# Enhancing Communication Abilities of the Deaf-Blind with AI-Embedded Gloves

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Abstract

*The presented project is an enhanced version compared to existing solutions available for individuals who are blind and deaf. Firstly, the Braille TTY device, priced at $6,560, allows blind-deaf individuals to answer calls through writing and screen display. Secondly, the Orbit Reader, priced at $750, is a braille display device that connects to electronic devices, enabling writing and reading for this population. Lastly, the My Vox device facilitates communication between blind, deaf, deaf-blind, and unimpaired individuals, incorporating two keyboards, a braille display, and a regular screen. To develop the improved project, an Arduino device is utilized to control the project's components. Blind-deaf individuals primarily learn through kinesthetic learning and tactile experiences, utilizing tactile sign language, tracking, tactile fingerspelling, print on palm, and Braille. The impact of this project on the community is significant, as it empowers individuals with blind-deaf disabilities to lead more normal lives, addressing their needs instead of ignoring them. Our system has a vibration motor in each position. When a name is sent to the gloves, its letters are translated to braille language like the right side, and some vibration motors are turned according to the letter. All the vibration motors are turned when there is an object near. The prototype can detect the object by using a smartphone. The prototype of the project has been successfully tested in four systems: writing, reading, obstacle avoidance, and obstacle detection. The research methodology depends on a simulating survey and measuring the accuracy and time.*

## I. Introduction

Human contact depends heavily on communication, which also has a big impact on how we conduct our daily lives. For normal people, it is possible to network with others, exchange ideas, and gain knowledge from one another. However, for those who have disabilities like blindness or deafness, communication can be very challenging. Communication access presents special difficulties for blind people, which might limit their quality of life and social participation. Their freedom and wellbeing can be increased by learning how to communicate with and listen to others. People with that case need more communication, social isolation, and reduced opportunities in education and employment. Approximately 0.2% of the global population suffers from severe deaf blindness, while 2% experience moderate deaf blindness. There are estimated to be over 15 million people with severe deaf blindness worldwide, just like the population of Norway and Sweden combined[6]. In addition to blindness and deafness, these individuals also experience other disabilities. The causes of blind deafness include childbirth complications, congenital syndromes, brain injuries, inherited conditions, and meningitis.[5]

Previous devices are too big for mobile, and they only contain way for writing and reading. [7]

This project will address the communication challenges faced by individuals who are both blind and deaf by developing a multi-functional, innovative system. This system aims to empower deaf-blind individuals by enhancing their communication abilities and independence in daily life. The chosen solution integrates four essential systems to foster full engagement with society and the surrounding environment. These systems are managed like a glove, ensuring the solution's portability and handiness. Two prospects for the feasibility of the project before implementing it are presented. The writing system displayed three tested letters on the LCD screen. The reading system connected to the Bluetooth module and activated the vibration motors for each tested letter. The obstacle avoidance system effectively detected and avoided obstacles. Overall, the prototype.

In Egypt, this project will be the only available and most affordable solution for the blind-deaf population, contributing to the country's sustainable development goals of reducing inequalities and enabling greater inclusion of education.[9]

## II. Literature Review

The first prior project is MyVox—Device for the communication between people: blind, deaf, deaf-blind and unimpaired. People with visual impairments face challenges in utilizing smartphone technologies for communication due to their limited visual capabilities, and to address this issue, a voice-interaction-based messaging application was developed, enabling individuals with visual impairments to communicate using smartphones. This application offers touch and voice command controls as shown in figure(1), providing speech output as feedback for each command. The application's voice-interaction service received a Mean Opinion Score (MOS) of 3.7, indicating that users found it to be of good quality [2].

Figure 2: Picture of the first model of the system. The first deaf-blind person to try it is already actively using it at home. A second model is currently being built.

The second prior project is a communication aid for deaf-blind people using vibration motors. This project proposes the use of a Braille type input/output device as a communication aid for individuals who are both deaf and blind. The device allows for both input and output operations in 6-point Braille format as shown in figure(2). It features a combined structure of a vibration motor and a push-button switch for input/output functions. Braille information can be easily inputted or presented using specific hands. positions. An experiment was conducted to determine the optimal position for presenting Braille information, resulting in visually impaired subjects achieving an 84% recognition rate after ten minutes of training. Inputting Braille information by a sighted subject yielded a rate of approximately 36 characters per minute after five hours of training [3].

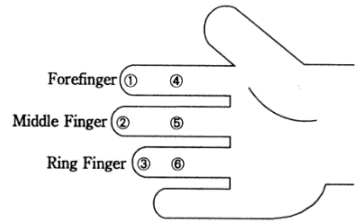


Figure 1: Proposed stimulus points.

