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Refreshing Braille Display: An Eye for the Eyeless

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Abstract: ***To increase the ability of getting information directly from the electronic devices like computers or to understand graphics by individuals with visual impairments, we are implementing a display device using braille language. A display which is of two-dimensional is been developed for visually impaired people and is fabricated and is successfully worked. The language characters like letters and alphabets are displayed dynamically by pins/needles in up and down positions that are connected in series. The movement of the coil actuators moves the pins upward and downward directions, and these coils gets heated up by an electrical current that flows through it. A structure which is like tube is fabricated and permanent magnet exactly moves the pins/needles in an upward or downward state without the feedback control. This mechanism of latch magnet overcomes problems of heat consumption and electrical consumption of the coil because the current is supplied to the coils only when the pins/needles move and also the costly devices which are available now. The cost is reduced with the use of materials normally found available and making it easy to handle. The present works describe a variety of other techniques for easy movement and to decrease power consumption. This system uses electromagnets and also strives to reduce interference for the smooth and error free working.***

Keywords: Electromagnetic-coil actuator, mechanism of latch, display for blind.

I. INTRODUCTION

Louis Braille is the well known person who developed a code that is read by moving the fingers across a series of raised dots which is popularly known as the Braille Language. Braille language description is used all across the globe in all of the countries, and it can also be used in other languages with pictorial representation or by phonetic based alphabet which mainly uses sounds and pronunciations for communication. Braille is useful for the blind people when they use devices like computers. Braille is good for those people who learn to read it and the inherent combination of Braille and screen display is beneficial for many people.

The way to promote exposure in this language is by making the Braille interpreting devices more reliable, cheaper, with accessibility, affordable, and user friendly. The mostly available Braille devices need various improvements with reduction in their market price. The people who are blind and the visually blind people the depend mostly on hearing of sounds and touch response to communicate and they navigate along with Braille, which is the most common technique used by blind people for accessing the knowledge through reading.

The Braille alphabets and the letters and the characters are displayed within a structure with a specified space and area known as a Braille cell. Braille cell is just a six dot mechanism. Braille display is one such kind of device which is portable, i.e. get the information and communicate anywhere.

The Braille language works on various combinations of dots which protrude outside the paper and are to be felt by touch. The different numbers of dots raised in their different patterns allow the user to understand what is written on the paper. It basically works on the sense of touch and the reader can move or feel their hand move in any direction and understand the need to make a dynamic display which allows the user to feel the letter previously read.

This system is highly helpful because the letters are protruded out or embossed to make sense. This is greatly reliable in case of information acknowledgement in the form of text but not in same way for graphical information.

Braille display is portable device that can be carried any where to get the information. In many proposed papers, the cells are made of different kinds of polymers. The defining problem existing in this display is the power consumption by the system. Large number of papers provide innovative, novel and cost effective approach to solve this problem and to develop an effective and user friendly display device. The proposed works include micro valves, polymers and magnetic coils.

The haptic sensing system is the one used in these displays but it costs way too much. The requisite right now is to make a system which has comparatively low making cost, is easily manageable and configurable, is dynamic and reliable. The systems which are available now constitute high cost and they do have a large size. To reduce size, refreshable displays are introduced as they only constitute which changes its display every few seconds. Refreshable displays do not show the prior information which is their

limitation and also users tend to read in both left to right and right to left manner. These points are to be kept in mind while designing a versatile and compact display.

In the paper, A Portable Braille Refreshable Display Using Micro Servos [1], the method used for displaying is Micro Servos. These Servos as opposed to screw activation are to work more effectively and efficiently.

The paper, PINDOTS: An Assistive Six-dot Braille Cell Keying Device on Basic Notation Writing for Visually Impaired Students with IOT Technology[2], the proposed system uses easily programmable, low cost and readily available microcontroller. The system would be available at very low cost and be highly useful.

