Application of PIC Microcontroller for Controlling Piezoelectric Braille Cell

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Abstract: - Piezoelectric Braille cells are used in many Braille display applications. The Braille displays using piezoelectric are able to refresh the Braille character that are read by visually impaired or blind people by touching the dots at Braille cell. Each piezoelectric Braille cell consists of six or eight movable pins or dots in rectangular array. The height of pins or dots in Braille cell is controlled by a piezoelectric bimorph. This will cause the pins or dots at piezoelectric Braille cell is rise or fall and therefore, create the Braille character or word. In this paper, the piezoelectric Braille cell is integrated by using PIC18F452 microcontroller while the software is written with CCS C program language. The pin or dots at Braille cell which represent a certain character is also presented.

Key-Words: - Piezoelectric Braille cell; Microcontroller; CCS C program language

1 Introduction

A Braille display is an electronic device, typically attachable to a computer that allows a blind person to read the contents of a display one text line at a time in the form of a line of Braille characters. It consist several Braille cell to represent a Braille character or word. Each Braille cell consists of six or eight pins or dots in a rectangular array. The pins can rise and fall depending on the electrical signals they receive. This simulates the effect of the raised dots of Braille impressed on paper. There are usually 40, 65, or 80 arrays (characters) per line of text, depending on the device. Less expensive devices display fewer characters per line, and require the user to read the standard 80 characters of a normal text line in several readings [1].

A Braille display operates on either electromagnetic or piezoelectric principles. When currents or voltages are applied to points in each six-pin array, various combinations of elevated and retracted pins produce the effect of raised dots or dot-absences in paper Braille. At the moment, the piezoelectric Braille cell is a common type of Braille display cells and commercially available [2] because it has relatively light weight, small size and direct-electrical control.

In this research, the piezoelectric Braille cell will be integrated by a PIC 18F452 microcontroller. PIC18F452 microcontroller will send an electrical signal to control the pins or dots at Braille cell. The input data from computer will send to microcontroller to display some of Braille characters. Fig.1 shows the block diagram about the system.

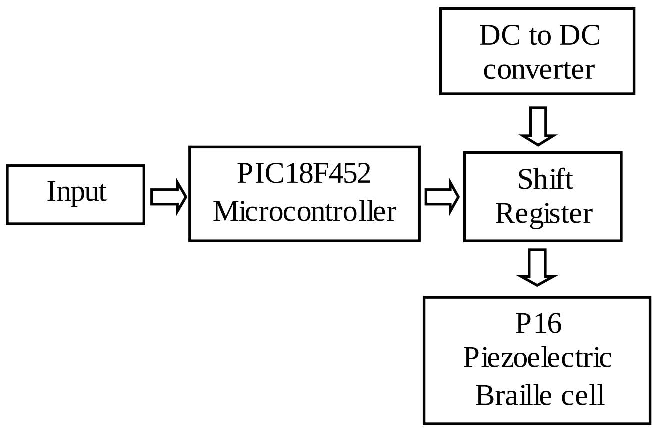


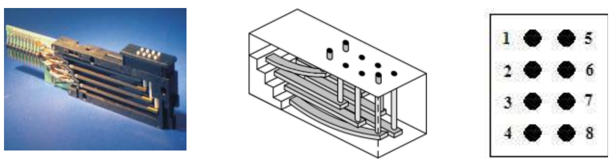
Fig.1 A system to control the dots of piezoelectric Braille cells.

2 System Involved

There are four systems involved in order to control the height of pins or dots at piezoelectric Braille cells. Those systems are piezoelectric Braille cell, shift register, DC to DC converter and PIC18F452 microcontroller system.

2.1 Piezoelectric Braille Cell

A piezoelectric Braille cell consists of eight dots in a rectangular array 4x2. Each dot is controlled by piezoelectric bimorph [1]. This piezoelectric bimorph is located inside Braille cell and attached to every single dot. Those dots will represent a Braille character or alphabet. Piezoelectric bimorph will bend up or down depending on the value of current and voltage applied to it. P16 piezoelectric Braille cell module from Metec Company as illustrated in Fig.2 has been used as a Braille actuator in this study.



(a) (b) (c)

Fig.2 (a) P16 piezoelectric Braille cell module [3], (b) Piezoelectric bimorph inside Braille cell [4], (c) The position of the pins in columns and rows of in the Braille cell.

Voltage supplied for this module is around 200VDC. There are 10 pins in each P16 Braille cell [3] as shown in Fig.3. When the voltage 200VDC is applied to each pin of Braille cell, piezoelectric bimorphs inside Braille cell will bend down and make the dot fall. If voltage 0V is applied, the situation is reversed. Some of character Braille can be formed by applying these two voltages.

