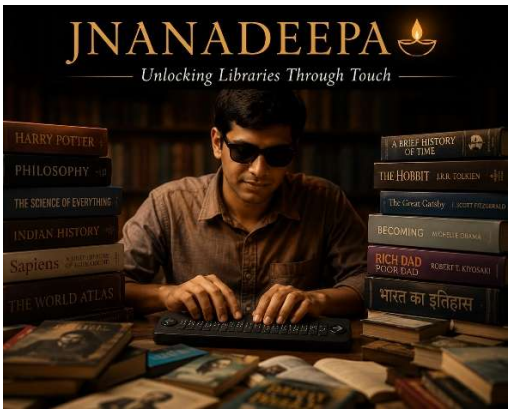

A Concept for a Low-Cost Braille E-Reader

JnanaDeepa aims to make digital libraries accessible through an affordable, low-power tactile reading device capable of rendering ordinary electronic text as Braille.

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India has one of the world's largest visually impaired populations. It is estimated to contain roughly **25% of the world's visually impaired population**. Blindness and visual impairment are significantly associated with poverty and low socioeconomic status. One Indian demographic study found about **68%** of blind patients came from lower socioeconomic groups. Blindness is reported to be **1.37× more common in rural areas** than urban areas. India loses an estimated **US$54.4 billion annually** due to blindness and moderate/severe visual impairment.

Visually impaired persons who wish to become part of mainstream society have to depend on Braille material as a source of information. Such material is available in two forms, Braille books and Braille displays.

Braille books are notorious for being heavy and expensive. Braille books may become much **larger and heavier** than corresponding print books. For example, the paperback edition of Harry Potter and the Sorcerer's stone is 223 pages in paperback and weighs about 230g. A Braille version of the same (Blind in Mind: the braille book store) weighs about 3.5 kg. Braille books can be much more **expensive** than ordinary books. The paperback version of Harry Potter costs between Rs. 150 and Rs. 400 depending on the seller; the Braille version costs around Rs. 7000! Further, only a **tiny fraction** of books are available in Braille versions.

Refreshable Braille displays depend on a variety of techniques to display Braille dynamically. One method is to use pins that can be retracted when required, arranged in cells. These pins are electronically controlled. Such displays can be prohibitively expensive for Indian users. For example, the All India Confederation Of The Blind makes available a subsidized version of the Orbit Reader 20 at a cost of about Rs. 35000. Even the subsidized cost is beyond the reach of most visually impaired

persons. Commercial premium devices can cost several hundred to several thousand US dollars! The major reason for the high cost is the difficulty of ensuring that the pins adhere to size standards set by Braille standards and are at the same time strong enough to withstand the up and down movement for displaying characters.

This proposal uses a combination of well-known technologies to build an affordable solution to this problem. The machine has a set of conveyor belts, each bearing all the 64 possible Braille displays for a 2 x 3 cell. These belts are arranged in a row, with belts parallel to each other. At any given time, one such cell is available for the user to touch; by moving her finger to the right, the reader can read many words one after the other. Once she is through with the words on display, she presses a button, which changes the displayed words by moving each belt to a new position. For the reader, the process of reading the text is the same as with any Braille book: start with the leftmost cell, move right one letter at a time, till she hits the end of the display, hit the next line button, move back to the leftmost cell and so on. The actual repositioning of the conveyor belts is done by a small processor, which reads an ASCII file on the storage medium, converts the next character into Braille and figures out how much to move the conveyor belt to let the reader touch the correct cell.

The basic advantages of the proposed device are:

1. Existing refreshable Braille displays dynamically raise and lower pins using complex electromechanical actuators. JnanaDeepa proposes a different approach in which all Braille patterns are permanently embossed on mechanically indexed conveyor belts. The device therefore replaces hundreds of moving pins with a much smaller number of motors and simple mechanical components.
2. The belts have to be moved to precise positions for easy reading. However, this is easy to do, as seen in split-flap displays.
3. The system uses very low power, just to move the conveyor belts to the correct position.
4. The system uses conveyor belts rather than a rotating drum, as the belt provides a flat tactile surface and allows for closer packing of adjacent cells than cylindrical drums.
5. JnanaDeepa devices potentially incur much lower manufacturing cost.
6. The construction used is more rugged.
7. The device has the ability to read ordinary digital text files. Thousands of books are readily available in ASCII format on the web.
8. There is no need for special Braille editions.
9. The simplicity of the design shows the potential for local manufacture and repair.

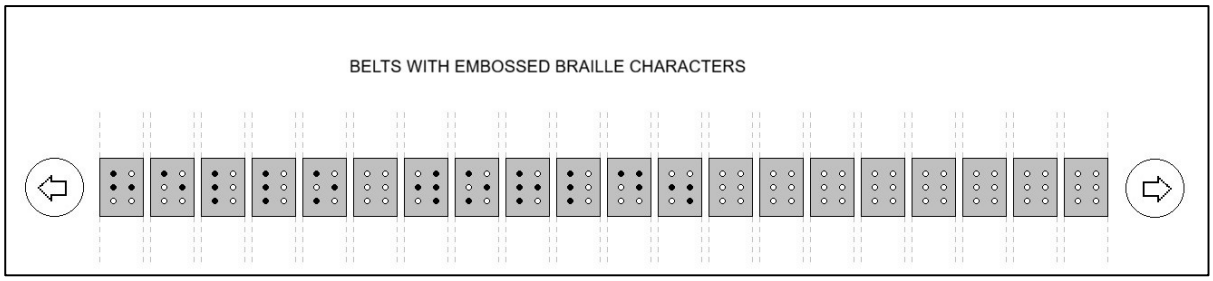
Key questions to be investigated and answered include:

1. Can embossed conveyor-belt cells be read comfortably?
2. What is the optimal number of cells per line?
3. What positioning accuracy is required?
4. What is the achievable reading speed?
5. What materials provide the best tactile experience?

The way ahead

1. Designing and fabricating a device with 20 letter display.
2. Test the device with the assistance of the Blind People's Association.
3. Manufacture the device and make it available at low cost to the public.

Top view of the device



Side view of conveyor belt