



# An interactive and multi-functional refreshable Braille device for the visually impaired



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## ABSTRACT

Although visually impaired people are generally considered to be dependent and helpless people, they actually share the same characteristics as other people. Thanks to the Braille alphabet, which has been developed to reduce inequality of opportunity to minimum, their lives become a little bit easier. Besides Braille alphabet, there are many devices and software developed for visually impaired people. In this study, a readable, vocalized and refreshable Braille device, which can ease the lives of visually impaired people, has been developed. The results of the tests on this device with 20 visually-impaired people whose ages ranged between 5 and 15 and who do not know the Braille alphabet indicated the usability rate of this device to be 81.8%. The usability rate of the device was found to be 97.16% in the tests with 30 visually-impaired people whose ages ranged between 10 and 33 and who know the Braille alphabet. The durability test of the device indicated that Braille cells worked with 100% efficiency in the trials from 50 characters to 4000 characters. The device was superior both in terms of features and 35% cheaper compared to the ones available on the market. Besides, it was determined that USB connection transmitted data faster compared to the Bluetooth connection.

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## 1. Introduction

The Braille alphabet, developed by Louis Braille [1], is used by visually-impaired people with special needs [2,3]. Visually-impaired people can live easier lives thanks to this alphabet. Each Braille character in the Braille alphabet is composed of 6 dots in 2 columns and 3 lines. Besides, some dots are made more dominant compared to other dots so that visually-impaired people can read by touching [4]. Visually-impaired individuals read by touching their fingers on the dots of Braille characters [5]. Many applications that can facilitate the lives of visually impaired people in the environments they live have been developed using the Braille alphabet.

Refreshable Braille Display is one of the most developed applications and transfers any text to Braille cells via computers to help visually-impaired individuals read by touching [6]. The Braille cells are developed for the Braille alphabet by using Braille displays as hardware. Many articles have been written on the Refreshable Braille Display and many applications have been developed in

the industry. There are many commercially available devices like Power Braille, Braille Star, Brilliant BI, Alva, PacMateOmni, Focus Series. Besides, many different types with 10 cells, 20 cells and 40 cells are also available. The material used in the pins of Braille cells in the Refreshable Braille Displays is important because they need to transfer the desired information flawlessly and in the shortest time possible. The construction elements used include relay [7,8], polymer actuator [9], elastomer actuator [10], piezo electric actuator [11], flapper actuator [12], micro bobbin actuators [13], bistable electroactive polymers [14,15], pneumatic balloon actuators [16], field-effect transistor and polymeric actuators [17].

In this study, a bookreader device with 96 Braille cells was developed to end visually-impaired individuals' dependency for reading texts. They can both read and listen to texts in any book in the Braille alphabet form by touching with their hands on the tablet. Currently available bookreader machines can only export written texts in audio format. If one wants to read the book with the Braille alphabet, Braille display can be purchased to read by touching if the reading machine supports the Braille alphabet. However, if the bookreader machine purchased does not support Braille display, it can only be listened to. In this study, both place and money were saved by developing a device including both in one.

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## 2. Material and method

Initially the type of connection for communication with the device, which has been developed for visually-impaired individuals, is to be chosen automatically or manually. Later on, the document to be read is to be scanned using a scanner and necessary OCR processes are implemented to obtain the text in the image scanned. After the operating mode is determined, data can be transferred on the Braille cells or can be listened to. During these operations, data can be explored by continuously checking whether any information comes from the buttons. The operations steps for the device developed are shown in Fig. 1.

### 2.1. Type of connection

USB and Bluetooth connection are used to achieve communication between the computer and the device. When sending information with USB and Bluetooth, band width is important because bandwidth determines how many bytes of data will be send. Bluetooth connection is preferred as default connection type as it does not cause cable mixing. If no device is seen when connected with Bluetooth, USB connection is checked.