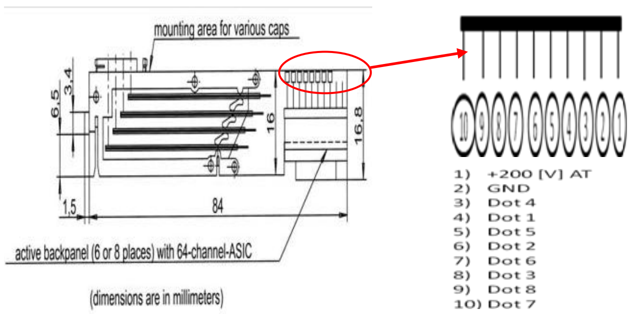


Fig.3 Braille cell pins configuration [3].

2.2 Shift Register

Shift register is used to control every single dot at Braille cell. Each Braille cell has eight pins representing each dot at one Braille cell. As illustrated in Fig.3, all pins need to be triggered by some voltage value whether 200V to raise the dots or 0V to fall the dots. HV507PG chip has been used as a shift register for this system. The HV507PG chip is a low voltage serial to high voltage parallel converter with 64 push-pull outputs. This device has been designed for use as a printer driver for electrostatic applications. It can also be used in any application requiring multiple output, high voltage, low current sourcing and sinking capabilities [5]. The supply voltage for this shift register is around 0.5V to 6.0V and it can produce output voltage on each pin up to 300V.

HV507PG chip consists of a 64-bit shift register, 64 latches, and several control logic pins such as direction (DIR) pin, Latch Enable (LE) pin, blanking (BL) and polarity (POL). This device also has two control data pins named DIOA and DIOB and both pins are controlled by DIR pin. For example, when DIR grounded, DIOA is Data-In and DIOB is Data-Out; data is shifted from HVOUT64 to HVOUT1. When DIR is at logic high, DIOB is Data-In and DIOA is Data-Out: data is then shifted from HVOUT1 to HVOUT64. Data is shifted through the shift register on the low to high transition of the clock. Transfer of data from the shift register to the latch occurs when the LE is high [5]. The data in the latch is stored during LE transition from high to low. The HV507PG can be controlled by some peripheral in PIC microcontroller called serial peripheral interface (SPI).

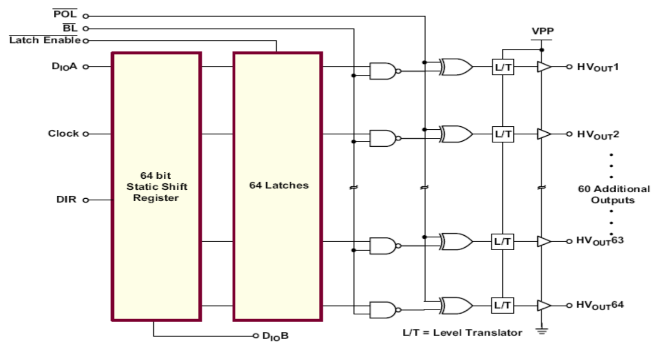


Fig.4 Functional block diagram for HV507PG shift register [5].

2.3 DC to DC Converter

Electronic switch-mode DC to DC converters convert one DC voltage level to another, by storing the input energy temporarily and then releasing that energy to the output at a different voltage. The storage may be in either magnetic field storage components (inductors, transformers) or electric field storage components (capacitors). Most DC to DC converters are designed to move power in only one direction, from the input to the output. DC to DC converter that has been used for this system is also is one direction, from 12V input voltage to 200V output voltage. This output voltage will be applied at each pins of P16 Braille cell. The maximum output power for this DC to DC converter is 1.5Watt [6].

2.4 PIC18F452 Microcontroller

The PIC is one of the most popular single-chip microcontroller families for low-power very-compact embedded systems [7]. It has been used in many application devices such as manufacturing equipment, instrumentation and monitoring, data acquisition, power conditioning, environmental monitoring, telecom and consumer audio/video applications. The PIC18F452 features a 'C' compiler friendly development environment, 256 bytes of EEPROM, Self-programming, an ICD, capture/PWM functions, 8 channels of 10-bit Analog-to-Digital (A/D) converter, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and Enhanced Universal Asynchronous Receiver Transmitter (EUSART) [8]. For this research, PIC18F452 will be used as a controller to control every single dot at each Braille cell according to the input data from PC.

3 Design Considerations for Software Implementation

In the software implementation process, initialization processing, data input processing from PC and data output to P16 Braille cell modules processing are considered. All of the software programs are written by using CCS C compiler.

