

# PC Text Document Reading Aid for the Blind

*by* Lanny Augustine

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# PC Text Document Reading Aid for the Blind

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## Abstract

The information spread faster in the form of electronic document lately. Blind persons require information as much as normal people. An appliance is needed to convert electronic text document in PC to Braille code format that could be read by blind persons.

An assisting device has been designed to fulfill the need. The device system consists of Character Scanning program on PC and a microcontroller-based embosser. The main function of Character Scanning program on PC is to open .txt file, to scan character, and to collect words. This program is able to deliver groups of 30 characters that will be received and converted to Braille codes by the microcontroller system. Further on, the Braille codes will be dynamically embossed on Pin Matrix Mechanic module. The navigation of each delivered group words can be controlled by up and down buttons which prepared in the microcontroller system. A Dot Matrix LED display (light-based display) also prepared to assist partially blind persons.

Keywords: Braille code, electronic text document, microcontroller system, mechanic, dot matrix.

## 1. Introduction

Braille is a coding system for helping the blind and visually impaired to read and write. It was invented by Louis Braille on 1821. It is a system of raising dots that could be sensed by user fingers. Each character is coded into a Braille cell that consist of 6 dots, which are arranged into 3 rows and 2 columns as shown in Figure 1.



Figure 1. Dots position rule of Braille cell

A Braille code generator has been developed for computer use. One of the code combinations that used in US computer has shown in Figure 2, which is known as un-contracted code, is used in the designed system. Totally 63 code combinations are able to be constructed by this method.

⠁	⠃	⠉	⠇	⠑	⠕	⠓	⠙	⠛	⠚
A	B	C	D	E	F	G	H	I	J
⠅	⠋	⠍	⠎	⠏	⠒	⠖	⠘	⠜	⠞
K	L	M	N	O	P	Q	R	S	T
⠕	⠖	⠘	⠜	⠞	⠢	⠦	⠨	⠬	⠮
U	V	X	Y	Z	[	=	(	!	)
⠠	⠡	⠣	⠤	⠥	⠦	⠧	⠨	⠩	⠪
*	<	\$	?	:	@	]	\	[	W
⠩	⠪	⠫	⠬	⠭	⠮	⠯	⠰	⠱	⠲
1	2	3	4	5	6	7	8	9	0
⠄	⠆	⠇	⠈	⠉	⠊	⠋	⠌	⠍	⠎
/	+	#	>	'	-				
⠇	⠈	⠉	⠊	⠋	⠌	⠍	⠎	⠏	⠑
Ⓢ	Ⓐ	Ⓜ	Ⓝ	Ⓟ	Ⓡ	Ⓣ	Ⓥ	Ⓦ	Ⓩ

Figure 2. Un-contracted Braille codes<sup>1</sup>

The designed system will enable blind user to “read” an electronic document directly. There are two types of display module; the light-based module and mechanic-based module; have been prepared. The raised dots will be replaced respectively by LEDs’ light and raised pins. The light-based display is designed for normal person or visually impaired who can still distinguish dark and light, and the mechanic-based (embosser) for the blind. The system involves PC as the source of text, in .txt file, to

<sup>1</sup> <http://library.thinkquest.org/J0112389/braille.htm>

arrange words. A microcontroller system is used to convert the words into Braille codes and control the display modules to visualize the codes.

## 2. System concept

The main function of the system is to convert the content of an electronic document, in .txt file, and to raise solenoids (as the pins) to form Braille codes of the content. A PC, a microcontroller-based hardware module (Figure 3), and 2 software modules, which are designed for PC and microcontroller programming, are needed in this system.

The PC is used to store electronic documents, as the source of text, and to arrange the content into rows of words. Maximum characters per rows are 30 characters, including spacing, but no fragmented word. Delphi 6.1 programming language is used to build "Character Scanning program" that serve those functions. PC will send the ASCII codes of each row to microcontroller system (uC system) through serial communication.

The microcontroller-based hardware module was built from a DT-51 microcontroller module, which connected to PC, and two Braille code display modules. Solenoids movements, in Pin Matrix Mechanic module, will emboss the codes, while Dot Matrix display will visualize 30 Braille codes in LEDs' light.

DT-51 microcontroller module is based on an 8-bit AT89S51 microcontroller system with 4 Kbytes Flash PEROM (*programmable and erasable read only memory*). This module was programmed with Assembly language to serves two functions. First, accept ASCII codes from PC, convert it to Braille codes, and save it. Second, to control those modules explained earlier to display the Braille codes. Up and down button are prepared to navigate the displayed document content.