#### 2.1.1. USB

USB is one of the most commonly used connection types [18]. When data are transferred with USB, transmission is done through 4 cables on the line. The red cable carries 5 V signals, black cable carries 0 V signals, green cable carries data and white cable carries CLK (Clock) signals. USB communication uses synchronized serial communication protocol. Synchronized serial communication protocol, receiver and transmitter work simultaneously. This

simultaneous operation is controlled by CLK signal. CLK signal is send when each byte of data is transmitted. In other words, CLK signal is 1 when data is transmitted. Data transmission to the circuit and data reception from the circuit is realized in 8 bytes. There are a total of 96 Braille cells, so in order to achieve simultaneous writing process in all cells, 8 bytes are sent at once but after there are 96 bytes on the side of PIC, data is transmitted to Braille cells.

#### 2.1.2. Bluetooth

Bluetooth communication is preferred to achieve communication without cable mess. Bluetooth HC06 integrated circuit shown in Fig. 2 is used to achieve communication via Bluetooth.

When Bluetooth HC-06 module is used, it is important to know which comport is used. After the relevant comport is determined, data is transmitted at 9600 baudrate to send 8 bytes at each time.

In serial communication, first of all it is stated that data transmission will be started with Start bit. Later on, data of 8 bytes is transmitted. If the parity bit, which checks whether data is transmitted accurately, is to be used, it is added to the data package. If it will not be used, Stop bit is added to the data package and data transmission is finalized.

### 2.2. Braille cells

The Braille alphabet is developed to help visually-impaired people to read. Braille cells were developed to electronically display the Braille alphabet on any type of electronic device like computers or Braille display. Piezo actuators, which convert electrical energy to pin movements [18], were used in the structure of the Braille cell used in this study and it is shown in Fig. 3. The pins replaced

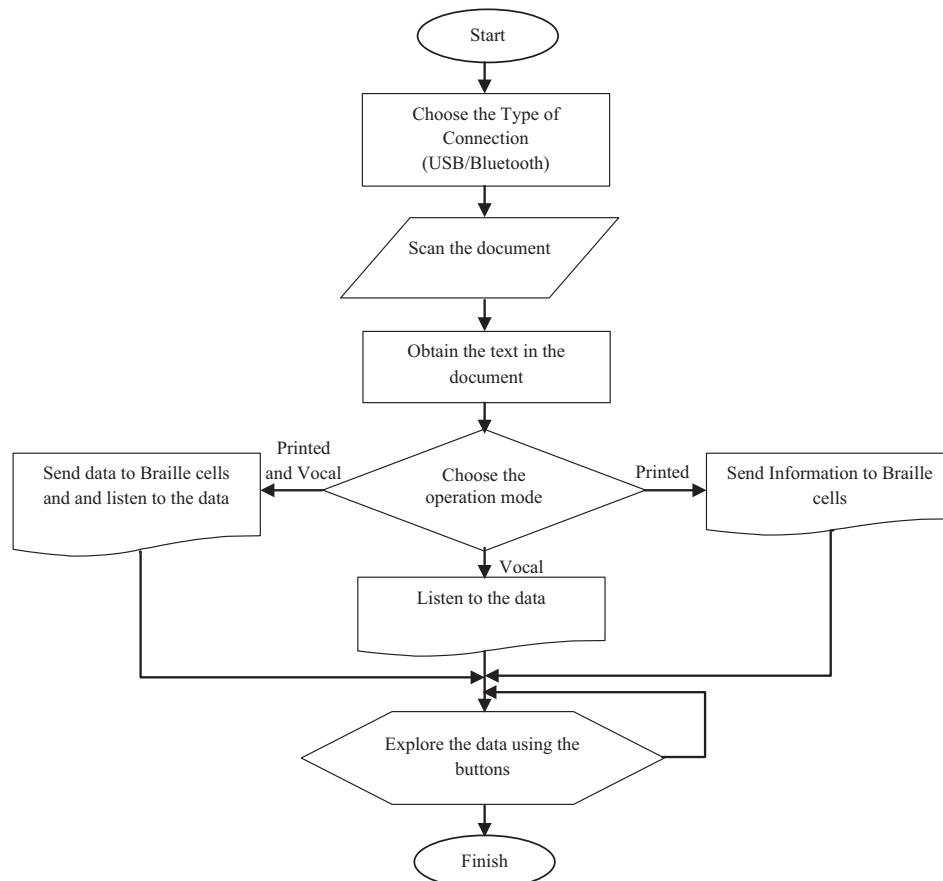


Fig. 1. Process steps.

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