Palestine Polytechnic University
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Smart Glove for Blind and Deaf Blind People

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Abstract

People with "blindness" and "Deafness-blindness" are often isolated and forced to live in a limited world, as they face serious compound communication problems. This project introduces a system to support the communication of blind and deaf-blind people, thus fostering their independence and integration in the society.

This project uses small and cheap components to build a communication device that solves the previously mentioned problems. It includes a Smart-Glove that translates the braille alphabet, which is "a system of raised dots that can be read with finger sensation by blind and vision impairment people all over the world in their native languages"[1]. The Smart-Glove enables the blind and deaf-blind user to create a text message by pressing properly ordered push button switches located on a Smart-Glove. The message is then transmitted by Bluetooth to the other mobile user. The Smart-Glove can also receive incoming messages using small vibration motors located on the back of the glove, which allows the blind to perceive the alphabets.

An important advantage of the system is that it does not require people to have knowledge of braille in order to interact with the blind person.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 Overview of the Project

According to world health organization (WHO), it has been estimated that 39 million people are blind worldwide, and 285 million people are visually impaired [2].

Many developing countries including Palestine have limited facilities for those people, for that they are living isolated with no education and employment as they and their families are afraid to face and communicate with the world.

Globally, braille is the way that those people communicate with, and it is a system of raised dots which are formed by six dots that can be read by fingers sensation, and it is used by millions of people around the world in their native languages [1]. This method proved its affectivity. However, the problem lies in that most people do not understand the braille.

In developing countries, limited technologies are available to serve these people. In Palestine, with our little materials we came with this project, designing a Smart-Glove that enable deaf-blind, blind and low vision people to receive and send text messages.

1.2 Motivation and Importance

The common way of writing and reading for many people with severe visual impairment and blindness is through braille system. While these persons can read and write using the braille system, the majority of normal persons cannot, and thus there exists communication barrier between seeing and blind people.

The most important motivations for the project are to overcome this communication barrier. The Smart-Glove developed in this project provides the ability to blind person who use braille system to send and receive a text messages.

This achieves several points, the most importance point is to enable the blind person to communicate with other people in an easier way, also to overcome the difficulty of communication in school between the blind and deaf-blind with their teachers and other students, or even solve the problems that can face them at work [3].

1.3 Objectives

The main objective of this project is to help blind and deaf-blind people to communicate with other people. In essence, we aim to design and implement a system that:

1. enables the users to send and receive messages.
2. is small and light, so blind person can carry it comfortably.
3. is easy to use for blind people, where the blind person doesn't need to learn a new method because the project supports braille system.
4. provides a mechanism to communicate with deaf-blind people.

1.4 Description of the Project

This project is mainly designed to help blind and deaf-blind people communicate with other people. We will design a Smart-Glove which translates the braille alphabet into text and vice versa.

The Smart-Glove has a set of pushbutton switches. Blind user can write messages through pressing pushbuttons located on the Smart-Glove. Hence different Pushbutton patterns correspond to different braille codes. These braille codes are sent by Bluetooth to the mobile, where they are converted to display the corresponding alphabets, words and sentences.

If user receives a message from the mobile, then the character corresponds to a braille code which is matched to the six vibration motors on the braille hand Smart-Glove. Hence, the vibration motors corresponding to the braille code of the particular character vibrates and the character is read efficiently by the reader.

1.5 Problem Analysis

At the present, message exchange is becoming one of the most important social communication media. Braille is a well–established "system" for communicating with blind people. However, most people do not understand braille.

The design of the Smart-Glove, presented in this project, will support the blind and deaf-blind person's involvement in the society by converting braille characters into written text characters and vice versa. In this way, the communication problem between blind and deaf-blind persons and other people is efficiently solved.

1.6 List of Requirements

In this section, we present the hardware and software requirements of the system:

Functional Requirements

1. Blind user can write messages in braille system.
2. Blind user can receive messages in braille system.
3. Normal user can write a text messages.
4. Normal user can receive a text messages.
5. System can establish a connection between normal user and blind user.
6. The system translates from alphabet to braille and vice versa.

Non-Functional Requirements

1. Simplicity: The system should be simple for blind people to learn and use. Blind user can easily write and receive braille message without need to learn new method, and the system should not represent an overhead for them.

2. Performance and quick response: The system sends and receives messages between users in a short time like any send/receive message operation.

3. Security: The system supports the privacy of the user; only the Smart-Glove user can read the messages by vibrators motors.

1.7 Project Time Line

Table 1: Project Time Line

Task No.	Task Name	Duration(Weeks)
1	Project planning	4
2	Determination project requirements	4
3	Analyzing and project design	8
4	Project development	10
5	Project testing and maintenance	4
6	Documentation	28

1.8 Project Gantt chart

Table 2: Project Gantt Chart

Task	Duration(Weeks)													
	First semester							Second semester						
	2	4	6	8	10	12	14	2	4	6	8	10	12	14
Planning														
Project Requirements														
Analyzing and design														
Project development														
Project testing and maintenance														
Documentation														

1.9 Report Outline

This report is organized as follows: Chapter 2 introduces some literature review including available braille devices and related project. It also goes briefly over the theoretical background of the project, hardware and software components and languages. Chapter 3 discusses the conceptual design of the system, block diagrams, flowchart, and detailed hardware connection. Chapter 4 discusses the hardware and software implementations of the project and Chapter 5 shows the testing which is made until we reach the final system design. Finally, Chapter 6 presents the final results of the project, the future works and conclusion.

Chapter 2

Literature Review and Background

2.1 Literature Review

Overview

There are several types of braille systems. These types appear with many features, but nearly with the same task. In the next two sections, a discussion about the braille system that exists and the scientific topic of some braille applications is presented. In addition, we make a comparison between all of them.

2.1.1 Braille devices

This section will show the famous braille devices in the markets, their specifications, features and limitations.

A. Perkins braille writer (Six-key entry)

Figure 1: Perkins braille writer (Six-key entry), source: [4]

Description

A braille Writer contains a row of keys across the lower part of the device corresponding to the six dots in the braille, which is analogous to a traditional typing machine. The writer produces a paper with raised dots. The raised braille dots that are made can be read with the fingers [5].

Features

The first type that enable braille users to read and write, and is reasonably expensive.