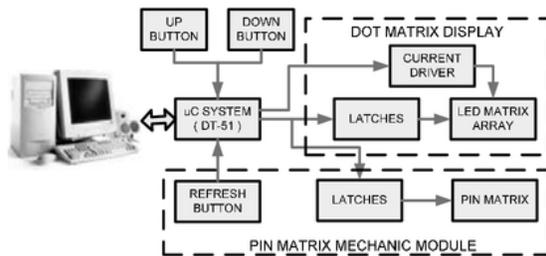


Figure 3. Block diagram of the whole system

## 3. Hardware design

As mentioned earlier, it was built from a DT-51 microcontroller module, and two Braille code display modules (Pin Matrix Mechanic module and Dot Matrix

display). The design of the display modules will be explained here.

### 3.1. Pin Matrix Mechanic module

The function of Pin Matrix Mechanic module is to visualize the Braille code into mechanic movement of solenoids. There are 6 solenoids that arranged to form 1 Braille cell. Latches are needed to hold the data of the 3 rows of the cell. This module uses L293D H-Bridges for conditioning latches to solenoids voltage level, 12 volt. A button is prepared to refresh the solenoids position. The function of this refresh button is further explained in microcontroller software programming.

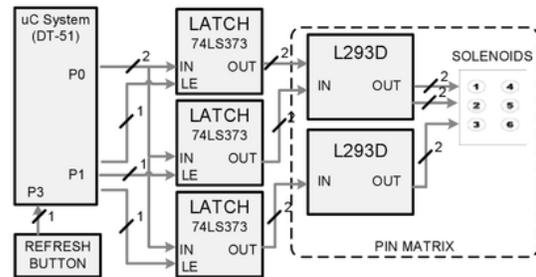
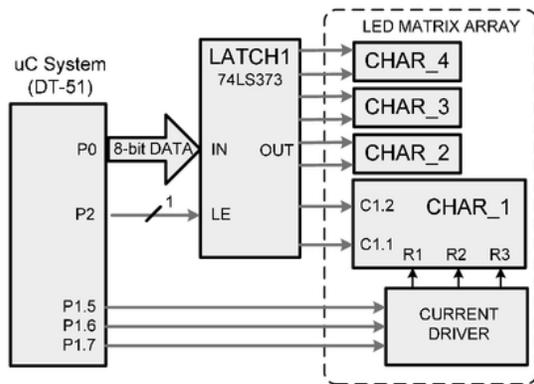


Figure 4. Wiring diagram of microcontroller system to Pin Matrix Mechanic module (1 Braille cell)

### 3.2. Dot Matrix display

This module is consist of 30 Braille cells. The method of raising dots is replaced by turned on LEDs. Latch is used to temporarily save the data that was received from port 0 microcontroller. This 8-bit data will generate 4 characters, while each 2-bit represent the information of 1 row for each character (e.g. pin C1.1 and pin C1.2 for the data of the first character). Therefore, 8 latches and 6x30 LEDs are needed to build a 30 characters display. Figure 5 shows the first latch that support the first 4 Braille cells.

To save the system power, a row scanning method is used to turn on the LEDs. A logic low from Port 1 (P1.5 – P1.7) is needed to activate one row at a time. It will display the data of each row continuously, to perform a full display of Braille cells. A transistor is needed on each pin of port 1 to drive enough current to LEDs (2x30 LEDs).[2] Each row of all LED matrix array is connected in parallel. R1 is simbolize the first row, R2 for the second row, and R3 for the third row.



**Figure 5. Wiring diagram of microcontroller system to Dot Matrix Display**

#### 4. Software design

In the system description, it has been mentioned that two software modules have been designed for PC and microcontroller programming. The detail of each software flow is explained here.

##### 4.1. Software module in PC

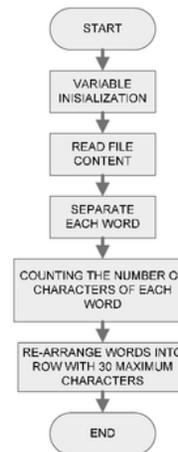
Delphi 6.0, an object oriented programming language, is used to build the software module in PC. The main function of this module is to arrange the content of electronic text document into rows of words that suitable with the display modules. The file content could be numbers, alphabets, and special characters as mentioned in Figure 2.