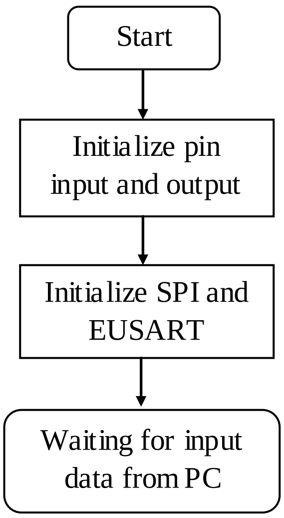


Fig.5 Flow chart of initialization process.

First, the required mode is initialized. In this process, pin RB5 at ports B is defined as an input or play button. This button will execute the program after all initialization has been made. Serial Peripheral Interface (SPI) and Enhanced Universal Synchronous Asynchronous Receiver Transmitter (EUSART) are also being configured and initialized in this process. The SPI is used to communicate between PIC18F452 microcontrollers with HV507PG shift register. The size data transfer by SPI is eight bit serial data. One bit represents one dot at Braille cell. EUSART is used to communicate between PIC18F452 with PC through hyper Terminal.

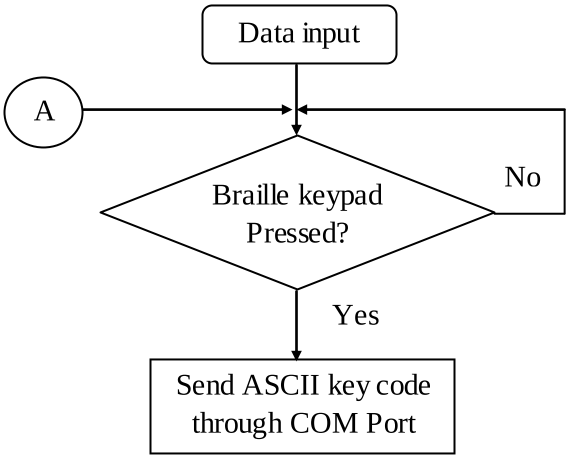


Fig.6 Flowchart of data input processing.

In data input processing, the program will wait until some of Braille keypad is pressed. The Braille keypads mentioned here is computer keyboard keys that are "f","d","s","j", "k" and "l" . Those keys represent the six key of Perkins Brailler. The Perkins Brailler is a typewriter to write Braille character or alphabet. The Perkins Brailler has several keys corresponding to each of the six dots of the Braille code. By simultaneously pressing different combinations of the six keys, users can create any of the characters in Braille code [9]. Fig.7 shows the Braille alphabet or character that can be formed by using all six key that mentioned above.

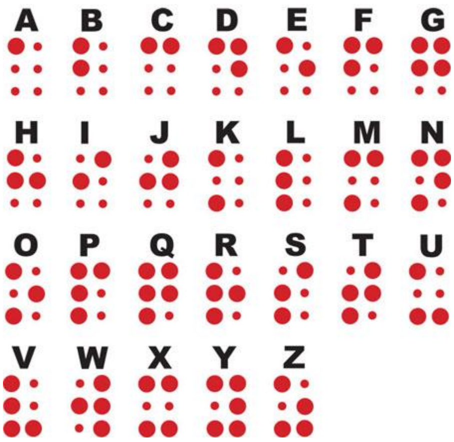
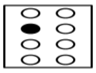
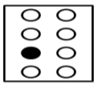
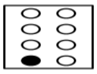
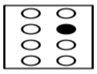
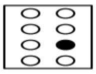
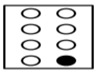


Fig.7 Braille Alphabets [10].

Table 1

ASCII Code and Braille Code for “f”, “d”, “s”, “j”, “k” and “l”.

Computer Keyboard Key	ASCII Code	Braille Code	Dots Braille
“ f ”	0x66	0x04	
“ d ”	0x64	0x02	
“ s ”	0x73	0x01	
“ j ”	0x6A	0x40	
“ k ”	0x6B	0x20	
“ l “	0x6C	0x10	

In this study, six keys on computer keyboard that are “f”,”d”,”s”,”j”,”k” and “l” will be data input for the system. These six keys will control every single dot at Braille cell. For example, “f” key will control dot 2 to rise if this key is pressed. This entire function key is shown at Table I. In order to show “A” Braille alphabet at Braille cell, we need to raise dot number two which refer to “f” key. For case “B” Braille alphabet, we need to raise dot two and three. To achieve this, the “f” and “d” keys are pressed simultaneously. By combining some of these six keys, we can write the Braille alphabet from “A” to “Z”.

