An Electronic Design of a Low cost Braille Typewriter

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This paper documents a new design for a Braille Typewriter. Comprising of a majority of electrical components, the design aims to produce a product that fills the gap in the range of Braillers available. A low cost and robust design will provide the blind with an affordable and reliable alternative to the Perkins and Mountbatten Braillers.

1 Introduction

Braille is an important language used by the blind to read and write. It is vital for communication and educational purposes. In Western Australia alone there are an estimated 22,500 vision impaired persons (Australian Bureau of Statistics, 1993) who cannot read standard print, many of whom rely on embossed Braille for their written communications[2]. Although there is an important market in the western world, a far greater rate of blindness occurs in third world countries. Literacy levels amongst sight impaired people in developing nations could be aided by supplying equipment such as these Braillers.

Braillers are needed for everyday communication and therefore importance lies on the option to have a light weight, transportable unit accessible at all times. This paper proposes a relatively inexpensive, light weight, reliable and easily maintained Brailler.

The features of the proposed brailler include:

- 12 Volt Power Supply allowing the common car batter as a power source.
- A small, light weight design allowing the unit to be transported easily.
- Robust Components to ensure reliability and life of the unit.
- A Reading Option in which the brailler scrolls the paper up after a certain time period, enabling the writer to read the last Braille written.

Numerous design ideas were conceived concerning the embossing mechanism, as this is the heart of the project [1].Upon analysing the design concepts a viable, modified embossing mechanism has been developed.

2 Background

2.1 Braille

There are two basic forms of Braille, Eight dot and Six dot Braille. Eight dot Braille is in limited use in the computer application area and is used in the display of text attributes. As such, the more practical Six Dot Braille will be concentrated on. In Six Dot Braille, each cell consists of a 3 x 2 Matrix of raised dots. Each cell is made up of six raised dots that relate to either: a letter, number or character. These dots are raised roughly 0.9mm by pressure from a cylindrical pin, causing an indentation underneath the thick paper. The paper used for Braille is especially thick to ensure that it cannot be easily squashed and become illegible over time. It's thickness also stops any tearing during the indentation.

There are 64 combinations for each individual cell. If each cell is embossed half at a time there is only eight, one of which is needed to represent no dots (used for the erasing function).
It is for this reason that half of one cell shall be embossed at a time. These 8 combinations are shown in figure 1.

All dots on a Braille page should fall on an orthogonal grid. When texts are printed double sided (Interpoint), the grid of the interpoint text is shifted so that the dots fall in between the primary side dots. The prototype brailler shall only emboss single sided.[2].

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2.2 Current Products

In the 1950's the Perkins Brailler was developed. It's hardy metal structure, cheapest price and simple operation has ensured that it has remained the most popular brailler amongst the visually impaired. It's complicated mechanics and the large number of components has resulted in a price just above A$1200.

In 1983 the Mountbatten Brailler Standard was built to be a multi-functional stand-alone unit. As well as Braille writing, it features use though connection to computer, built in memory, options for several Braille standards, quick correction of typing errors and a Floppy disk drive for storing and allowing the transport of data. Another good feature includes the backward and forward Braille translations software. Aimed at the Upper end of the market, this is an expensive product of A$ 2,300 [3].

The proposed design has to be innovative enough that it not only competes in the market, but hopefully establish it's own mark. This is obtainable since the Perkins is a very old mechanical design, while the Mountbatten is expensive and relatively complex.

3 The Design Concept

This Braille typewriter will be comprised of the following key components.

- 10 Digit Keypad
- PIC 16F877 Micro Controller
- 3 Stepper Motors
- 3 Stepper Motor Controllers
- Embossing Tool
- 2 Solenoids
- Warning Speaker
- Nylon Casing

3.1 10 Digit Keypad

This keypad is the user interface of the brailler. Braille keyboards are unlike normal keyboards because typing involves pushing the keys at the same time. Upon releasing the keys, the embosser shall move to the next cells position.

All inputs including Braille and options for operating the typewriter are on the keyboard. The keyboard layout is comprised of:

6 Input Keys – Representing each of the 6 dots in a cell

1 Space Key – Spacing between characters

1 Backspace Key – Allowing the writer to rewrite manually erased characters

1 Next Line Key – Moves the embosser to the next line

1 Function Key – For use of other functions

The **function key** will be used in conjunction with the other keys. It has the same function as the **Control** key on a Qwerty keyboard ie: holding down this key and pressing any other. This key will double the number of inputs through the existing keys. This permits options to be built without the use of additional Input lines.