The third prior research is a study of the field of assistive technology for visually impaired and blind individuals. While subjective accounts have been written in the past, we conducted an objective statistical survey using information analysis and network-theory techniques. By analyzing a comprehensive database of scientific research publications from the past two decades, we identified key research areas, growth patterns, leading journals and conferences, and active research communities as shown in figure(3). Our findings indicate sustained growth in the field, with an increase from fewer than 50 publications per year in the mid-1990s to nearly 400 publications per year in 2014. This growth suggests that assistive technology for visually impaired individuals will continue to advance and positively impact their lives as well as the elderly population [1].

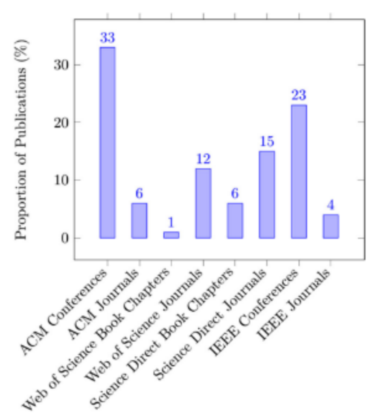


Figure 3:. The bar chart represents the proportions of publications relevant to ‘Assistive Technology for the Visually Impaired and Blind people.

The fourth project states that the inability of blind people to see makes it difficult for them to obtain the most recent knowledge and technologies that could give them alternate communication skills. Due to their increased price and limited portability, modern technological advancements are not easily accessible to persons who are visually impaired. Because of this, it has become increasingly important to provide a quick, cheap, and portable Braille system for persons who are blind. In this study, a novel communication channel for deaf, blind, and visually impaired individuals is introduced. It consists of three distinct subsystems that offer various facilities to enhance the communication abilities of those who are visually impaired. The following three modules make up the system: a portable low-cost refreshable device Using six tiny vibrators, the Body-Braille device displays Braille characters. ii) a straightforward Braille writer for writing Braille characters, and iii) an SMS-based remote communication system as shown in figure(4). This new communication method is affordable, transportable, quick, and precise [4]

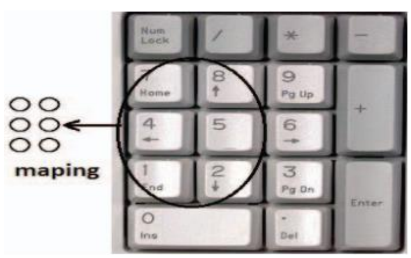


Figure 4: Digital Braille writer using numeric keyboard.

## III. Proposed Model

(I)approach and tools/techniques:

The project is a device consisting of four systems. Firstly, the project depends on braille language, which means every letter consists mainly of six units.

1- The first system is to understand what people say. The smartphone application will be connected to the device to send the letters that will be expressed by vibration motors.
2- The project aims to send words from the blind-deaf to the normal one through six push buttons. The words will be shown on an LCD.
3- The third system is an ultrasonic sensor that will help the blind-deaf to avoid obstacles.
4- The last one will be about object detection. The application on the smartphone will send objects detected through the camera to the Arduino.

The idea will be easier for blind-deaf people to communicate faster, and the project can be edited by making it smaller like a watch or a small

(II) overview of system modules

Keypad:
It is a set of buttons arranged in a grid or a matrix used to enter numerical or alphabetical data as shown in figure(5). It's a common input device used in various electronic devices like calculators, security systems, and mobile phones. In this project, a keypad is used as an input device to write for normal people. Each number in figure (2) represents a circle in braille language.

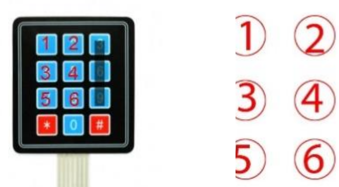


Figure 5, the keypad

Vibration motors:
small-sized electric motors that produce mechanical vibrations when a voltage is applied to them as shown in figure(6). vibration motors are used to transform text messages through vibrations for the deaf-blind.

Figure 6, a vibration motor

Ultrasonic module:
An ultrasonic module shown in figure(7) is a sensor that emits ultrasonic waves and measures the time it takes for the waves to bounce back from an object. It is commonly used in distance measurement, obstacle detection, and navigation systems. In this project, an ultrasonic module is used to detect obstacles and prevent collisions.

Figure 7, the ultrasonic sensor

Bluetooth module:
The bluetooth module shown in figure(8) is a small electronic circuit board that enables wireless communication between devices over short distances. It is used in connecting the device to the smartphone application. It works by sending letter by letter to the serial which is convenient.