The paper, Single Cell Bangla Book Reader for Visually Impaired People[3], the system is to make users rest their hands over the cell and actuate the cell parts so as to feel the pins move across the fingers and it was done using electromagnetic relays.

In the paper, Design of Piezoelectric Actuator for Braille Module by Finite Element Method [4], tactile interfacing is done using piezo-electric actuators. The study included response of structure, torque force on various materials.

All these papers give many innovative methods for converting text into braille language output.

II. BRAILLE SCRIPT

In this Braille device, we are implementing a set of raised dots that are to be felt by fingers. Each set of raised dots represents a character of the alphabet, and can also represent the numbers and punctuations and etc.

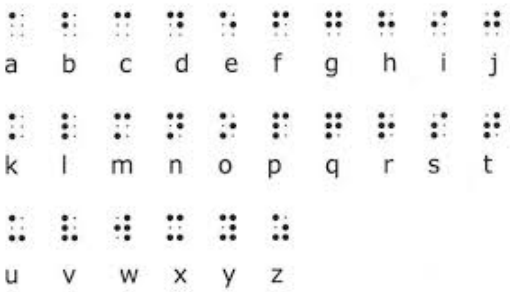

Fig 1 : Braille alphabet

Braille system can also be produced by special machines which has six keys, where one for each dot in the Braille cell is used. A full braille cell consists of six raised dots arranged in two parallel rows each consisting of three dots. The dot positions are identified by giving numbers from one through six. Sixty four combinations are possible using one or more of these six dots. A single cell can represent an alphabet letter, number, punctuation mark, or even a whole word.

A. Braille Cell

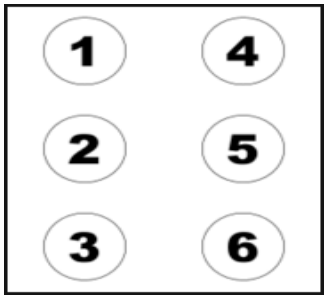

Fig2 : Braille cell with six dots

Braille cells are designed in a six dots fashion that are in a rectangular alignment in two columns with three dots each, example like a 3×3 matrix. We can make upto 64 combinations that can be made possible using Braille characters that have 6 dots. A six-dotted Braille pattern can represent different letters and characters in different languages meaning that a script written for one language may have different meaning in another language. All languages example English language letters and characters can be represented using only a single Braille cell.

B. Arduino Based Braille Display

1) Ease of Programming: It can be necessatily re-programmed utilising the Integrated Development Environment issued by Arduino open source company enabling the user to add or remove text files using a computer.

2) Peripherals: Arduino board has in-built protection circuits and a reset button which facilitates the users to restart the program being executed by the Micro-controller at any point of time along in-built USB implementation for effective communication from computer.

3) Cross-Platform: A program written for a distunct Arduino board can be implemented on other Arduino boards with less or no modifications whatsoever. Hardware Shields can be employed in all Arduino boards because of their similar functioning with Arduino boards.

4) Stand-alone System: Every Arduino board has its very own inbuilt power regulator though it also can be powered externally by employing a USB cable or whichever sort of external power supply including a wall-adapter, a cell,a battery, that works for its portability.

C. Electromagnetic Coils

The coils are employed for provision of the output from the microcontroller so as to cause the movement of pins in Braille cells. These coils build a magnetic field when current is passed through them and henceforth this magnetic force opposes or aids the magnetic force of the permanent magnet attached to the tube inducing the linear motion of the actuator.

Such kinds of electromagnetic coils are aligned in predefined number of rows and columns to form in the semblance of many Braille cells.

The coils are prepared identical and connected in series connection in such a way that they can create magnetic flux in opposite directions in the space or area of the permanent magnet. This is the way where the polarity of the power supply and the permanent magnet will create the movement of the inner tube in either upward or downward direction.

When the inner tube moves in upward motion, the coil creates a flux in the air gap that coincides with the flux of the permanent magnet. The increase in its energy efficiency is obtained as it needs the power supply only during the switching between the two end positions of the movement. And at each end positions; the permanent magnet creates a force, which keeps the mover in this position.

