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Electronic and Computer-Assisted Refreshable Braille Display Developed for Visually Impaired Individuals

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***Abstract*—**Braille alphabet is an important tool that enables visually impaired individuals to have a comfortable life like those who have normal vision. For this reason, new applications related to the Braille alphabet are being developed. In this study, a new Refreshable Braille Display was developed to help visually impaired individuals learn the Braille alphabet easier. By means of this system, any text downloaded on a computer can be read by the visually impaired individual at that moment by feeling it by his/her hands. Through this electronic device, it was aimed to make learning the Braille alphabet easier for visually impaired individuals with whom the necessary tests were conducted.

***Keywords*—**Visually Impaired Individual, Braille, Braille Display, Refreshable Braille Display, USB.

I. Introduction

BLIND person as a special group in society is in need of more care and attention from the public [1], [2]. The Braille alphabet is one of the most important tools developed for these special people. The word Braille is defined in all dictionaries of the world as the writing system of the blind that uses raised dots for reading by touch [3].

The Refreshable Braille Display System (RBDS) is a tactile reading aid, which provides blind people with improved computer accessibility by translating the on-screen text into tactile Braille cells [4]. In a refreshable Braille cell, the dots are formed by independently controlled pins driven by a variety of actuators that are generally controlled by the output of a computer [5]. A Braille cell should be small, lightweight, consume less power for its portability, fast and it should be interfaced to the computer on-line for easy communication [6]. A Braille device which aims to teach Braille to visually-impaired people was developed and applied at a technical level [7]. Electromagnets, bimetals, shape memory alloys, pneumatic drives, piezo ceramic reeds and many other actuation technologies have been extensively investigated for Braille cells [8]. A compact dielectric elastomer actuator is developed for Braille applications [5]. The proposed flapper actuator was designed with numerical analysis, including contact mechanics, heat transfer, and electromagnetics to ensure the feasibility and durability of the design [9]. Electrotactile Display System was developed and investigated effectiveness of the proposed system in terms of the perception of roughness of a surface by stimulating the palmar side of hand with different waveforms and the perception of direction and location information through forearm [10]. An electrothermally controlled microactuator that exploits the hydraulic pressure due to the volumetric expansion of melted paraffin wax was used for Braille cell [11]. Each dot was independently driven by the piezoelectric linear motor; real-time display of a braille character was available in the braille cell [6]. An endoskeletal 2 x 3 microbubble array was employed as the actuation scheme for the Refreshable Braille Display System [12]. A refreshable tactile system based on the opto-mechanical properties of liquid crystalline elastomers (LCE) composites was presented for Braille characters [13].

In this study, a new device related to teaching the Braille alphabet was developed to facilitate visually impaired individuals' lives. By the help of this device, it was aimed to make visually impaired individuals who do not know or will learn the Braille alphabet learn it by actively using the device. As for the size, the device was developed in a way that it can be easily carried by visually impaired individuals.

II. Material and Method

After a letter, number, symbol, text or sentence was entered on the display, character separation is done when necessary. Then, the characters are sent to the electronic device and read by the visually impaired individual by feeling them by his/her hand. The operation steps in the device developed are represented in Fig. 1. USB correspondence was used to be able to program the electronic and computer-assisted Refreshable Braille Display circuit and do the necessary routing.

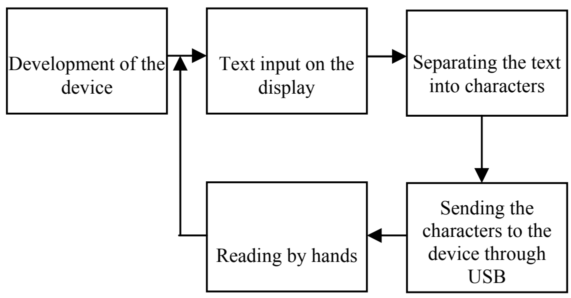

Fig. 1 Operation steps

In the Refreshable Braille Display, there are exactly 96 Braille cells. The Braille cells were joined using an electronic circuit named backpanel.