Figure 8, the Bluetooth module

LCD display:
It is a flat panel display that uses liquid crystals to produce images as shown in figure(9). It is commonly used in digital watches, calculators, and electronic devices that require low power consumption. In this project, an LCD display is used to display the text messages written on the keypad.

Figure 9, LCD display

Android Mega pro
It is a device to connect and program all the device's components as shown in figure (10). It is preferable to use because of containing many pins options. It helps to connect all the components together.

Figure 10, Arduino Mega

## IV. Methods

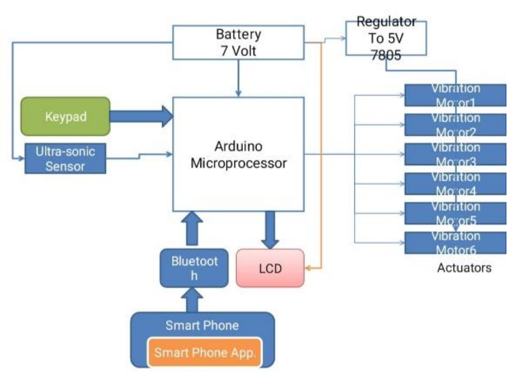


Figure 11, the flowchart of the prototype

(I)the prototype method.
The method to make the device in figure (11):
To make the writing part:
The first step is to connect the keyboard to the breadboard and then connect each button of the keyboard to the Arduino.

The next step is to write the code as follows: define two variables, a null variable, and an empty string variable., Make if statement, so if each button of the six button is pressed and represent 1 and not is equal to zero. At the end the null string will make a unique number and each number represents a unique letter. The letter will be added to the empty string. There are two push buttons: 1- to start and end writing 2- to move to a new letter.

To make the reading part:
it is important to do the following: connect the six vibration motors to the breadboard, connect the Bluetooth driver to the Arduino, use the application "Bluetooth connection" in making the keyboard and, lastly, Send the numbers to the Arduino program, and then by if conditions the vibrations will be shown and a delay 0f 5 seconds between each letter.

For the ultrasonic part:
Initially, it is important to connect the ultrasonic to the Arduino and then program the Arduino if the distance is less than 50cm, all the vibration motors will be on.
To make the object detection system: It is essential to use the object detection model on the application and connect to the Arduino by Bluetooth. Then, letters are transferred to braille on the vibration motors.

### (II) Research Methodology:

The research methodology for the project is adjusted for making a practical project. The research concern is to make a project with three significant features – usable, considerable, well-price. Depending on these criteria, the project results will mainly focus on the qualitative results – achieved, or not achieved. Some will be used as quantitative results: describing the AI model efficiency.
The methodology of the research will be divided into two parts. The first part is testing the code validity, components status, and the accuracy of the model. The second part is the survey for the user experience with the project, importantly for being practical.

The main challenge of the project is the tested sample. The experience of finding the blind-deaf and to teach him how the device will work needs a long-term plan, extended for years. The sample will be normal people, but the difference is preventing their senses from work for the experiment.

## V. Result

### (I)Survey

The aim of the survey is to simulate the experience of the device to many people. The number of responses is 14. The required information of the survey were:

1- Experience with using assistive technology.
2- The most comfortable shape for long-standing usage.
3- The time length of the survey from 1 to 10
4- The satisfaction of the survey from 1 to 10

Do you have any experience with using assistive tech?

There are also questions about the mechanism of the gloves. Some rules were given, and they are essential to answers the questions.
Rules:
1- if all the vibration motors are on, so write avoid
2-If some vibration motors are turned, someone is writing you a word
You should decide which state it is and decide the letter if available.
These images were given to help the respondent to fully understand.

Results:

