

REFRESHABLE BRAILLE READER**RELATED U.S. PROVISIONAL PATENT APPLICATIONS**

This application claims the benefit of U.S. Provisional Patent Application No. 60/134,887, filed May 19, 1999, and U.S. Provisional Patent Application No. 60/178,699, filed Jan. 28, 2000, this application including all the written descriptions of the inventions described therein and making claim to the inventions therein disclosed.

FIELD OF THE INVENTION

This invention relates to tactile display devices and methods, and, more particularly, relates to such devices and methods wherein a tactile display is readily reconfigurable.

BACKGROUND OF THE INVENTION

One of the potential benefits of advances in computer and related technologies is the prospect for improved accessibility to information services for the handicapped, particularly electronically stored or transmitted information. For the blind and vision impaired, work has been done on improved accessibility by special adaptations to visual displays, by voice-based systems (voice output and in some cases voice input), and by touch-based devices. Each of these approaches is particularly useful for certain applications, and serves a certain part of the population of users.

The most common implementation for a touch-based computer-driven display is the refreshable Braille reader. This is a device which produces a pattern of raised dots in the six (or eight) dot cells that represent Braille characters (see U.S. Pat. No. 4,551,102, for example). The dots are controlled by actuators (typically one per dot in each cell), and can be individually set to change the Braille characters being displayed on each Braille cell. Typically, a single line of Braille is made available, ranging from a relatively short line for a portable device, to 80 characters or more for a device built into a desktop keyboard. These devices produce a usable, refreshable Braille display, but suffer the drawbacks of extremely high cost and mechanical unreliability (due in large part to the great number of mechanical components). Cost and reliability issues have thus hindered the expanded use of Braille as a computer interface.

Heretofore known full-scale Braille readers may contain hundreds of actuators. Since the traditional method of constructing a refreshable Braille display producing a linear array of Braille cells requires a separate actuator for every dot of every cell in the display, an 80 cell display of 8-dot Braille (per cell) would require 640 actuators. Actuators are the primary expense in traditional Braille displays, and also represent the most likely source of introduced unreliability into the system.

Improvement in such devices producing computer-refreshable Braille text for tactile reading by the blind and visually impaired could thus be utilized thereby broadening accessibility to computer services such as electronic books, e-mail and other network access, and general computer use. Improvements in cost and mechanical reliability must be attained in order to facilitate more widespread use of refreshable Braille devices. Mechanically simplicity over existing refreshable Braille devices, while providing much of their functionality as well as additional features, would be desirable for users while greatly lowering cost and improving reliability in comparison to existing systems.

SUMMARY OF THE INVENTION

This invention provides improved apparatus and methods for producing refreshable tactile display, particularly refreshable Braille text. The apparatus can be produced at a great reduction in cost of manufacture over heretofore known devices while yet realizing greatly increased mechanical reliability and simplicity.

The refreshable tactile display apparatus of this invention includes a housing having a display area, with a structure maintainable at the housing and defining a tactile display surface with a selected surface characteristic. Actuators are maintained at the housing for selective formation and repeated selective reformation of tactile display characters at the display surface of the structure in cooperation with the selected surface characteristic. The tactile display surface of the structure and the actuators are relatively movable in a direction substantially parallel to each other so that a tactile display is streamed at the display area of the housing.

One implementation of the apparatus of this invention embodied for streaming of Braille text at a display surface may be characterized as a rotating-wheel refreshable Braille reader. This device would produce computer-refreshable Braille text for tactile reading by the blind and visually impaired, thus improving accessibility to computer services such as electronic books, e-mail and other network access, and general computer use. The apparatus is designed to be mechanically simpler than existing refreshable Braille reader devices, while providing much of their functionality as well as additional features. The design of this apparatus allows for greatly lowered cost and improved reliability in comparison to existing systems and can be implemented in such a way as to provide refreshable Braille text to the user from a typical reading rate of 60 to 125 words per minute up to a high reading rate of 250 words per minute.

The rotating-wheel refreshable Braille reader of this invention addresses cost and reliability issues of heretofore known systems by greatly reducing the number of actuators utilized to set Braille text at a reading surface, from hundreds in heretofore known implementations, to as few as three or four (though as many as sixteen may be desirable) depending on the particular configuration. Instead of a static linear array of Braille cells that the user reads by moving one or more fingers along the line, the rotatable wheel Braille reader herein disclosed sets the Braille dots on the surface of a wheel or disk, which rotates under the user's finger, giving the user the sensation of a line of static Braille text moving under the user's finger. The Braille text on the wheel is refreshed as the wheel rotates, either in a repeating pattern around the wheel, or (using actuators internal or external to the wheel) at a specific point in the rotation of the wheel, setting a pattern of Braille dots on the wheel that are passively retained until they have passed under the reader's finger, after which they may be erased and then rewritten in the next rotation.

Preferred embodiments of the reader apparatus of this invention use a passive pin displacement approach, which can be used as the basis for either an external or internal actuator stationed refreshable Braille display. It can also be adapted to a linear Braille display, to certain types of tactile graphic displays, and may be applicable for non-accessibility application. Multiple Braille cells (potentially a large number) may be deployed displaying a valid text stream to the user. Improved control, precision, reliability of the device, greater versatility of operation, rapid display, long useful service life for the device, and extremely low cost of manufacture compared to now known systems will