Fig3: A prototype of electromagnetic actuator

It is a illusion of a Braille actuator where the pins(dots) are driven by linearly by the actuators. To increase in resolution in a better manner, the Braille screen must be larger.

D. Block Diagram

The system requires having an input device and then a microcontroller to process the input. The microcontroller sorts each character to its predefined output value. Each character requires a Braille cell for display purpose. So there will be six output lines for each character with a different combination of HIGH and LOW.

Consider the input "abcde" given from the Bluetooth module. The microcontroller first checks for the output combination of the letter 'a'. The output combination then raises the pre assigned tubes to rise. In a similar and effective manner, the other letters of the string are exhibited on the display device for the haptic touch. All these can be felt by human hand and they are then translated to words by the person reading the display device.

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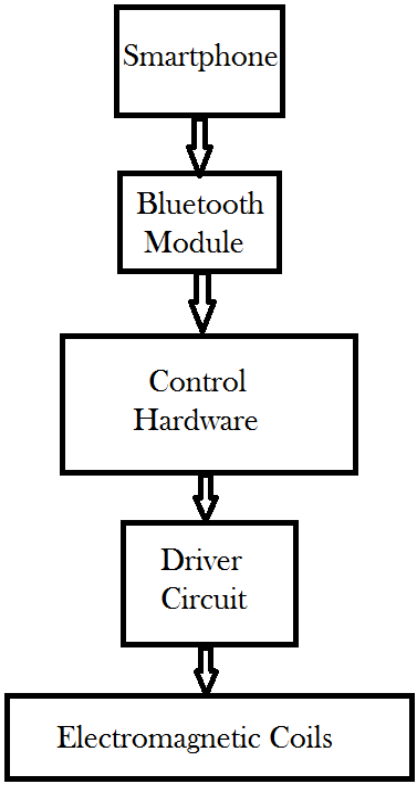

Fig 4: Block Diagram

E. Bluetooth

Amid all of the parts, the foremost point is about the wireless connectivity of the device with the text sending part. Here, we can try using Wi-Fi which is a salient substitution for cabled networks and also known for its higher data rate. Every existing similar device uses either Bluetooth or zig-bee for the transmission of information. For the first stage of this system, we have selected the Bluetooth module for the aforementioned wireless connectivity purpose and it can predominantly support devices with a substantially low power supply.

F. Electromagnetic Coils

Six 5V Electromagnetic coils arranged in the form of a 3x2 matrix comprise a Braille cell. The raising and lowering of these solenoids represent each dot in the language of the Braille characters. There are 64 possible combinations (two raised to the power six) available using this matrix arrangement. This includes 26 alphabet, 10 numeric and it also includes other special characters. For 5V Electromagnetic coils, the output current of particular output pin is not sufficient. Therefore we need a driver circuit.

G. Control Hardware

Using the Arduino Integrated Development Environment free software, we have programmed the Arduino in such a way that it can take the input from the computer using serial read function or from external Bluettoth connection and show the relevant outputs. Therefore, using the Bluetooth module we can feed the input by the means of phone too.

Henceforth, we are also using a LCD display in order to see whether the kit is working in a proper way. It is just for a testing purpose scenario.

H. Driver Circuit

For this purpose, ULN2003 stepper motor driver is used. ULN2003 is a high voltage and high current Darlington array IC. The inputs and outputs are provided on opposite ends of the IC. A 5V DC supply is given to the driver IC at the COM pin, so the output that is given to the six input pins of ULN2003 from the Arduino board is powered up to the required amount and can take out from the six output pins connected to the coils.

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III. PROPOSED WORK

To increase the capability in reading information, people with visual impairments have expressed much interest in the development of Braille displays. Actually, the available Braille systems provided are of high cost which sequentially reduced the usage number of Braille systems as it was not reasonable to every blind student. So this paper outlines a low cost refreshable Braille display which is very functional for the primary education purposes.