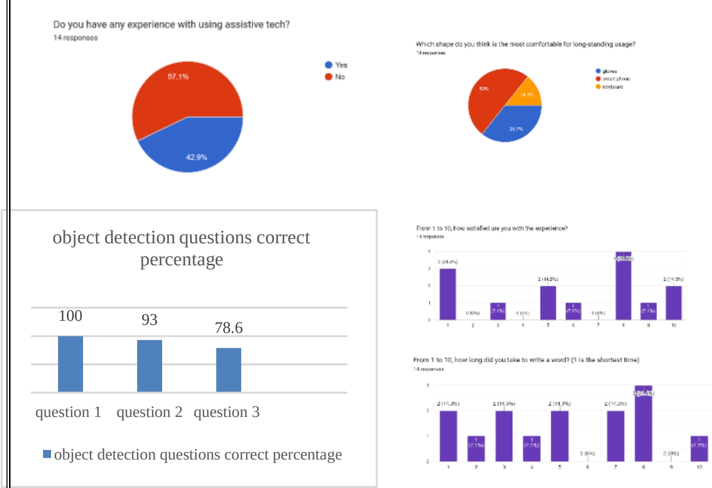


*Figure12, the conclusion of the answers of the survey*

As shown if figure(12), 50% preferred the smartphone shape while 35.7% preferred the gloves shape. 57.1% of the respondents have no experience with assistive technology. 100% answered the first question right, 93% answered the second right, and 78.6% answered the third right. People rated its length on average 5.14 out of 10, meaning it is not long or short. Respondents rated the experience on average 5.9 out of 10.

(II)quantitive test:

The prototype was tested for these features:

1- Object detection:

| Object name | Model prediction | Model effectiveness |
|---|---|---|
| mouse | mouse | 50% |
| pen | Toothpaste | |
| chair | chair | |
| lamp | Refrigerator | |
| person | person | |
| calculator | cellphone | |
| Laptop | Laptop | |
| couch | couch | |
| bag | person | |
| window | oven | |

Table 1, model accuracy

2- Writing and reading

| sentence length (in letters) | Time to receive | Time to send another |
|---|---|---|
| 7 | 42 sec | 20 sec |
| 20 | 2 min | 1 min 39 sec |
| 12 | 1 min 12 sec | 44 sec |
| Average per letter | 6 sec | 4.87 sec |

Table 2, writing and reading time.

3- Obstacle avoidance

| Distance (cm) | Measured distance |
|---|---|
| 20 | 23 (15% increase) |
| 40 | 40(0% decrease) |
| 52 | 57(9.6% increase) |
| 35 | 36 (2.9% increase) |
| 50 | 53(6% increase) |
| Result/real | 106.7% |

Table 3, obstacle avoidance accuracy

According to tables(1),(2),(3), the writing system is considered 4.87sec/letter, and the reading is 6 sec/letter. The model accuracy is 50%, and the ultrasonic sensor measures the distance by an error of 6.7%.

**VI. Discussion and Future plan**

Depending on results, analyses and future plans have been made. Although most people were satisfied with smartphones, it was harder to do. Smartphones need tiny components and complex programming. On the other hand, the gloves – the second option in voting – were easier to do and easy to lift.

(I)reading section of the prototype:

The braille language is expressed by vibration motors. 90.5% of all answers were right, so that proves the technique is good. The average estimate of the length of the experience was 6 out of 10, so a little long time was need. It was chosen for 6 seconds for each letter. The letters were sent by an application as shown in figure (14).

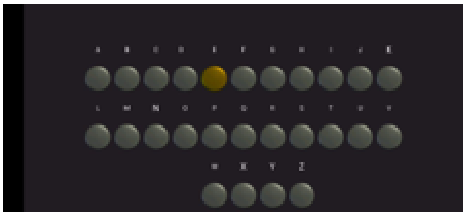

Figure14, the message application

(II)writing section of the prototype shown in figure (15):

The average time per letter is 4.87 seconds, which varies depending on the experience with the system. A normal sentence needs about 1 minute 10 seconds, which considers acceptable time, being able to improve with more practice.

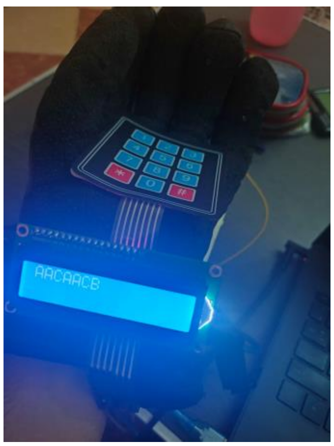

Figure15, the writing section of the prototype

(III)obstacle avoidance system:

The ultrasonic sensor worked well, but the problem is that the wires distracted its function, so when wearing the gloves, the ultrasonic sensor should be attached to the arm below or it can be connected to a mobile device on the chest or the shoes.
50 cm or less is detected accurately, so the blind-deaf can feel the vibration if something is close to him.

(V)obstacle detection system:

The results show that the model has a 50% accuracy, which is unacceptable. It can only detect basic elements. However, the connection to the application shown in figure (16) is successful and fast.

To solve this problem in the future, another model (Yolov8) shown in figure(17) was tested. It showed a range of accuracy from 70 to 90 percent. The problem is to insert it into the application. That model could be a subsequent solution.

In conclusion, the future plans of the project:
1. The gloves shape will be better as a smartphone.
2. Using a new object detection model.
3. Separating the ultrasonic sensor from the original one
4. Using a PCB board instead of cables.


