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Design of Cost-effective Printer to Print tactile Images for the Visually Impaired

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Abstract

Teaching text for visually impaired people is not a difficult task. But, learning the subjects like Science, Geography etc requires the perception of two dimensional images. This is very difficult for the visually impaired people. They cannot be easily taught images and graphics. In developed countries, the visually impaired students are taught about the images from their childhood days. So, they are familiar with image representations. One way to teach graphics is to use tactile images. Tactile graphics allow the visually impaired to perceive two-dimensional imagery easily. But, printing tactile graphics is costlier. Hence, the visually impaired people in developing and under developing countries grow up without any exposure to tactile images. To address this issue, the paper proposes a new approach for designing a new printer that helps to print high quality tactile images with low cost.

Keywords: *Tactile graphics, visually impaired, printers, low cost, high quality tactile images*

INTRODUCTION

In recent years, school books have presented more and more information graphically, and teachers are using visual approaches in classrooms. Increasingly blind students are called upon to learn how to use tactile graphics, and teachers and other producers of educational materials must learn how to produce such graphics. The use of tactile graphics materials is a growing component in the education of visually impaired people. Visually impaired are usually provided with text material in Braille, but the pictures, diagrams, graphs and maps which come along with the text material are often removed or only very briefly described.

Tactile imaging is the process of rendering pictures into a touchable raised version of the image, so that this tactile rendition represents the original information. This provides access for visually impaired persons who are normally inaccessible to

such pictures. For textual data, screen readers and optical character recognition (OCR) software, Braille embossing printers are the media of choice for visually challenged persons.

Tactile graphics are images that use raised surfaces so that a visually impaired person can feel them. They are used to convey non-textual information such as maps, paintings, graphs and diagrams. To print tactile images, a special kind of printers is needed. Usually, a Braille embosser is used to render such tactile graphics. These embosser are devices connected to a computer that do the actual embossing of Braille onto thick (heavyweight) paper. An embosser can cost roughly anywhere from US$2,000 to $150,000 which is not affordable for developing countries like India. Hence, handmade tactile images are created with the use of available materials such as stone, chalk piece, sand. It is difficult to create handmade models for all images and it is time consuming and tedious. And, they are not reusable forever. Hence, it is necessary to investigate on the solutions for printing tactile images with relatively low cost embossing device. The objectives of the proposed research are:

- To explore the potential of currently available printers to print the tactile and to redesign a new one
- To design a low cost printer for printing tactile images
- To make available as many images as possible to the visually impaired
- To investigate on the different varieties of papers for printing long lasting tactile images

RELATED WORKS

Tactile graphic images are used by visually impaired people to obtain information that sighted people get from looking at pictures. There are a few approaches for generating tactile images. These approaches use swell paper, thermoform or German film for producing tactile images. The disadvantages of these approaches include lack of variation in height of the different parts of generated tactile images, time consuming, costly to produce.

Another way to produce tactile graphics is by using a thermal paper expansion machine. Thermal expansion paper is expensive, ranging in price from $.85 for one 8.5-by-11-inch sheet to $1.70 for one 11-by-17-inch sheet. This high cost may not be affordable by all. An alternative to this is to use handmade tactile images, which is cost effective. Handmade tactile images use the easily available materials such as stone, chalk piece, sand etc for making models of images to teach the people about the images. Nevertheless, it is practically infeasible to create models for all images because it is time consuming and tedious.

Apart from producing printers from industry perspective, several research articles have been published that proposed a variety of solutions for producing tactile images. Some of the promising articles are summarized below

Braille embossing printers, microcapsule paper and custom hand-made labor-intensive representations of paper, paste and string are used for static rendering of graphical information [1]. Braille cell displays [2, 3] work well with simple two-dimensional graphs, maps and line drawings, but cannot adequately represent more complex photographic information. This shortcoming is the motivation for designing a printer system for translation of complex visual information into simplified tactually comprehensible form.

There are a few researches which have concentrated on the materials used for producing tactile images. The work in [4] insists on thermoforming a plastic sheet over a hand-made mould. The mould can be anything that is porous and can

withstand the temperature of the thermoforming process. Many moulds are made by cutting and pasting paper, cardboard, string, metal foil, etc onto a heavy paper base. But these moulds have poor accuracy and time consuming to make. The Tiger Tactile Graphics and Braille Embosser [5] is a Windows printer that embosses text and graphics instead of printing in ink. This work included an ability to emboss variable dot heights.