These Functions include:

- Scrolling the page up (as well as down)
- Changing the options to turn off Automatic paper scrolling.
- Erase key will delete the embossed cell.

The erase function requires an additional mechanism to implement this function. To erase a Braille cell, a plate must be inserted in front of the embosser's back-plate. This insertion will be done via a solenoid latch. A punch from the flat side of embossing tool (side number 8, figure 2) will now squash the cell between the two flat surfaces, erasing the Braille. Each cell will be deleted half at a time, using the same procedure that was followed to print.

3.2 PIC 16F877 Microcontroller

This controls the general operation of the brailler. Its functions include:

- Braille is typed with multiple key presses simultaneously, a fast scanning method of inputs is required. The input data is stored into memory.
- Reading the keyboard data stored in the memory.
- Providing a memory buffer allowing the typist to continue to type faster than the brailler can operate.
- Sending a warning signal from the speaker system when in danger of overflowing the memory buffer.
- Using optical sensors to detect the width of the page used.
- Coordinating the movements of three stepper motors (via the stepper motor controllers) and a solenoid.
- Sends interpreted data to three stepper motor controllers.

- Calculation of the time required for the rotation of the motors to ensure the operation is at the maximum speed.

3.3 Stepper Motors

These motors are used in applications where you need to control rotation angle, speed and position. They convert electrical pulses into discrete mechanical movements. The motor rotates an angle at a speed, depending on the number of input pulses and their frequency. There are no brushes in the motor. The life the motor is dependant upon the life of it's bearings. It has full torque at standstill. Very low speed, synchronous rotation is possible with a load that is directly coupled to the shaft. These properties make them ideally suited for our purpose [4].The three motors are used for three separate tasks. Horizontal Movement, Vertical Scroll and Rotation of the Embossing Tool.

3.3.1 Horizontal Movement

Horizontal Movement involves moving the embossing head backward and forward over the width of the page. The embossing head is shown in figure 3. The Solenoid and the Stabilising Platform cannot be secured together due to the paper feeding between them. Each unit runs on it's separate rails. Both units are controlled by the same stepper motor with power transmitted by a drive shaft the their individual rails and belts This motor will be the largest of the three steppers. It must pull a weight of the embossing mechanism at a fast speed. The constant acceleration and deceleration of this mass will put a large load on the motor. The stepper motor will be connected to the embossing mechanism via a strong belt. The belt has teeth to stop slipping and fix the relationship between the rotation of the stepper motor and the movement of the embossing mechanism across the page.

3.3.2 Vertical Scroll

Vertical Scroll involves advancing the page to the next line. Rollers surfaced with rubber are connected with the stepper motor via a belt. They will rotate a given angle supplied by the user.

3.3.3 Embossing Tool Rotation

Rotation of the Embossing Tool is an important feature. This application of a stepper motor may be the limiting factor for the speed of the design. It will be required to:

- Rotate the tool as fast as possible to the eight, half cell combinations
- Be light and small. It shall be fixed to the embossing mechanism, carried by the horizontal stepper motor.
- Use Breaking or position fixing during the impact of the tool and the back-plate. Any rotation of the motor at this time will cause an error in the known angle of the tool and hence will require recalibrating.
- The rotation of the tool will be a maximum of 180 degrees. The shortest rotation will have to be calculated via the CPU.

3.4 Stepper Motor Controllers

These Micro controllers convert the data from the PIC into electrical pulses controlling the rotation angle and the speed of the stepper motors. They must be compatible with their individual stepper motors. During the impact of the solenoid these controller will brake to hold the motors positions.

3.5 The Embossing Mechanism

The embossing involves is the most important mechanism used in this design. It's task is to imprint the Braille on the page. It will be activated as often as twice per second, requiring it to be tough enough to endure the fast and repetitive action.

A specialised part known as the Embossing Tool is rotated to a selected configuration and used to emboss the raised dots of each half-cell via the firing of a solenoid. It consists eight combinations of pins, each of which is approximately 3mm in length. This tool is connected to the shaft of a stepper motor as shown in figure 3.

The Embossing Tool is shown in the figure 1.