Figure 16, the mobile application of object detection

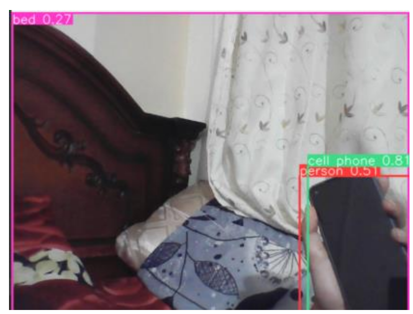


Figure 17, testing the new model

## VII. Conclusion

The main objective of this project is to minimize obstacles faced by individuals who are blind and deaf, aiming to enhance their communication abilities. One notable aspect of this project is its cost-effectiveness, making it a more affordable solution compared to other alternatives. The device's framework primarily consists of press buttons, vibration engines, and ultrasonic sensors. By utilizing this combination, the device enables deaf and blind individuals to communicate more effectively. The vibration engines play a crucial role in allowing users to read what they type on their smartphones. The words typed on the keypad are then displayed on an LCD screen, providing visual feedback. To further enhance usability, potential obstacles can be detected and avoided using an ultrasonic module. The significance of this technology extends beyond its immediate benefits, as it has the potential to positively impact the lives of millions of blind and deaf individuals, empowering them to move more freely and communicate with greater ease.