Limitations

Very heavy, not portable, difficult to learn and need special people that are familiar with braille signs to read, write and communicate with the blind person.

B. Jot-A-Dot braille.

Figure 2: Jot-A-Dot, source: [6]

Description

Jot a Dot is a newer innovation in braille writing. Jot a Dot has a standard 6 dot braille keyboard. It has cell indicators showing the position of the embossing head on the line that you are writing [7].

Features

Easily carried as a personal item, light (weight less than bound), and use lightweight paper.

Limitations

Has the same limitation as Perkins braille writer (Six-key entry).

C. Braille sense

Figure 3: Braille sense, source: [8]

Description

The braille Sense is a braille note taker. It is an electronic device that combines 9 key Perkins-style keyboard and 32 cell braille display, allows users to create and read files [9].

Features

Read Texts, Take notes, can communicate with other blind people have the same device.

Limitations

Very expensive, hard to learn and needs time to deal with it.

2.1.2 Scientific Theoretical Braille Projects

This section discusses some scientific braille projects, summarizes them and makes a comparison between them in the next section.

A. BrailleBand: Blind support haptic wearable band for communication using braille language

Year: 2017

Summary: Connectivity between the BrailleBand and the phone is established using Bluetooth. It consists of six nodes in three bands worn on the arm to map the braille alphabet, which are actuated to give the sense of touch corresponding to the characters. It consists of a microcontroller, a Bluetooth module and six haptic motors [10].

Figure 4: The BrailleBand, source: [11]

B. A system to convert electronic message to braille for visually impaired.

Year: 2014.

Summary: The message received in a mobile phone is converted into braille format using an Arduino Due. It consists of Arduino Due, vibration motors and HC-05 Bluetooth module [12].

C. Low cost real-time communication braille hand-glove for visually impaired using slot sensors and vibration motors.

Year: 2014.

Summary: This glove allows the person to type characters based on different braille combination using six slot sensors. The vibration in six different positions of the glove which matches to the braille code allows them to read characters. It consists of slot sensors, vibration motors**,** Motor Driver IC, Comparator IC Circuit, AVR Microcontroller Development Board and CC 2500 Trans Receiver (Radio Frequency Module) [13].

D. Braille FAMZ

Year: 2013.

Summary: In 2013, Braille FAMZ device was designed as a graduation project by a student at the Polytechnic University of Palestine.

Braille FAMZ is a mechatronic device that teaches blind and visually impaired students how to read and write braille, students can learn any language in an easy way without need for a teacher help or any assistance [14].

Figure 5: Braille FAMZ, source: [15]

2.1.3 Comparison between Braille products and Braille projects

This section shows a comparison between braille products in the markets which are mentioned in section 2.1.1, and the theoretical braille projects which are mentioned in section 2.1.2 with our project.

Table 3: Comparison between Braille products and Braille projects

Comparison	Cost/Price	Size	portability	Communication [Send /Receive]	Need to Know braille for normal people
Perkins braille writer	650.00$-2,195.00$	Big	Bad	Not possible	Need
Jot-A-Dot braille	450.00$ - 2,195.00$	Average	Good	Not possible	Need
Braille sense	cost up to 5,685.00$	Average	Good	Not possible	Need
BrailleBand	Cost is not specified	Average	Good	Possible	No need
Project in (B)	Cost is not specified	Average	Good	Not possible	No need
Project in (C)	Cost is not specified	Average	Good	Possible	No need
Braille FAMZ	Cost is not specified	Average	Good	Not possible	Need
This Project	100$	Small	Good	Possible	No need

2.2 Background

Overview

This section briefly describes the theoretical background of the project. Short description of the hardware and software parts which are used in the system is also introduced.

2.2.1 Theoretical Background

Arduino Micro R3

Arduino Micro R3 is a small microcontroller board, its small size is convenient to install on the glove. The number of pins it contains fits our project requirements and it can be connected to a computer with a small USB cable [16].

Arduino (IDE)

The Arduino Integrated Development Environment or Arduino Software (IDE) is an open source. It contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them. It runs on varies operating systems [17].

Android Studio

Android Studio is the official Integrated Development Environment (IDE) that provides developers tools needed to build applications for the Android OS platform [18].

2.2.2 System Hardware Components

This section shows the hardware components which are used in the project, and how they are used.

1. Android mobile phone.

The system use android mobile application to receive/send text messages.

2. Arduino Micro R3

This small and light microcontroller is pretty suitable for our project.

Figure 6: Arduino Micro R3, source: [19]

3. Cotton glove

We need a glove to fix the Buttons and the vibration motors on it and also connect the wires with the microcontroller. The glove must be made of comfortable fabric to be easy to use and dielectric material that does not contact the wires attached to the glove.

4. Vibration motors

It's a small DC motor. The primary function of the vibration motor is to inform the users of receiving the signal by vibrating. Vibrating motors represents dots in braille system. Upon receiving a character the pattern of vibrating represent the character in braille system.

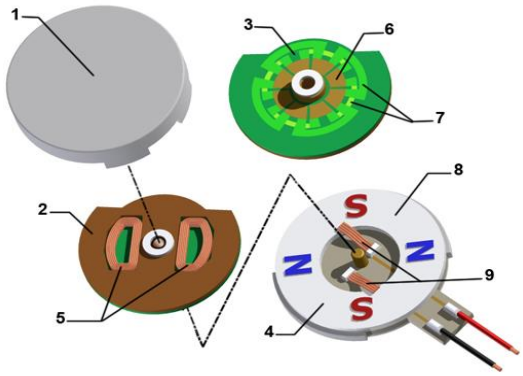


Figure 7: vibration motors, :(1) enclosure top, (2) rotor (view as mounted), (3) rotor (inverted view), (4) enclosure bottom, (5) coils, (6) commutation points, (7) alternating power supply circuits, (8) ring magnet (showing representative polar zones), (9) power supply brushes. source: [20]

Figure 7 shows, the internal construction of the vibration motor. The commutation points are arranged in alternating polarity pairs, so as the rotor moves; the coils are constantly reversing polarity as they pass over commutation points. In this way, the motor continually rotates, and at a speed that is proportional to the applied voltage" [21].

5. Bluetooth Module CH-06

Bluetooth is a wireless technology standard for exchanging data over specific distances .This Bluetooth module can achieve serial wireless data transmission between microcontroller with the mobile and the glove.

