a lap top vs. a desk top computer; and cannot "display" technical, accounting, spreadsheets, or other specialized forms of display which are not a basic textual document.

Accordingly, a need exists for a refreshable Braille display that overcomes the above mentioned limitations and drawbacks.

**BRIEF SUMMARY OF THE INVENTION**

The present invention provides a device to satisfy the aforementioned need.