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**Appendix**

This is the coding for the Arduino:

```
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>

#define SCREEN_WIDTH 128 // OLED display width,
in pixels
#define SCREEN_HEIGHT 64 // OLED display height, in
pixels

// declare an SSD1306 display object connected to I2C
Adafruit_SSD1306 oled(SCREEN_WIDTH,
SCREEN_HEIGHT, &Wire, -1);

#include "BluetoothSerial.h"

#if !defined(CONFIG_BT_ENABLED) ||
!defined(CONFIG_BLUEDROID_ENABLED)
#error Bluetooth is not enabled! Please run `make
menuconfig` to and enable it
#endif

BluetoothSerial SerialBT;
String lets;
int lcdColumns = 16;
int lcdRows = 2;
char let;
int swit = 0;
int pin1 = 5;
int pin2 =17;
int pin3 = 4;
int pin4 = 2;
int pin5 = 15;
int pin6 = 16;
int letter = 0;



#include <Keypad.h>
const int ROW_NUM = 4; //four rows
const int COLUMN_NUM = 3; //three columns

char keys[ROW_NUM][COLUMN_NUM] = {
  {'A', 'B', '0'},
  {'C', 'D', 'G'},
  {'E', 'F', '\0'},
  {'*', '0', '#'}
};

byte pin_rows[ROW_NUM] = {14, 26, 25, 33}; //connect
to the row pinouts of the keypad
byte pin_column[COLUMN_NUM] = {32, 12, 27};
//connect to the column pinouts of the keypad
Keypad keypad = Keypad( makeKeymap(keys), pin_rows,
pin_column, ROW_NUM, COLUMN_NUM );
void setup() {
pinMode(5,OUTPUT);
pinMode(17,OUTPUT);
pinMode(4,OUTPUT);
pinMode(2,OUTPUT);
pinMode(15,OUTPUT);

  Serial.begin(9600);


  SerialBT.begin("ESP32test"); //Bluetooth device name
// initialize OLED display with address 0x3C for 128x64
if (!oled.begin(SSD1306_SWITCHCAPVCC, 0x3C)) {
  Serial.println(F("SSD1306 allocation failed"));
  while (true);
}

}

void loop() {
  if(swit == 0 ){
   char key = keypad.getKey();

  if (key == 'A') {
    letter = +1;
  } else if (key == 'B') {
    letter += 10;
  } else if (key == 'C') {
    letter += 100;
  } else if (key == 'D') {
    letter += 1000;
  } else if (key == 'E') {
    letter += 10000;
  } else if (key == 'F') {
    letter += 100000;
  }else   if (key == 'G') {
    if(swit == 0){
      swit+=1;
       oled.clearDisplay(); // clear display

        oled.setTextSize(1);          // text size
        oled.setTextColor(WHITE);     // text color
         oled.setCursor(0, 10);        // position to display
        oled.println("recieving"); // text to display
        oled.display();
      }else if(swit == 1){
        swit+=1;
       oled.clearDisplay(); // clear display
```

```
    oled.setTextSize(1);          // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("sending"); // text to display
    oled.display();
     }else{
    swit=0;
     oled.clearDisplay(); // clear display

    oled.setTextSize(1);          // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("detecting"); // text to display
    oled.display();
     }
}
if (key == '*') {
  if (letter == 1) {
    oled.clearDisplay(); // clear display

    oled.setTextSize(1);          // text size
   oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("A"); // text to display
    oled.display();
   letter = 0;
  } else if (letter == 101) {
    oled.clearDisplay(); // clear display

    oled.setTextSize(1);          // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("B"); // text to display
    oled.display();
   letter = 0;
  } else if (letter == 11) {
   oled.clearDisplay(); // clear display

    oled.setTextSize(1);          // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("C"); // text to display
    oled.display();
   letter = 0;
  } else if (letter == 1011) {
   oled.clearDisplay(); // clear display

    oled.setTextSize(1);          // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("D"); // text to display
    oled.display();
   letter = 0;
  }
```

```
else if (letter == 1001) {
      oled.clearDisplay(); // clear display

        oled.setTextSize(1);          // text size
        oled.setTextColor(WHITE);     // text color
         oled.setCursor(0, 10);        // position to display
        oled.println("E"); // text to display
        oled.display();
      letter = 0;
    } else if (letter == 111) {
     oled.clearDisplay(); // clear display

        oled.setTextSize(1);          // text size
        oled.setTextColor(WHITE);     // text color
         oled.setCursor(0, 10);        // position to display
        oled.println("F"); // text to display
        oled.display();
      letter = 0;
    } else if (letter == 1111) {
      oled.clearDisplay(); // clear display

        oled.setTextSize(1);          // text size
        oled.setTextColor(WHITE);     // text color
         oled.setCursor(0, 10);        // position to display
        oled.println("G"); // text to display
        oled.display();
      letter = 0;
    } else if (letter == 1101) {
      oled.clearDisplay(); // clear display

        oled.setTextSize(1);          // text size
        oled.setTextColor(WHITE);     // text color
         oled.setCursor(0, 10);        // position to display
        oled.println("H"); // text to display
        oled.display();
      letter = 0;
    } else if (letter == 110) {
      oled.clearDisplay(); // clear display

        oled.setTextSize(1);          // text size
        oled.setTextColor(WHITE);     // text color
         oled.setCursor(0, 10);        // position to display
        oled.println("I"); // text to display
        oled.display();
      letter = 0;
    } else if (letter == 1110) {
      oled.clearDisplay(); // clear display

        oled.setTextSize(1);          // text size
        oled.setTextColor(WHITE);     // text color
         oled.setCursor(0, 10);        // position to display
        oled.println("J"); // text to display
        oled.display();
```

```
  letter = 0;
} else if (letter == 10001) {
  oled.clearDisplay(); // clear display

    oled.setTextSize(1);         // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("K"); // text to display
    oled.display();
  letter = 0;
} else if (letter == 10101) {
 oled.clearDisplay(); // clear display

    oled.setTextSize(1);         // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("L"); // text to display
    oled.display();;
  letter = 0;
} else if (letter == 10011) {
  oled.clearDisplay(); // clear display