Figure 8: Bluetooth Module CH-06, source: [22]

6. Pushbutton Switch

We need six pushbuttons switches representing the six dots in braille system, to write a braille messages.

Figure 9: Pushbutton Switch, source: [23]

7. LiPo Battery

Lithium Polymer batteries (LiPo Battery) is a small sized, little weight and rechargeable battery.

Figure 10: LiPo Battery, source: [24]

2.2.3 System Software Components

- **Software Tools**
  1. Android Studio: used to build the Android application.
  2. Arduino IDE: used to program Arduino.

- **Used programming Languages**

Android and Arduino

Chapter 3

System Design

This chapter discusses the conceptual design of the system; it shows a block diagram of the system, flow charts, wiring diagram and schematic diagram.

3.1 Design options

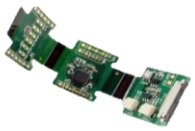
Design options based on requirement analysis (see section 1.6):

Table 4: Requirement analysis

	Touch sensor	Buttons	Pushbuttons	Analysis:
				We chose pushbutton because it achieves all of the requirements.
Requirements	**Option**			
1. Fit on the glove.	X	✓	✓	
2. Easy to use for blind.	X	X	✓	
3. Can be installed on the glove.	✓	X	✓	
4. Similar to braille printer buttons.	X	X	✓	

	Vibration	Vibration motors	Analysis:
			We chose vibration motors because it achieves all of the requirements.
Requirements	**Option**		
1. Fit on the glove.	✓	✓	
2. Suitable shape and size.	X	✓	
3. Can be installed on the glove.	✓	✓	
4. Blind user can touch it while vibrating, to distinguish the braille character.	X	✓	

Table 4: Continued

	Arduino mega	Seeduino film	Micro R3	Analysis:
				We chose Arduino micro R3 because it achieves all of the requirements.
Requirements	**Option**			
1. Number of Pins is sufficient.	✓	X	✓	
2. Light weight.	X	✓	✓	
3. it can be installed on the glove	X	✓	✓	
4. Suitable size.	X	✓	✓	

	Bluetooth	Wi-Fi	GSM	Analysis:
				We chose Bluetooth because it achieves all of the requirements.
Requirements	**Option**			
1. Easy to use	✓	✓	✓	
2. Suitable size	✓	✓	✓	
3. lower cost	✓	X	X	
4. Less energy consumption	✓	X	X	

	Android Studio	Inventor	Analysis:
	Android Studio	MIT App Inventor	We chose Android Studio because it achieves all of the requirements.
Requirements	**Option**		
1. Open source	✓	X	
2. Easy to use	✓	✓	
3. More flexible	✓	X	

3.2 Smart-Glove Design

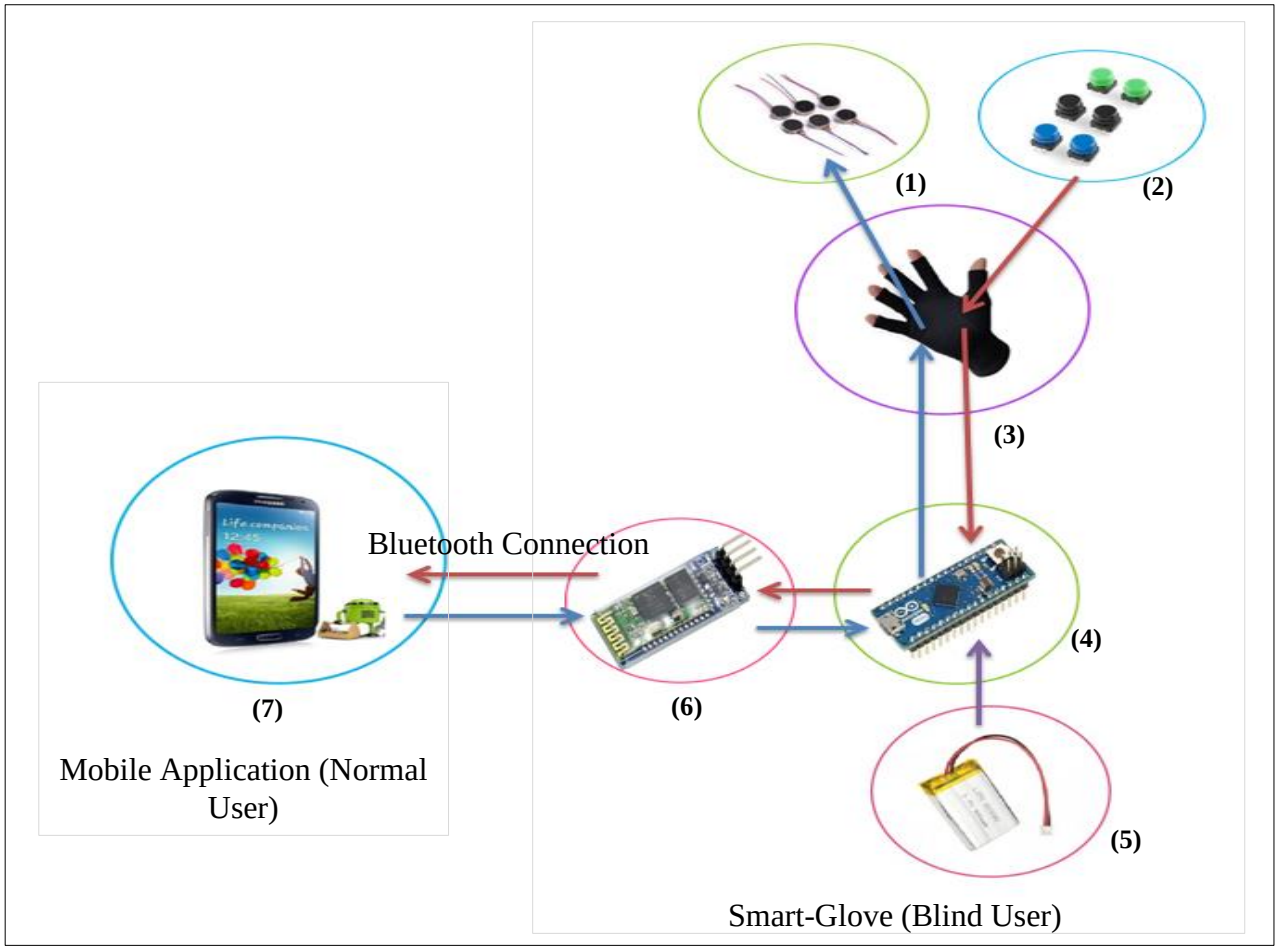


Figure 11: Smart-Glove Design: (1)Vibration motors, (2)Pushbuttons, (3)Glove, (4)Arduino controller, (5) Lithium Battery, (6) Bluetooth module, (7) Mobile application.