In this system, we are actually trying to design a display which is helpful for the blind people to read the information, because in this system, the alphabet are represented in the Braille language.

Here, we are developing a display, which has a mechanism made up of electromagnetic coils. Whenever the coils are energized, like by the provision of power supply, the current starts flowing through the coils and the magnetic field across the coils cuts the one belonging to that of a permanent magnet and hence a linear motion is developed and the pin is raised above the position it rests.

This system essentially can be considered as a conversion from English text to Braille script with the use of a microcontroller. There are many Braille cells and each one has the six dots, consisting in which the display tube raises and lowers to represent each letter of the alphabet and the numerals. The system raises the dots depending on the character to be displayed. It displays by moving tubes up and down depending on the signal sent by the controller judged based by character to be displayed which is called as protruded.

We are planning on making it more convenient and more reliable so that users can effective use the device.

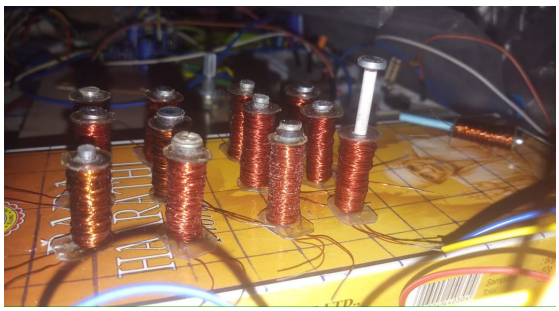

Fig 5: A raised dot indicating cell

IV. RESULTS

The input is given using Bluetooth module and the text is then analyzed by the Arduino MEGA which sends the appropriate HIGH and LOW signals to the cells. Each cell then shows the letter in Braille format.

Each actuator in the Braille cell receives input through the output line of ULN2003 IC. The input can be sent HIGH or LOW from the microcontroller and the same input deflects to whether the dot raises or stays down in the cell.

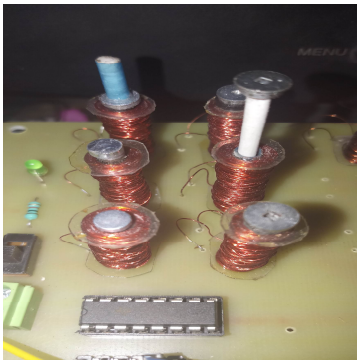

Fig 6: Braille cell on PCB

After providing input through Bluetooth module HC-05, through an app, text is sent to the Arduino UNO.

The microcontroller has a program which compares the predefined values written in it and compares and sends the output signal to ULN2003 and finally to electromagnetic coils which is placed on the printed circuit board.

The coils require precise voltage and current values to work correctly and desirably. Also the protrusion mechanism of the tubes requires some sort of pull down after it loses current when the value zero is sent through the micro controller.

For this we use a spring mechanism which wouldn't allow it to stay up by pulling it down. The spring is a small one and it is placed at the bottom of the tube.

V. CONCLUSION

Braille screen that causes force applying sensation on the users hand at the interference has been developed. Electromagnetic micro actuator that moves in a linear motion has been developed to drive the Braille display screen. The magnet is intended to move in a linear motion that drives a tube in Braille screen. We made many tests and numerous experiments have been performed on electromagnetic linear actuator in order to control the display or the Braille screen. The results that are obtained by our research show the actuators static force characteristics that are very well suitable in this application. This device can be implemented in a classroom at low cost which requires very little space and it is a portable device due to its compact nature This technology can be utilized to provide primary education for a huge number of students at a time and it is quite user friendly.

This display shows character from a string of text provided as an input as an individual character. Then the characters are shifted to form a word. The person can feel the movement of the protrusion on their fingers and it helps them to read in their own language. It acts as an eye for the visually impaired, the eyeless in a sense. This system is useful in many cases as it can be configured depending on requirement.

A. Instead we are using the induction coils in place of solenoid motors.
B. We are planning to make it a cost effective device.
C. Hence we are making use of scrap and unused materials to make it more cost effective and more reliable.