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A. Braille Cells

The Braille cells were developed so that visually impaired individuals can easily learn the Braille alphabet on an electronic environment. Braille-cell with 8 dots is driven by piezo-actuators [14]. A piezoelectric actuator converts an electrical signal into a precisely controlled physical displacement (stroke). If displacement is prevented, a useable force (blocking force) will develop [15].

When no expressions are sent, all points in the cells are motionless. Depending on the information sent, the relevant pins on the relevant cells move. At this moment, the energy on the relevant pins is 200V. In other words, the pins move by means of the piezo actuators. The Braille cell used in the application is shown in Fig. 2. And Braille cell's technical properties are shown in Table I [14].

Fig. 2 Braille cell

TABLE I
TECHNICAL PROPERTIES FOR BRAILLE CELL

Properties	Values
Dimensions (w x h x d)	6.42 x 12,4 x 53,2 mm
Dot spacing	2.45 mm
Dot stroke	ca. 0.7 mm
Cell spacing	6.42 mm
Tactile force	Min. 17cN
Dot rising time	50 ms
Power requirements	200 V +-5% absolute max. rating 215 V 1,2 µA typ. per dot
Accessories	Metal trays active Backpanel Caps B12 connecting Cable Backpanel 200mm (Connector DF13-7S-1,25)
Average piezo actuations	$>10^9$

Braille cells take the power by USB. USB works with 5V but Braille cells work with 200V. So 5V must convert to 200V by an electrical circuit which is shown in Fig. 3.

B. Backpanel

Thanks to the backpanel, more than one Braille cells can be used side by side. 2, 4, 6 or 8 cells can be mounted on one backpanel. The backpanel used in the application is represented in Fig. 3. The cells could be used side by side by mounting the Braille cells on the sockets shown in Fig. 4. Backpanel technical properties are shown in Table II [14].

Fig. 3 Boost circuit

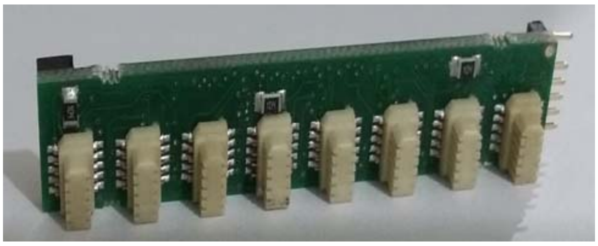

Fig. 4 Backpanel

TABLE II
TECHNICAL PROPERTIES FOR BACKPANEL

Properties	Values
Max. Transition time clock & strobe	125 ns
Max. clock speed	500 kHz
Power requirements	3,3 - 5 +-5% : 25 µA typ. per cell (with static driven signals, no key pressed)
	200 V +-5%: absolute max. rating 215 V / 5 µA typ. per dot

A total of 12 backpanels were used in this application, 8 Braille cells were mounted on each backpanel and connected to the computer over USB. The block diagram of the circuit developed using braille cells and backpanels are shown in Fig. 5.

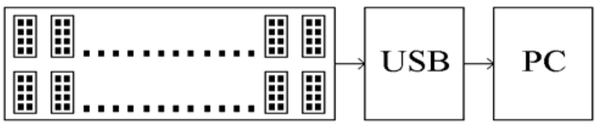

Fig. 5 Block diagram

C. USB

Universal Serial Bus (USB) is an industry standard developed in the mid-1990s that defines the cables, connectors and communications protocols used in a bus for connection, communication, and power supply between computers and electronic devices [16]. USB is the most popular connection used to connect a computer to devices such as digital cameras, printers, scanners, and external hard drives [17].

In the application, the USB 2.0 Type – B connector is used for connecting to the Braille display which is shown in Fig. 6. The pin structure of USB 2.0 Type – B connector is shown in Table III.