The Smart-Glove design shown in Figure 11 illustrates the detailed description of the project connections and components. Smart-Glove contains pushbutton switches and vibration motors located on soles and back of the glove. These are connected with the Arduino controller, which enables blind user to write, send and receive braille messages. The Bluetooth module, located on the glove, established the connection between the two system parts. For more details of components connections see Figure 13 and Figure 14. Furthermore, mobile user can write and receive text messages from and to Smart-Glove user using the same connection. Follow the arrows track to see the path of the messages on each time. The blue arrows show the process of sending message from mobile application to Smart-Glove (vibration motors), and the red arrows show the process of sending message from the Smart-Glove (push buttons) to the mobile.

3.3 Diagrams

A. System Block Diagram

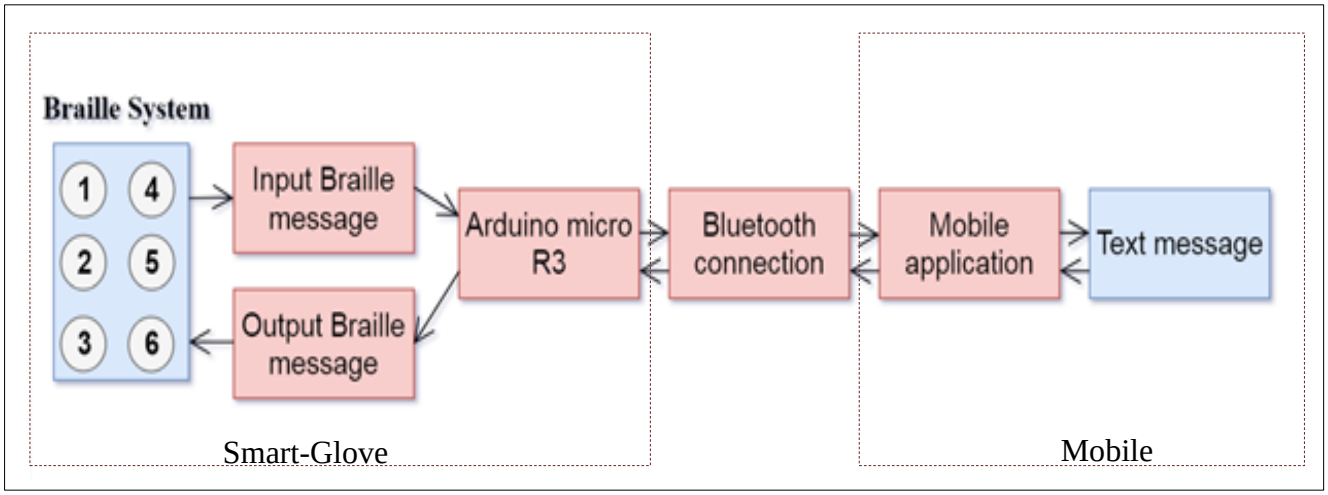


Figure 12: Block Diagram

The block diagram in Figure 12 shows how the system works in both directions. Braille system box represents pushbuttons and vibration motors each time according to the direction of messages. In the first way (from left to right), the blind enters a braille message by pressing pushbuttons. Pushbuttons readings will be transformed to Arduino. The Arduino should receive these readings as data form and send signals to the mobile application using Bluetooth connection, then the message will display as a text message on the mobile screen. In the other way (from right to left), the text message, which is written in mobile application, will be transformed as data form by Bluetooth connection to Arduino. The Arduino should receive data and send signals as an output braille message to the vibration motors. This is done by actuating vibration motors for every received character.

Based on previous Figures 11 and 12, the usage of the system is illustrated in the following points:

1. Start by activation the Arduino by connects it with the Buttery.

2. Turn on the mobile and activation the android application.
3. Check the Bluetooth connection. If there is no Bluetooth connection an attention message will appear to a mobile user telling him to try reconnect by select the Bluetooth

name to make a pair. If there is Bluetooth connection then the application is ready to send and receive messages.

4. Mobile user can write a text message in the application and send it to the Smart-Glove (blind) user. The message will receive to the Arduino and then the vibration motors will vibrate for every received character "vibration representing the braille characters".

5. The Smart-Glove (blind) user can write a braille message and send it to the mobile user. Then the mobile user will receive a text message shows on his mobile screen.