After one of Braille keypad has been pressed, an ASCII code for that key will be send by computer using Hyper Terminal through the COM port and this will be received by PIC18F452 microcontroller via EUSART. Computer will send ASCII code only but not Braille code. For example, if “f” key (without caps lock) has been pressed, the Hyper Terminal will send ASCII code “0x66” in hexadecimal. This value needs to be converted by microcontroller to Braille code value such as “0x40” for “f” key to raise the dot number 2 at Braille cell.

In data output processing, the program will check at EUSART buffer whether the data has been received or not. If the data are not received via EUSART, the program will not execute to next step and it will wait until a data has received. When PIC18F452 has received data via EUSART, that data will be converted to Braille code first before sending it to shift register. Then, that Braille code will be send to HV507PG shift register. Shift register will spread the data to every single Braille cell to perform a character of Braille. All of three processes will continue until the reset button is pressed.

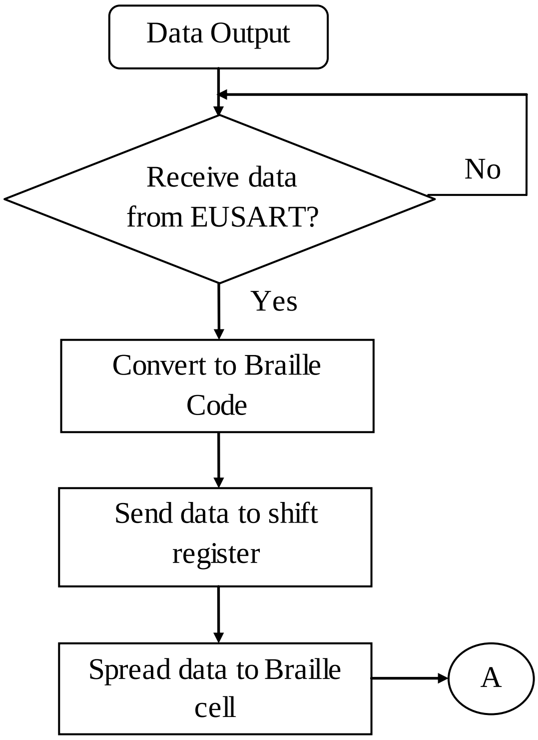


Fig.8 Flowchart of data output processing.

4 Finding/Result

In this study, results were obtained from entering the input data by pressing Braille keypad at computer keyboard. All of this input data will represent a character of Braille alphabet. Fig.9 shows the data input is send to microcontroller through Hyper Terminal while the Table II shows several Braille character appeared at Braille cell after pressing different combinations of the six keys that mention in this paper.

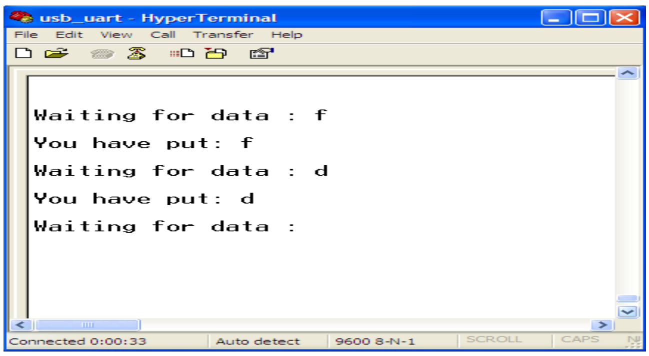
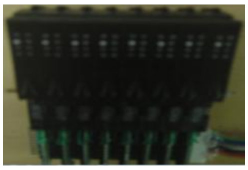
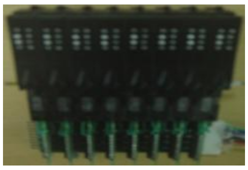
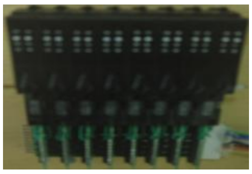
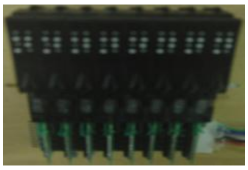


Fig.9 Input data from Hyper Terminal

Table 2

Braille Character Appeared at Eight P16 Piezoelectric Braille Cell.

Computer Keyboard key	Result Display at Braille Cell	Braille Alphabets
"f"		A
"f" & "d"		B
"f" & "j"		C
"f" & "j" & "k"		N

5 Conclusion

This paper has presented the piezoelectric Braille cell is integrated by using PIC18F452 microcontroller. By pressing the Braille keypad, a certain character or word can be displayed at piezoelectric Braille cell. The table results show the character of Braille alphabet appeared at Braille cell after Braille keypad has been pressed.This paper can be extended to cover electronic fields and would like to be a little support for other researchers in the field of electronics.

6 Acknowledgment

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