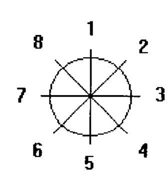

Figure 1: Cross Section of the Embossing Tool

It is attached to the shaft of the embossing stepper motor through a belt or preferably direct attachment to the shaft. Seven of these have raised pins in the seven possible combinations. The eighth is a raised, flat surface used to flatten any unwanted embossing. This is effectively an erase.

The embossing tool combinations for half a cell as shown in figure 2.

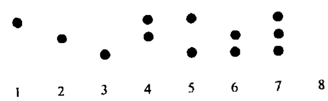

Figure 2: 8 Pin Combinations on the Shaft

The Solenoid will compress the impression Plate into the tool pins, embossing the paper between them. The impression Plate has three circular impressions roughly 1mm deep. Aligned with the pins on the embossing tool, these circles give the dots of the cells their dome shape.

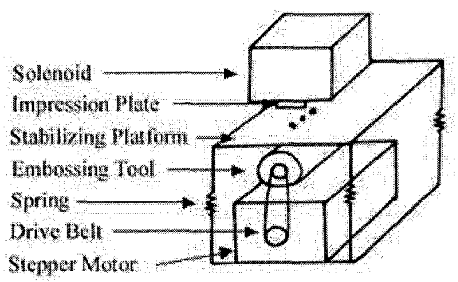

Figure 3: The Embossing Mechanism

3.5.1Tool Positioning

The stepper motors are controlled with no feedback of their current position, however the initial position of the embossing tool must be know. A shaft encoder with one position and an optical sensor is sufficient. After the brailler is turned on, the stepper motor will rotate the embossing tool until the sensor reports the position is known. It will also be used to monitor the position during operation. If it were to become inaccurate, the subsequently Braille would be meaningless.

3.6 Stabilizing Platform

Comprising of 4 springs and a thin plate, this has the purpose of providing support for the paper, allowing the tool to rotate freely beneath it. It also serves to lightly clamp the paper to ensure the papers alignment will not move during the solenoid activation. This is shown in figure 3.

4 Discussion

There were a number of design concepts that were assessed for alternative forms of Brailing including pneumatics and plastic sheeting. These have been abandoned, to the more conventional methods.[1] If made of solid steel, the weight of the embossing tool will slow the rotational speed of the stepper motor (however light this may be) and also add to the cost of the product. A strong, lightweight version can be created from a durable plastic.

The length of the pins in the preferred design will be long relative to the thickness of the stabilising plate. When the solenoid is activated, fast, forceful movement presses the paper down upon the stabilising platform. The springs supply a small force.The embossing tools pins are struck via the impression plate, creating the raised dots or Braille. When the impression Plate presses down upon the tool, the stabilising plate will move with the page effectively clamping it. Holes in the plate allow the pins to make contact with the back-plate. Longer pins will be easier to bend and may fail quicker. To keep the paper aligned the impression Plate and the embossing tool will be extremely close together to eliminate any horizontal forces on the page from this downward movement. The paper shall not be secured after the embossing mechanism. This free end will allow the papers necessary movement (however slight) and help prevent any creasing.

Certain basic features are required in any Braille typewriter design. A compromise has to be made between adding extra features and the need for simplicity and cheap production costs. The following features will be added if the costs remain as low as expected.

- **Page Width Detection** to facilitate the use of several page sizes. A small optical sensor could easily be fitted to the edge of the embossing mechanism.

- **Communications with a Personal computer** (PC) for use as a printer. This has obvious benefits to educational and personal home users. These products are also very expensive and vision impaired people would like to see a low cost, simple product developed.

The device could then be utilised as a printer or "fax" when coupled with the appropriate software. Keeping this in mind during prototyping will facilitate the advancement to this next version of this design. It may also be used with translational software and other educational programs.

Many of the components of the final product will be made with using a hard nylon plastic. The nylon is self lubricating, durable and inexpensive material that be used for the casing, embossing tool and structural components

5 Conclusion

The proposed design will reap the benefits of low costs with a simple design. A large demand exists amongst the visually impaired community for a new inexpensive Brailler. The Mountbatten, which tried to take over from the Perkins, was a significant improvement in terms of features, but a step back in regards to price, simplicity, noise and most importantly reliability. The ultimate goal is to maintain the simplicity of the Perkins while at the same time modernising it.

6 References

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[3] "HumanWare Price List" A Pulse Data International Company. Published electronically, http://www.humanware.com/K/K2.html

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