B. Wiring diagram

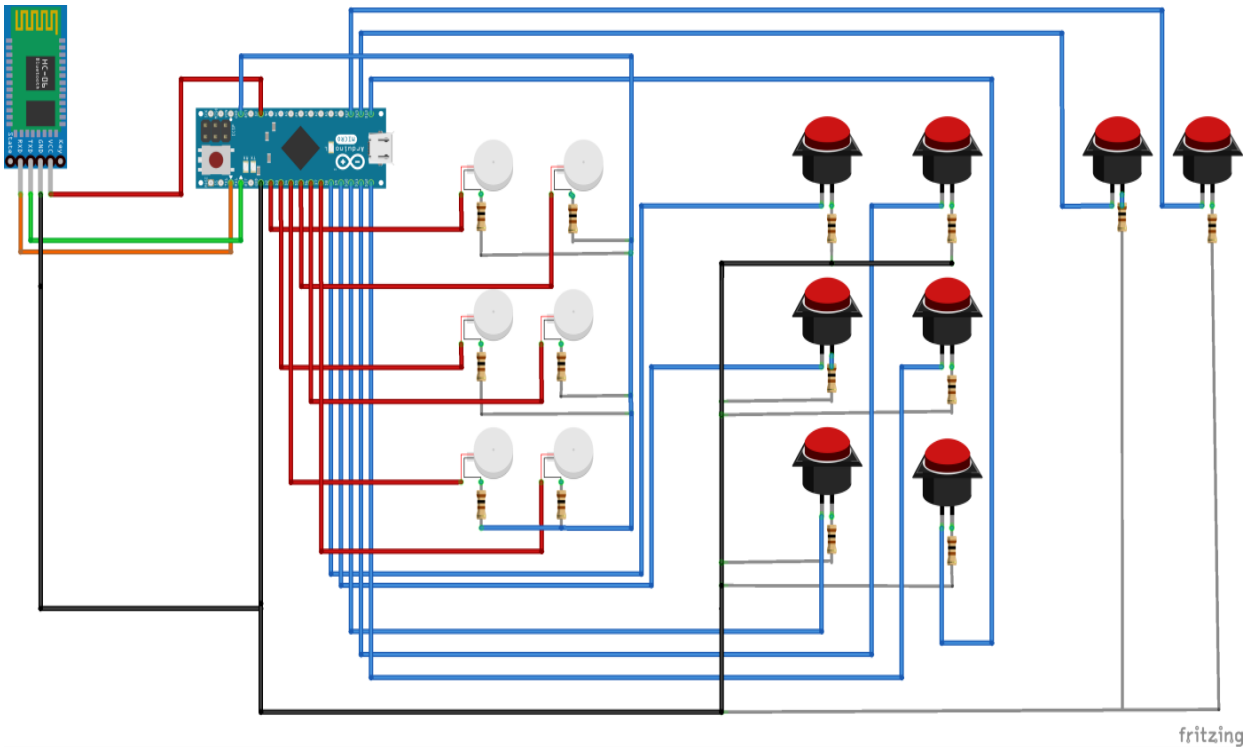


Figure 13: Wiring Diagram

C. **Schematic Diagram**

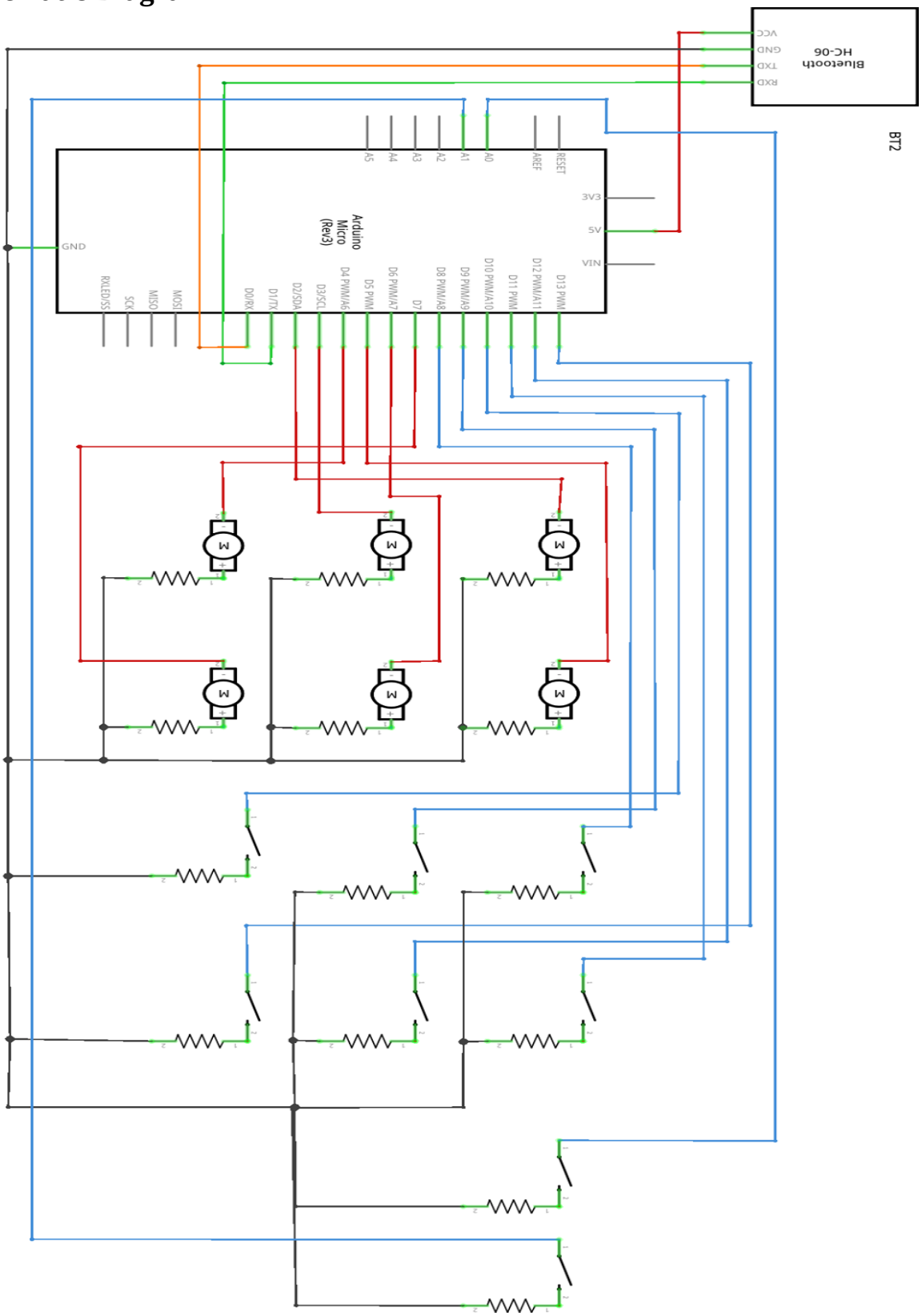


Figure 14: Schematic Diagram

3.4 Mobile application Design

- **Android Application**

Build an Android application using Android Studio program through Android language. The function of the application is to send and receive text messages from and to Smart-Glove. The normal user uses the application to send and receive text messages from and to blind user who wear a Smart-Glove. The application must support these processes:

1. Make a Bluetooth connection.
2. Write and send a text message.
3. Receive a text message.
4. Supports audio-to-text conversion.

In addition, the application contains many activities as Home page, practice, speech, setting and Bluetooth connection. The Figure below shows the main interface of application. For more details see section 4.3 on "Software Implementation".