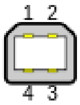

Fig. 6 USB 2.0 Type-B connector

TABLE III
STANDARD PINOUT

Pin	Name	Description
1	V_{BUS}	+5 V
2	D -	Data -
3	D +	Data +
4	GND	Ground

III. Application

In this application, an electronic and computer-assisted Refreshable Braille Display that visually impaired individuals can used was developed. The system is composed of two elements; hardware and software. In the hardware element, the Braille cells are mounted side by side using backpanels. In the software element, information was sent to the hardware developed using C# programming language over USB. Sending a character or text input in any of the textboxes in the software interface, visually impaired individuals performs the reading action using their hands on the Braille display. In other words, if "Ahmet" is written in a textbox, the word "Ahmet" will be send to the device, and the visually impaired individual will read the word by feeling it by his/her hands. The system developed is represented in Fig. 7.

Fig. 7 Refreshable Braille Display

The text input in a textbox in the visual display developed in C# interface is also shown in the C# display actively. In this way, the control over the text sent from the display is achieved on the display. The screen shot generated in C# is shown in Fig. 8.

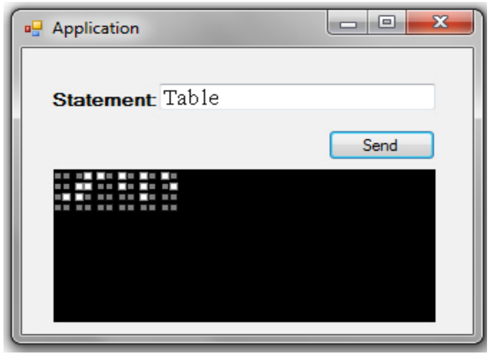

Fig. 8 C# Interface

Created pseudo code is shown on the below for the application.

```
Procedure USB_Connection()
{  Connect to the Braille display with USB
   if there is any connection
      Connect to the device
   else
      Exit the program
}

Procedure Clear_Braille_cells()
{  for (i=1 to Braille cell count)
      Clear Braille cell
}

Procedure Braille_Code_Control(char c)
{  if (c is 'a') The code is 1
   if (c is 'b') The code is 3
   …
   if (c is 'z') The code is 53
}

Main()
{  USB_Connection()
   Clear_Braille_cells()
   Go to the first position of Braille cell;
   for (i=1 to length of the Textbox)
   {  ch=Take only one character from the Textbox;
      Braille_Code_Control(ch);
      Send the code to the Braille display with USB;
      Go to the next position of the Braille display;
      Take the next position of the Braille display;
   }
}
```

In the implementations with students, practice was conducted first on the alphabet, then words and then sentences. During these practices, statements including capital letters, numbers and symbols were also considered. The letters, symbols, numbers, words and sentences used are given in Table IV.

TABLE IV
THE STATEMENTS USED IN THE APPLICATION

No	Statements
1	a,b,c,d,e,f,g,ğ,h,ı,i,j,k,l,m,n,o,ö,p,r,s,ş,t,u,ü,v,y,z A,B,C,D,E,F,G,Ğ,H,I,İ,J,K,L,M,N,O,Ö,P,R,S,Ş,T,U,Ü,V,Y,Z 0, 1, 2, ….. 8, 9 !, ', ^, …….. ?
2	Apple
3	Bean
4	Table
5	Socks
6	Cream
7	Ela, throw the ball.
8	I'm 7 years old.
9	Where are you from?
10	The police caught the criminal.

IV. CONCLUSION

The electronic and computer-assisted Refreshable Braille Display designed to help visually impaired individuals learn the Braille alphabet actively was developed. This system specifically focused on letters, numbers, symbols, words and sentences. In order for the visually impaired individuals to learn more easily, letters, symbols and numbers were firstly taught, and then words and sentences were practiced. The statements shown in Table I were practiced by 5 visually impaired individuals. The functioning of the system was tested on three students who knew the Braille alphabet and no problems were encountered. Then, it was tested on 5 individuals who did not know the Braille alphabet and their learning rates are given in Table V.