    oled.setTextSize(1);         // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("M"); // text to display
    oled.display();
  letter = 0;
} else if (letter == 11011) {
  oled.clearDisplay(); // clear display

    oled.setTextSize(1);         // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("N"); // text to display
    oled.display();
  letter = 0;
} else if (letter == 11001) {
  oled.clearDisplay(); // clear display

    oled.setTextSize(1);         // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("O"); // text to display
    oled.display();
  letter = 0;
} else if (letter == 10111) {
  oled.clearDisplay(); // clear display

    oled.setTextSize(1);         // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("P"); // text to display
    oled.display();
  letter = 0;
} else if (letter == 11111) {
  oled.clearDisplay(); // clear display

    oled.setTextSize(1);         // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("Q"); // text to display
    oled.display();
  letter = 0;
} else if (letter == 11101) {
  oled.clearDisplay(); // clear display

    oled.setTextSize(1);         // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("R"); // text to display
    oled.display();
  letter = 0;
} else if (letter == 10110) {
  oled.clearDisplay(); // clear display

    oled.setTextSize(1);         // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("S"); // text to display
    oled.display();
  letter = 0;
} else if (letter == 11110) {
 oled.clearDisplay(); // clear display

    oled.setTextSize(1);         // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("T"); // text to display
    oled.display();
  letter = 0;
} else if (letter == 110001) {
  oled.clearDisplay(); // clear display

    oled.setTextSize(1);         // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("V"); // text to display
    oled.display();
  letter = 0;
} else if (letter == 110101) {
  oled.clearDisplay(); // clear display

    oled.setTextSize(1);         // text size
    oled.setTextColor(WHITE);     // text color
     oled.setCursor(0, 10);        // position to display
    oled.println("V"); // text to display
    oled.display();
  letter = 0;
} else if (letter == 101110) {
```

```
    oled.clearDisplay(); // clear display

      oled.setTextSize(1);          // text size
      oled.setTextColor(WHITE);     // text color
       oled.setCursor(0, 10);        // position to display
      oled.println("W"); // text to display
      oled.display();
    letter = 0;
  } else if (letter == 110011) {
    oled.clearDisplay(); // clear display

      oled.setTextSize(1);          // text size
      oled.setTextColor(WHITE);     // text color
       oled.setCursor(0, 10);        // position to display
      oled.println("X"); // text to display
      oled.display();
    letter = 0;
  } else if (letter == 111011) {
    oled.clearDisplay(); // clear display

      oled.setTextSize(1);          // text size
      oled.setTextColor(WHITE);     // text color
       oled.setCursor(0, 10);        // position to display
      oled.println("Y"); // text to display
      oled.display();
    letter = 0;
  } else if (letter == 111001) {
    oled.clearDisplay(); // clear display

      oled.setTextSize(1);          // text size
      oled.setTextColor(WHITE);     // text color
       oled.setCursor(0, 10);        // position to display
      oled.println("Z"); // text to display
      oled.display();
    letter = 0;
  } else if (letter == 0) {
    Serial.print(' ');
    oled.clearDisplay();
    letter = 0;
  }
}

if (key == '0') {

  oled.clearDisplay();
}


}

if(swit ==1){
     char key = keypad.getKey();
if (key == 'G') {
   if(swit == 0){
    swit+=1;
     oled.clearDisplay(); // clear display

      oled.setTextSize(1);          // text size
      oled.setTextColor(WHITE);     // text color
       oled.setCursor(0, 10);        // position to display
      oled.println("recieving"); // text to display
      oled.display();
    }else if(swit == 1){
      swit+=1;
     oled.clearDisplay(); // clear display

      oled.setTextSize(1);          // text size
      oled.setTextColor(WHITE);     // text color
       oled.setCursor(0, 10);        // position to display
      oled.println("sending"); // text to display
      oled.display();
      }else{
      swit=0;
       oled.clearDisplay(); // clear display

      oled.setTextSize(1);          // text size
      oled.setTextColor(WHITE);     // text color
       oled.setCursor(0, 10);        // position to display
      oled.println("detecting"); // text to display
      oled.display();
      }
  }
  if (SerialBT.available()) {
    let = SerialBT.read();
    oled.clearDisplay(); // clear display

      oled.setTextSize(1);          // text size
      oled.setTextColor(WHITE);     // text color
       oled.setCursor(0, 10);        // position to display
      oled.println(let); // text to display
      oled.display();
    if (let == 'A') {
      digitalWrite(pin1, HIGH);
      digitalWrite(pin2, LOW);
      digitalWrite(pin3, LOW);
      digitalWrite(pin4, LOW);
      digitalWrite(pin5, LOW);
      digitalWrite(pin6, LOW);
    } else if (let == 'B') {
      digitalWrite(pin1, HIGH);
      digitalWrite(pin2, LOW);
      digitalWrite(pin3, HIGH);
      digitalWrite(pin4, LOW);
      digitalWrite(pin5, LOW);
      digitalWrite(pin6, LOW);
    } else if (let == 'C') {
      digitalWrite(pin1, HIGH);
      digitalWrite(pin2, HIGH);
      digitalWrite(pin3, LOW);
```

```
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
 } else if (let == 'D') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
 } else if (let == 'E') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
 } else if (let == 'F') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
 } else if (let == 'G') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
 } else if (let == 'H') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
 } else if (let == 'I') {
  digitalWrite(pin1, LOW);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
 } else if (let == 'J') {
  digitalWrite(pin1, LOW);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
 } else if (let == 'K') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