There are some steps to be done to accomplish that function, as listed below:

1. To open and to read all detectable content of .txt file that has been selected by user/operator.
2. To detect and to remove all space, tab, and enter.
3. To arrange words, that have been read, into several rows. The number of characters in each row should be less than or equal to 30 characters, due to the display module that constructed of 30 Braille cells. Flowchart of the main software could be draw as in figure 6.
4. To send the ASCII codes of those characters to microcontroller-based hardware module through serial communication. An operator is needed to click one row of words on the display to stimulate PC doing this step only right after this software read and arrange the document content.

As shown in figure 3, up and down button have been prepared to update the displayed row. It will drive the PC to send the ASCII codes of words of other row. Up button for the row before the selected row, and down button for

the next row. Due to how it works, this software module is named the Character Scanning program.



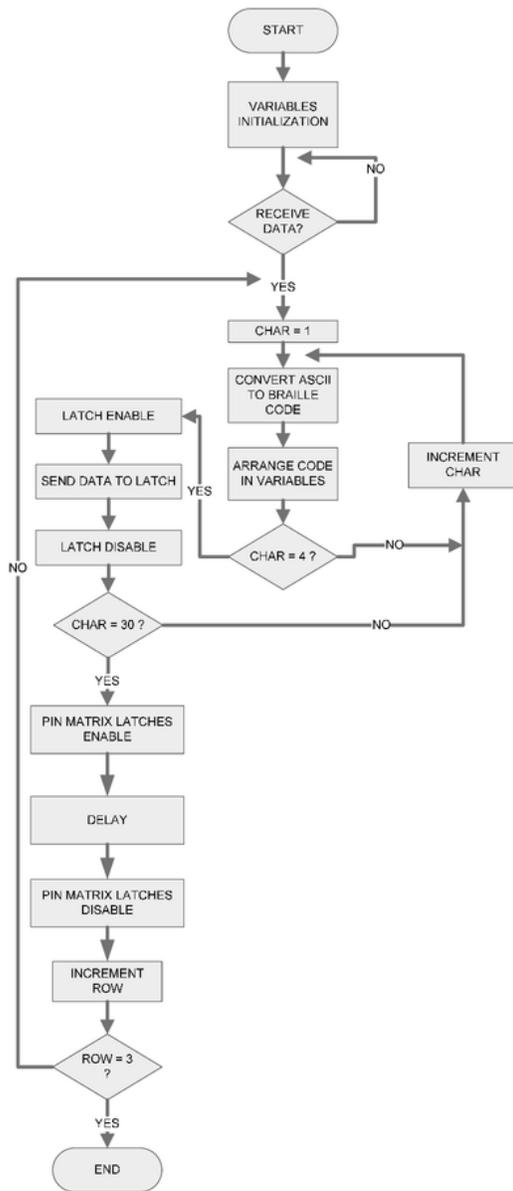
**Figure 6. Flowchart of Character Scanning program**

##### 4.2. Software module in microcontroller

As mentioned in the system's description, the microcontroller-based hardware module was programmed with assembly language to serves two functions. First, to accept ASCII codes from PC, convert it to Braille codes, and save it. Second, to control the modules those have been explained earlier to display the Braille codes. An additional function is to navigate the displayed document content. There are two buttons, up and down, have been prepared to stimulate the navigation process.

In order to perform those functions, there are steps should be arranged in the software module, that also described in the flowchart on figure 7. The steps could be explained systematically as follow:

1. To wait for the ASCII code of the first 30 characters from PC continuously. Then, to convert the received data into Braille codes, and to save it into microcontroller's registers.
2. To send the converted data and to save it temporarily through latch. Then to activate the display module and embosser. The sent data, 8 bit, bring the information of one row of 4 Braille cells, that handle by 1 latch.
3. To repeat step 2 for the next latches. There are 8 latches to handle 30 Braille cells.
4. To repeat step 2 and 3 in order to display the second and third rows of Braille cells.



**Figure 7. Flowchart of microcontroller's software module**

Microcontroller will repeat the row scanning process (step 2,3, and 4) continuously; as long as no data changing; to display a complete Braille codes on Dot Matrix Display module. It is done to save power.

Pin Matrix Mechanic Module have a different mechanism. The solenoids movement could be controlled by giving a constant voltage and current. Since the main program is doing row scanning process, then additional

latch is needed to hold the Braille code data for this module. Only the the first data from row scanning process will be received and then locked by the latch.