TABLE V
LEARNING RATES

Visually Impaired Individuals	Age	Learning Rate in the System Developed for Braille Alphabet
1. Individual	6	%80
2. Individual	5	%76
3. Individual	6	%91
4. Individual	6	%85
5. Individual	5	%60

As seen in Table V, while the learning rate of the 5 year-old group was 68%, it was 85,3% in the 6-year old group.

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REFERENCES

[1] Eldem A. and Basçiftçi F., The Electronic and Computer-Aided Periodic Table Prepared for the Visually Impaired Individuals, World Academy of Science, Engineering and Technology 80, 2013, 1051-1053.
[2] Yin J.,Wang L. And Li J., TheResearch on Paper-mediated Braille AutomaticRecognitionMethod, 2010 Fifth International Conference on Frontier of Computer Science and Technology (IEEE).
[3] Jiménez J., Olea J., Torres J., Alonso I., Harder D. and Fischer K., Biography of Louis Braille and Invention of the Braille Alphabet, Survey Of Ophthalmology, Vol. 54, No. 1, 2009, 142-149.
[4] Yobas L., Durand D. M., Skebe G. G., Lisy F. J. and Huff M. A., A Novel Integrable Microvalve for Refreshable Braille Display System, Journal Of Microelectromechanical Systems, Vol. 12, No. 3, June 2003, 252-263.
[5] Chakrabortia P., Karahan Toprakcia H.A.,c, Yangb P., Di Spignab N., Franzonb P. and Ghosha T., A compact dielectric elastomer tubular actuator for refreshable Braille displays, Sensors and Actuators A, 179, 2012, 151– 157.
[6] Cho H., Kim B., Park J. and Song J., Development of a Braille Display using Piezoelectric Linear Motors, SICE-ICASE International Joint Conference 2006, 1917-1921, Korea.
[7] Çentik G., Design and Application of a New Computer-Assisted Training Set for Teaching the Braille Alphabet to Visually Impaired Individuals, Master Thesis, Trakya Üniversitesi, 2009.
[8] Runyan N. H., Carpi F., Editorial, Seeking the 'holy Braille' display: might electromechanically active polymers be the solution, Expert Review of Medical Devices, Vol. 8(5), 2011, 529-532.
[9] Yeh F. and Liang S., Mechanism design of the flapper actuator in Chinese Braille display, Sensors and Actuators A, 135, 2007, 680–689.
[10] Yarimaga O., Lee J, Lee B., Ryu J., Tactile Sensation Display with Electrotactile Interface, ICCAS2005, June 2-5, KINTEX, Gyeonggi-Do, Korea.
[11] Lee S. J. and Lucyszyn S., A Micromachined Refreshable Braille Cell, Journal Of Microelectromechanical Systems, 14, 4, August 2005.
[12] Wu X., Zhu H., Kim S. and Allen M.G., A Portable Pneumatically-Actuated Refreshable Braille Cell, The 14th International Conference on Solid-State Sensors, Actuators and Microsystems,June 10-14, 2007, 1409-1412, France.
[13] Torras N., Zinoviev K.E., Camargo C.J., Campo E.M., Campanella H., Esteve J., Marshal J.E., Terentjev E. M., Omastova M.,Krupa I., Teplický P., Mamojka B., Burns P., Röder B., Vallribera M., Malet R., Zuffanelli S., Soler V., Roig6 J., Walker N., Wenn D., Vossen F., Crompvoets F.M.H., Nematic Opto-Mechanical Actuators For The Fabrication Of Refreshable Tactile Systems, Transducers 2013, 1691-1694, Barcelona, SPAIN.
[14] http://web.metec-ag.de/P20.pdf, Access Date: 23.08.2014.
[15] https://www.americanpiezo.com/piezo-theory/actuators.html, Access Date: 23.08.2014.
[16] http://en.wikipedia.org/wiki/USB#cite_note-2, Access Date: 01.12.2014.
[17] http://etc.usf.edu/techease/win/hardware/what-is-usb/, Access Date: 01.12.2014.