TACTICS [6] is a mechanism which converts computer images available on the Internet, into tactile information. Using this system complex images are easily depicted.

To overcome the limitations in the above works, redesigning a printer machine to generate good quality tactile images is proposed in the research work presented here.

PROPOSED SYSTEM DESIGN AND METHODOLOGY

In recent years, school books have presented more and more information graphically, and teachers are using visual approaches in classrooms. Increasingly blind students are called upon to learn how to use tactile graphics, and teachers and other producers of educational materials must learn how to produce such graphics. The use of tactile graphics materials is a growing component in the education of visually impaired people. Visually impaired are usually provided with text material in Braille, but the pictures, diagrams, graphs and maps which come along with the text material are often removed or only very briefly described.

Thermo forming is a method in which embossed curves and surfaces are generated on thermoform sheets. This is done using manual moulds, which have poor accuracy and highly time consuming.

To overcome these difficulties, this proposal suggests the design of a low cost printer to generate tactile images. As a prototype, currently available dot matrix printers have been already tested for producing the images. For making better variation in height, an aluminum foil is used for producing the images. The embossed images over the foil will last for long time. The dot matrix printer is very economical compared to currently available printers for tactile graphics. A few of the tactile images generated using dot matrix printers is shown below :

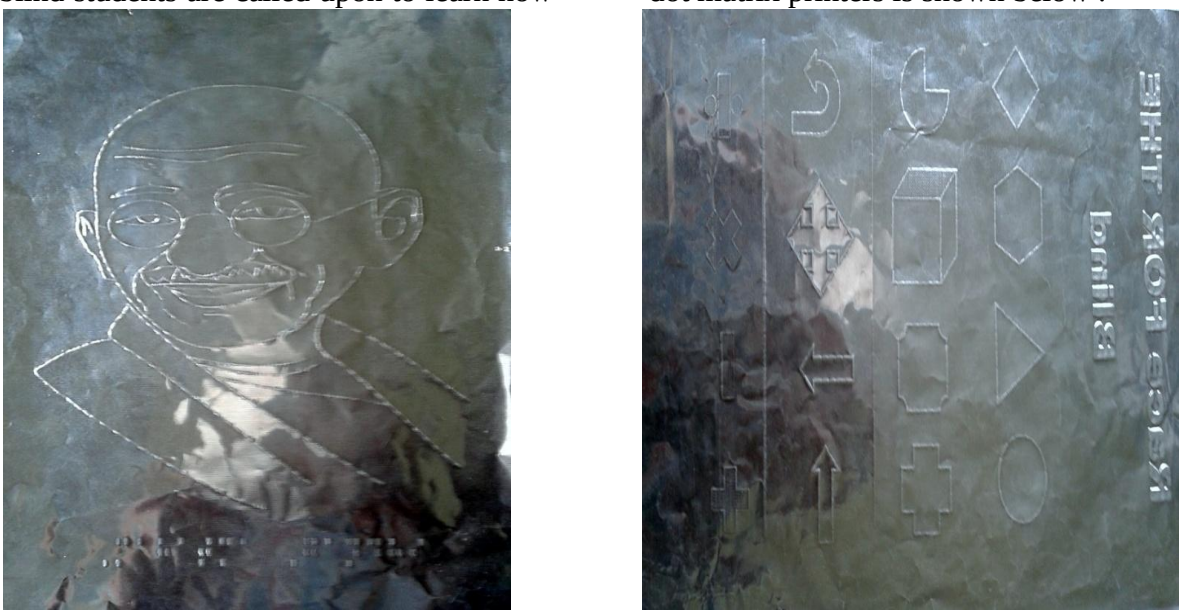

Fig 1 *Sample Print out for tactile images*

The prototype produces high quality tactile images using low cost printers. These printers are used to imprint tactile graphics on special sheets made up of aluminum foil. Using this prototype, diagrams, images and graphics may be included in Braille books cost effectively. This will be a boon for economically backward visually challenged people.

If dot matrix printers are used to produce the tactile images, the printer head will not last long. The head will go useless often. To address this issue, we have identified a new print head which will be assembled along with other components to produce a prototype printer. The essential components identified and used are

- Embossing printer head Winmax 8312
- ATMEGA 328 Controller
- SMPS power supply 230V to 12Vdc 5Amps

The block diagram for the modified printer is shown in Figure 2.