Microcontroller also handle three interrupts, they are the external interrupt, serial interrupt, and timer interrupt. [5]

#### 1. External interrupt

It will be activated by pressing up or down button. Afterward, microcontroller will postpone the main program and send a control signal to PC ("a" if up button pressed and "b" for down button). It is indicating a request for new data and microcontroller will restart the process from step 1.

#### 2. Serial interrupt

The function of this interrupt is to deal with serial communication to PC. It will manage data and control signal (as mentioned in external interrupt) transmission.

#### 3. Timer interrupt

It will check if refresh button has been pressed. Timer interrupt automatically activated every 0.5ms.

Due to the additional refresh button, microcontroller will update the data and reset the Pin Matrix Mechanic Module if it is pressed.

## 5. Experimental results

Figure 8 shows the Character Scanning program display. The main purpose of the display is especially to control the system and to monitor the PC's software performance. It consists of 3 columns. Column I displays the content of the opened text file. Column II shows the result of reading and arranging the file content. Column III displays the results of words re-arrangement into rows which maximum length is 30 characters that will be sent to microcontroller-based hardware module.

Three steps of experiment have been done to test the system, they are:

1. To test the 36 Braille code combinations which convertible by the system (figure 2). The experiment shows that all characters have successfully been converted.
2. To test with input of sentences. Figure 8 have shown that the software module in PC have a good performance.
3. To test the Dot Matrix display and Pin Matrix Mechanic Module. The highlighted part, "perbandinganantaradatayangada", in column III (figure 8) is the row that converted to Braille codes. Figure 9 shows the conversion result of the fragmented sentence into Dot Matrix display. A prototype of Pin Matrix Mechanic module, for 1 Braille cell, has been realized and plugged to the 6th character, i.e. the "n" alphabet. The test result of the module has shown in figure 10.

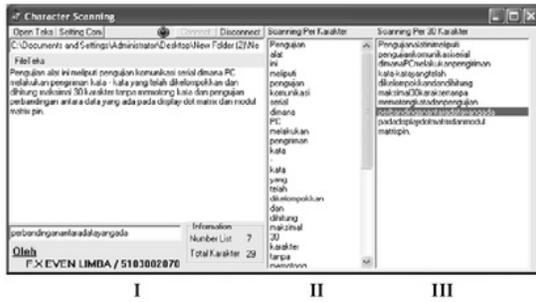


Figure 8. Character Scanning program display on PC

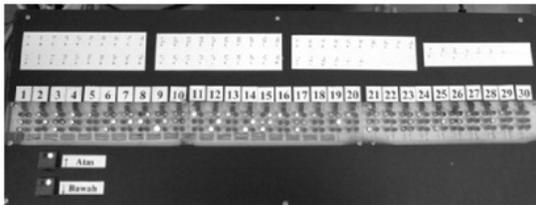


Figure 9. Dot Matrix Display

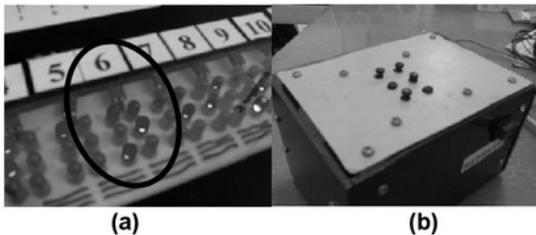


Figure 10. Display of the 6<sup>th</sup> character (a) Dot Matrix Display (b) Pin Matrix Mechanic Module (one Braille cell)

## 6. Conclusion

Due to the experimental results, the system is working properly. It also has been tested in Yayasan Pendidikan Anak Buta (Blind Children Education Foundation). The system is feasible to be used for the beginner due to the relatively large size of the mechanic Braille cell (about  $4.5 \times 6.5\text{cm}^2$ ) while the Dot Matrix Display could be used by visually impaired student which could still distinguish dark and light.

Since electronic documents were made of different type of files, further improvement is needed. In the future, the system should be able to be fully operated by the visually impaired person him/herself.

## 7. Acknowledgement

The authors gratefully acknowledge Yayasan Pendidikan Anak Buta (Blind Children Education Foundation) in supporting the field experiments, and also for the comment and suggestion for further improvement.

## 8. References

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- [2] Malvino, Albert Paul, Ph.D., EE., *Electronics Principles*, 1<sup>st</sup> edition, Salemba Teknika, 2003.
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C.N. Ravi Kumar, S. Srinath. "A Novel and Efficient Algorithm to Recognize Any Universally Accepted Braille Characters: A Case with Kannada Language", 2014 Fifth International Conference on Signal and Image Processing, 2014

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