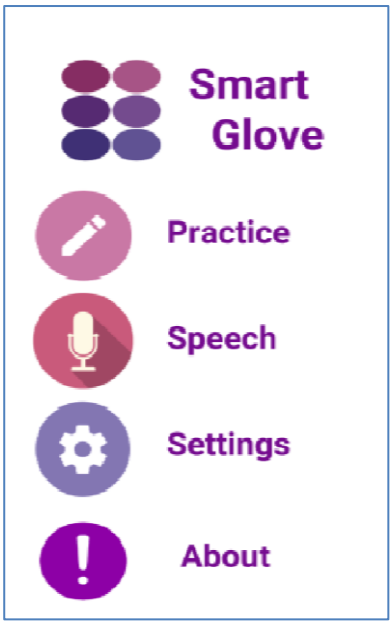


Figure 15: Application Design

Chapter 4

Implementation

4.1 Overview

This chapter describes the implementations of the software and the hardware of this project, such as the circuit connection, microcontroller, the IDEs which is used to build the project codes and Android studio program which used to build the application.

4.2 Hardware Implementation

Starting with **Arduino micro R3**, we successively connect the other system components as follows:

1. We connect Arduino micro R3 with **Bluetooth Module CH-06**, to receive and send signals.

2. We connect Arduino micro R3 with **vibration motors** using analog pins in the microcontroller, that we can control the vibration degree of each motor.

Result:

The vibration motors vibrate to enables the blind user to feel the vibrating of each point of vibration motors located on the Smart-Glove**.**

3. We connect Arduino micro R3 with six **pushbuttons** located in the Smart-Glove using digital pins, which represents a braille printer. We used another two pushbuttons to send the message from the Smart-Glove to mobile application, first one to send the character and the second button to send the complete message.

Result:

We write a message using braille by press the buttons in a particular pattern according the braille system and send it to the application which receives it as a text message.

4. We used two Lithium (Lipo) batteries each one is 3.7v to power the Arduino micro R3, we welded USB link with it to connect with Arduino and charge the battery.

5. Finally, we install the microcontroller circuit described above on **Smart-Glove** as follows:

1. We installed six vibration motors, which represent the six dots in braille system on the back of the glove.

2. We installed the six pushbuttons, which represent the six dots in braille system and two sending buttons below the six buttons on the palm of the glove.

3. We installed the Bluetooth on the glove.

4. Installed the Arduino micro R3 on the wrist and connect all components (vibration motors, pushbuttons, Bluetooth) with micro pins.

4.3 Software Implementation

- **Communication**

To connect Arduino micro R3 with mobile (mobile application) a Bluetooth connection is needed. We make a connection between mobile Bluetooth and Bluetooth Module CH-06.

• Android application Implementation

To develop the application, we used Android language. The Android application contains the many activities, such as Home page, practice, speech, setting and Bluetooth connection.

Home page: The main interface of the application that contains all the icons and activities.

Practice: This activity of application for writes a text message by a normal user and sends it to Smart-Glove (blind) user also to receive a text messages from the Smart-Glove.

Speech: In this activity you can use speech to send message depends on google translate speech.

Setting: This activity contain the setting of these application, one of them check Bluetooth connection.

Bluetooth connection: To make a connection between mobile and Smart-Glove which contain the Arduino and all components to send and receive data, check the Bluetooth connection between Bluetooth H06 and mobile Bluetooth.

Note: make a pair between the two Bluetooth is the first step before sending or receiving messages.

- **Application interfaces:**

Figure 16: Application Interfaces

3. Arduino Code Implementation

We used Arduino IDE to program the Arduino microcontroller and write the code. Overall code of system composed of following modules:

- **Bluetooth code**

Implement a Bluetooth connection using a simple code.

- **Receive code**

"Receive code" receives the message and outputs it on the vibration motors, which it vibrate according representation of each braille character. Receive code includes the translation process of text character to braille character**.**

The implementation of this code requires activating the mobile application to make a Bluetooth connection and send a text message from the application to Arduino.

The reception of the message appears as a vibration on "vibration motors", different vibration pattern for each character. By touching the six vibration motors with the other hand, the blind user can distinguish the vibrating "vibration motors" to know the character (Refer to Appendix A to see the representation of each braille character).

- **Send code**

"Send code" sends braille messages according representation of each braille character. Send code includes the translation process of braille character to text character.

Implementation this code required activation the mobile application to make a Bluetooth connection.

By pressing the six pushbuttons with the other hand, the blind user can write a braille message according representation of each Braille character. (Refer to Appendix A to see the representation of each braille character). The reception of the message appears as a text message on mobile application.

4.4 Implementation Issues

During the course of the project implementation, we faced many obstacles and had to take several issues to reach to the most suitable design of the system and reach the best properties related to the project's aims. We summarize these issues and results as follows:

1. Handle vibration motors carefully and accurately:
Vibrators motors are small size motors and the wires that connect it is very thin, we encountered problems in the welding and connecting these wires. In addition to taking into account the vibration strength of each vibration motor to avoid interference vibrations and the difficulty of distinguishing the vibrations.

2. Pushbuttons reading, we faced issues in pushbutton readings because our system more than one button (press) represents one character.

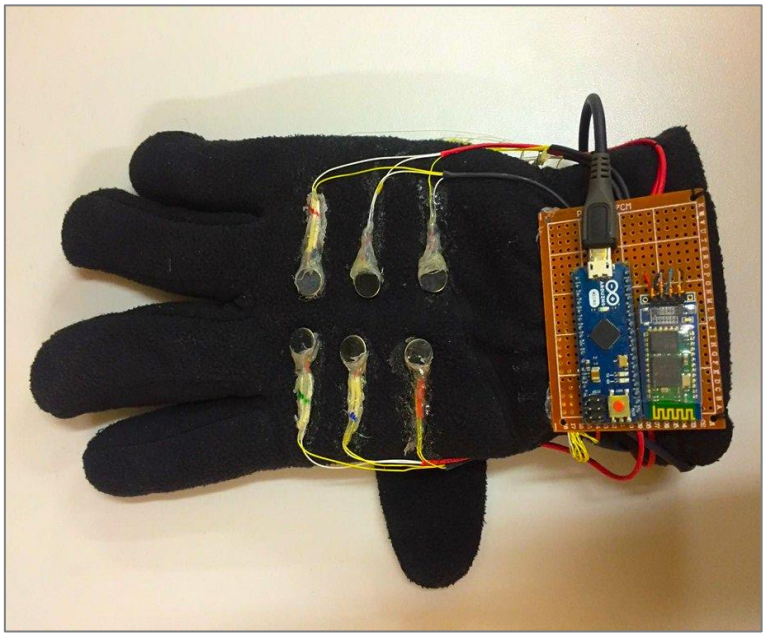
3. Glove material, we tried several gloves and we met issues according to the glove material. This is because the vibrations become very annoying and interference with each other if the glove material is thin.