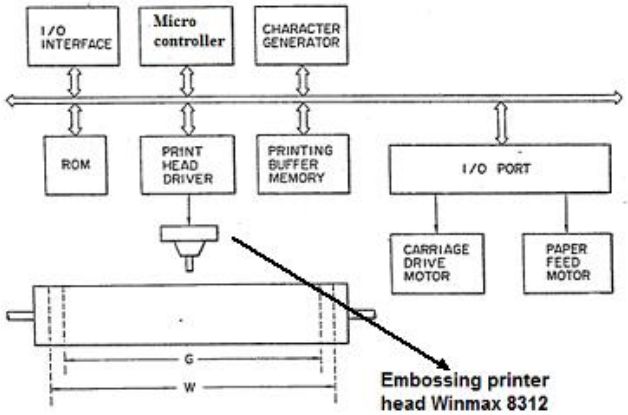

Fig 2. *Block Diagram of the Embossing Printer*

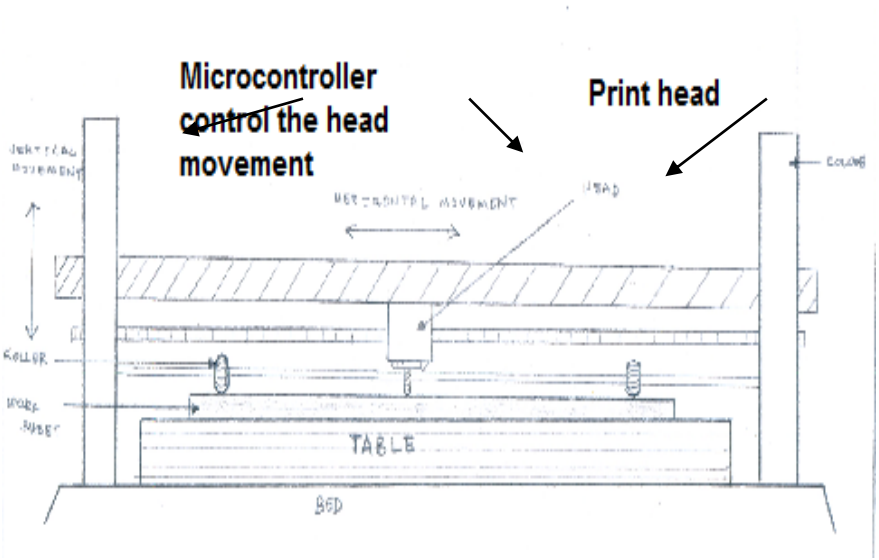

Fig 3. *Head movement control*

The componet are assembled as shown in Figure 3.
The purpose of the ATMEGA Controller is to control the movement of the print head. The proposal tries to reuse the existing dot matrix printers, which may required changes in the device driver of the printers. The benefits of the proposed design will be :

- Easy to operate
- Reliability
- Low cost

Non-textual information may be conveyed to the visually impaired by means of tactile graphics. Such people can touch and feel the embossed or raised surfaces in order to understand the images. This is shown in the figure given below :

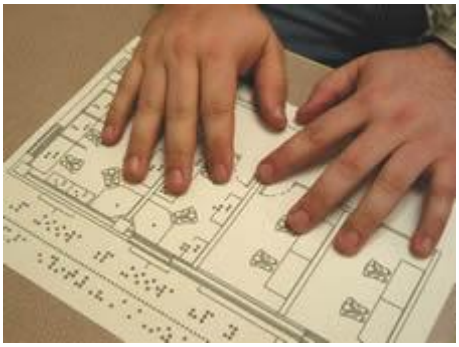

Fig 4. *Reading Images*

CONCLUSION

Visually impaired seldom have access to tactile pictures. As a consequence, blind students often have great difficulty with topics such as geometry and function graphs that are typically taught using pictures. The proposed work aims to develop a printer for quick realization of images by visually impaired. The proposal requires designing a blunt edged print head to make imprint over an aluminum foil placed under the carriage. A specialized printer is designed using the blunt edged print head. This requires careful organization of various components to design the printer. Once such a printer has been designed, several tactile images can be created to educate better the visually impaired people. Further, such design would help them to communicate their thoughts to other including good sighted people. Also, tactile graphics can be incorporated into teaching programmes for different subjects and into leisure activities to further enrich their knowledge.
As future work, it is planned to collect information from special educators, schools for visually impaired. The proposed design can be validated on some quality parameters by the real users of the system. To do so, frequent visits to meet various categories of blind people, social workers and teachers working in blind schools can be made. This will help us to improve the design better.

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