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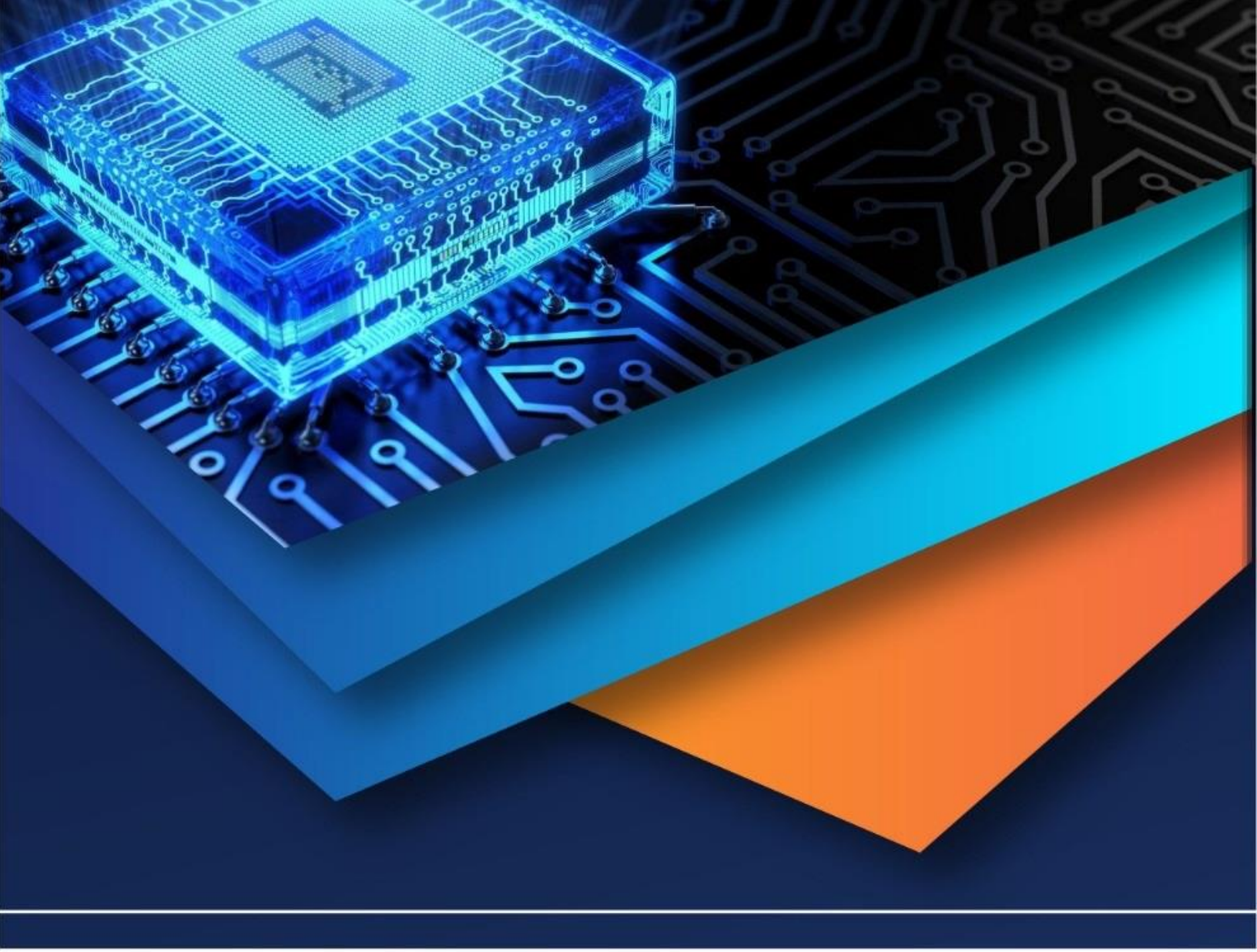

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