4. We faced many issues related to size and efficiency, so we tried several experiments to find the most suitable and achievable choice for the microcontroller and other components according to the requirements of the project.

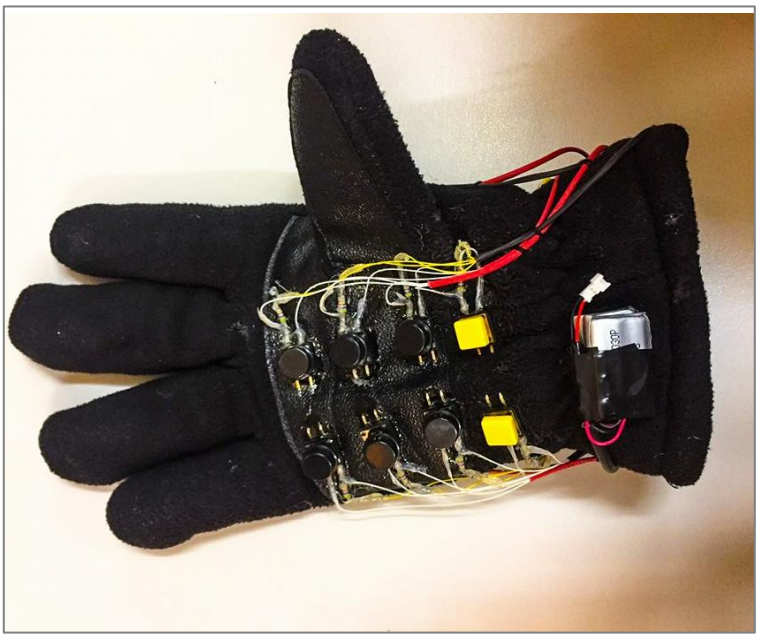
The solutions to the pervious implementation issues that we encountered, we have reached that the appropriate microcontroller for the system is Arduino micro R3, depending on pins number and the size of the Arduino. The Analog-pins in Arduino connect with vibrations motors to control the vibration degree of each motor and digital- pins connect with pushbuttons, we use another two pushbuttons to send the message, first button send one character and second button to send the complete message to the mobile application. To make a connection between the Arduino and the mobile we use Bluetooth CH-06. Finally, to avoid glove material problems we chose a thick glove to install the pieces on it**.**

4.5 Implementation Results

By the end of the implementation process, the Smart-Glove (shown in Figure 17) was constructed. Figure 17a shows the back side of the glove, on which the vibration motors are fixed. The pushbuttons and lithium battery are fixed on the inner part (Figure 17b). Detailed information about the connectivity of these components are presented in Sections 3.2 and 3.3.



(a)



(b)

Figure 17: Smart-Glove Implementation

Chapter 5

Validation and Testing

5.1 Overview

In this chapter we will discuss the testing of all component of the system and the results obtained. We test all the parts to ensure that all of the functions work perfectly and without errors.

5.2 Hardware Testing

In this section we will discuss the testing of all components.

1. **Testing vibration motors**

The first test of the vibration motors we connected the vibrations directly with vcc and ground pins (for power) in Arduino to examine the motor and degree of vibration.

2. **Testing Pushbutton**

To test pushbuttons we connected them with Arduino and tried to turn on and turn off a LED to check the buttons and tried to print buttons reading on the serial monitor in Arduino IDE. .

3. **Testing Bluetooth Module CH-06**

Connected the Bluetooth Module CH-06 with Arduino and used simple test code, and then test the connection between mobile Bluetooth and Bluetooth CH-06 using any Bluetooth application to validation and see the result on Arduino serial monitor.

4. Testing Arduino micro R3

In this test, we connect the Arduino with button and vibration on simple experience, to ensure validity of Arduino micro R3 pins and check if the size is as our system needs.

5. Testing glove

We tried several kinds of gloves and made inspections depending on the glove material, glove comfort and the glove width to locate all components on it.

5.3 Software Testing

Testing Android Application

We used Android Studio to design an android application to receive and send data.

In the first test, we try check the possibility of Bluetooth communication between mobile Bluetooth and Bluetooth CH-06 through a simple Bluetooth application.

In the second step, we designed the application's interfaces (Home page, messaging interface, Bluetooth interface, setting) then loaded the application on the Android mobile to check and test the functionality of each icon and the validity of sending and receiving messages.

5.4 System Testing

❖ **Test receive messages**

- This required a Bluetooth connection between the mobile and Bluetooth Module CH-06.
- Send a text message from the mobile application.

• Result:

Check the validity of reception on six LEDs according to braille system. We used the LEDs to make it easier to check the braille character for us. The below Figure shows

this experimental using LEDs. (Refer to Appendix A to see the representation of each braille character).