 } else if (let == 'L') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
 } else if (let == 'M') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
 } else if (let == 'N') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
 } else if (let == 'O') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
 } else if (let == 'P') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
 } else if (let == 'Q') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
 } else if (let == 'R') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
 } else if (let == 'S') {
  digitalWrite(pin1, LOW);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
```

```
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
 } else if (let == 'T') {
  digitalWrite(pin1, LOW);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
 } else if (let == 'U') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, HIGH);
 } else if (let == 'V') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, HIGH);
 } else if (let == 'W') {
  digitalWrite(pin1, LOW);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, HIGH);
 } else if (let == 'X') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, HIGH);
 } else if (let == 'Y') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, HIGH);
 } else if (let == 'Z') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, HIGH);
 }else if (let == '0') {
  digitalWrite(pin1, LOW);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, LOW);
    digitalWrite(pin5, LOW);
    digitalWrite(pin6, LOW);
   }

  delay(3000); // Delay for 1 second
 }
 }
  if(swit==2){
    char key = keypad.getKey();
 if (key == 'G') {
   if(swit == 0){
    swit+=1;
     oled.clearDisplay(); // clear display

      oled.setTextSize(1);          // text size
      oled.setTextColor(WHITE);     // text color
       oled.setCursor(0, 10);        // position to display
      oled.println("recieving"); // text to display
      oled.display();
    }else if(swit == 1){
      swit+=1;
     oled.clearDisplay(); // clear display

      oled.setTextSize(1);          // text size
      oled.setTextColor(WHITE);     // text color
       oled.setCursor(0, 10);        // position to display
      oled.println("sending"); // text to display
      oled.display();
      }else{
      swit=0;
       oled.clearDisplay(); // clear display

      oled.setTextSize(1);          // text size
      oled.setTextColor(WHITE);     // text color
       oled.setCursor(0, 10);        // position to display
      oled.println("detecting"); // text to display
      oled.display();
      }
 }
  for (int i = 0; i < lets.length(); i++) {
   // Print each character
    let = lets[i];
   oled.clearDisplay(); // clear display

      oled.setTextSize(1);          // text size
      oled.setTextColor(WHITE);     // text color
       oled.setCursor(0, 10);        // position to display
      oled.println(let); // text to display
      oled.display();
   if (let == 'A') {
    digitalWrite(pin1, HIGH);
    digitalWrite(pin2, LOW);
    digitalWrite(pin3, LOW);
    digitalWrite(pin4, LOW);
    digitalWrite(pin5, LOW);
    digitalWrite(pin6, LOW);
```

```
} else if (let == 'B') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
} else if (let == 'C') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
} else if (let == 'D') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
} else if (let == 'E') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
} else if (let == 'F') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
} else if (let == 'G') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
} else if (let == 'H') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
} else if (let == 'I') {
  digitalWrite(pin1, LOW);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
} else if (let == 'J') {
  digitalWrite(pin1, LOW);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, LOW);
  digitalWrite(pin6, LOW);
} else if (let == 'K') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
} else if (let == 'L') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
} else if (let == 'M') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
} else if (let == 'N') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
} else if (let == 'O') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
} else if (let == 'P') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
} else if (let == 'Q') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
```

```
} else if (let == 'R') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
} else if (let == 'S') {
  digitalWrite(pin1, LOW);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
} else if (let == 'T') {
  digitalWrite(pin1, LOW);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, LOW);
} else if (let == 'U') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, LOW);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, HIGH);
} else if (let == 'V') {
  digitalWrite(pin1, HIGH);
  digitalWrite(pin2, LOW);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, LOW);
  digitalWrite(pin5, HIGH);
  digitalWrite(pin6, HIGH);
} else if (let == 'W') {
  digitalWrite(pin1, LOW);
  digitalWrite(pin2, HIGH);
  digitalWrite(pin3, HIGH);
  digitalWrite(pin4, HIGH);
  digitalWrite(pin5, LOW);
digitalWrite(pin6, HIGH);
    } else if (let == 'X') {
      digitalWrite(pin1, HIGH);
      digitalWrite(pin2, HIGH);
      digitalWrite(pin3, LOW);
      digitalWrite(pin4, LOW);
      digitalWrite(pin5, HIGH);
      digitalWrite(pin6, HIGH);
    } else if (let == 'Y') {
      digitalWrite(pin1, HIGH);
      digitalWrite(pin2, HIGH);
      digitalWrite(pin3, LOW);
      digitalWrite(pin4, HIGH);
      digitalWrite(pin5, HIGH);
      digitalWrite(pin6, HIGH);


    } else if (let == 'Z') {
      digitalWrite(pin1, HIGH);
      digitalWrite(pin2, LOW);
      digitalWrite(pin3, LOW);
      digitalWrite(pin4, HIGH);
      digitalWrite(pin5, HIGH);
      digitalWrite(pin6, HIGH);
    }else if (let == '0') {
      digitalWrite(pin1, LOW);
      digitalWrite(pin2, LOW);
      digitalWrite(pin3, LOW);
      digitalWrite(pin4, LOW);
      digitalWrite(pin5, LOW);
      digitalWrite(pin6, LOW);
    }

    delay(3000); // Delay for 1 second
  }
}

    }
```