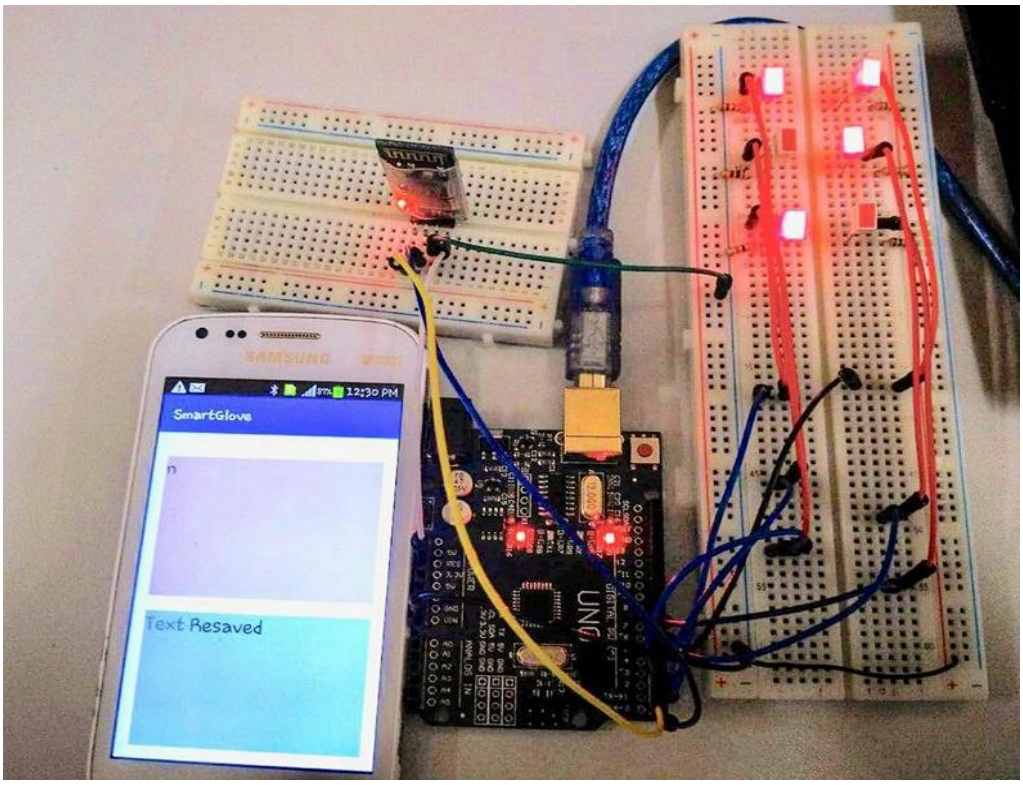


Figure 18: Receive testing

❖ Test Smart-Glove

Test overall system "final construction of Smart-Glove and application". This includes checking all the following points:

- Check Bluetooth connection between the mobile and Bluetooth Module CH-06.
- Check the mobile application validity to send a text message.
- Check the validity of reception the message according braille system on vibration motors (Refer to Appendix A to see the representation of each braille character).
- Check the validity of sending braille message according braille system by press the buttons.
- Check the application validity to receive the message from the Smart-Glove and print it as a text message.

Chapter 6

Conclusion

6.1 Summary

In this project, we constructed a Smart-Glove for supporting blind and deaf-blind people in communicating with normal people that are not familiar with braille.

The Smart-Glove is able to connect to Android mobile and facilitate exchange of messages. Whereas the android application is able to send and receive text messages from and to the Smart-Glove and the Smart-Glove able to send and receive braille messages from and to the application. The Smart-Glove is light, cheap, easy to use and no risk.

At the end of the project we believe that the project is an effective and very useful for blind people to communicate with others, and it is very useful for deaf-blind people if they are taught braille where they can communicate with their families and people around them.

6.2 Challenged faced

We faced some issues and problems while working on the project. The first issue faced that there is no deaf-blind person in the associations and schools in Palestine Know braille system or another language.

We faced another issues while working on the components of project due to the small size of the pieces and difficulty welding. (Refer to section 4.4 on Implementation issues).

6.3 Futures Works

Ultimately, with this project, we aim at supporting the largest number of blind people and blind schools. To achieve this, several features can be improved. Mainly the system should be extended to support other languages, and the system can use several way to communicate, it can use Wi-Fi connection, which enables a faster connection and better range from the base station or GSM module (Global System for Mobile communication) GSM is the most widespread and it's a cellular technology used for transmitting mobile data services, the most obvious advantage of it is widespread use throughout the world.

Appendix A

Braille System

The basic braille alphabet, braille numbers, braille punctuation and special symbols characters are constructed from six dots. These braille dots are positioned like the Figure 26, in a grid of two parallel vertical lines of three dots each. From the six dots that make up the basic grid [25].

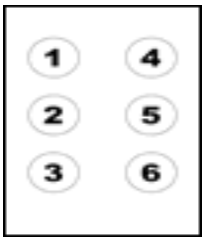


Figure 18: Braille system, source: [26]

The Braille Alphabet

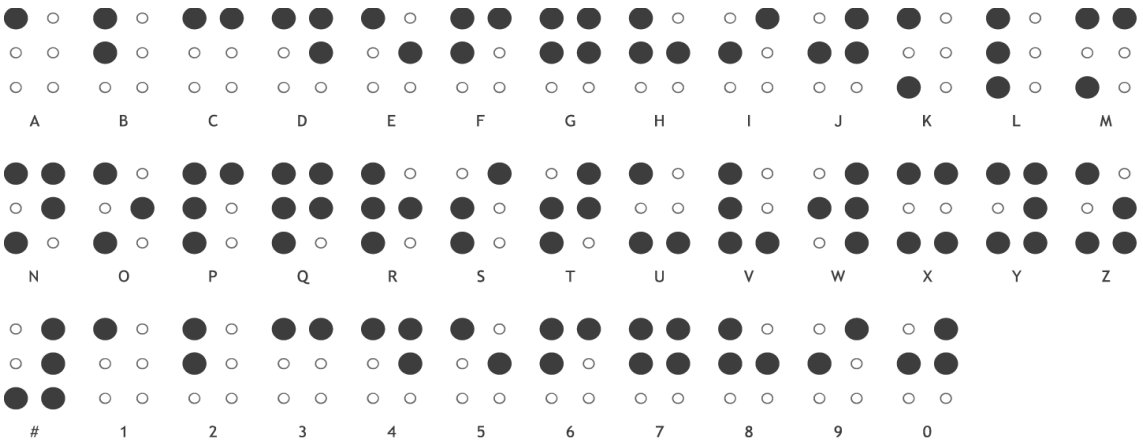


Figure 20: Braille character, source: [26]

Note: When indicating numbers the number sign should be placed before braille numbers to differentiate them from the letter symbols A to J.

Note: When indicating a capital alphabet capital (CABS) sign should be placed before braille alphabet to differentiate them from the small letters.

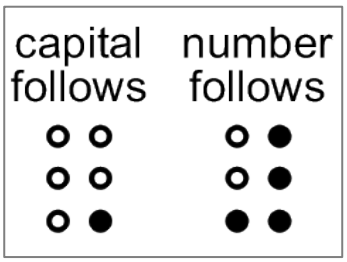


Figure 19: capital and number sign, source: [27]

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