B. Tech (EEE) SIDDHARTH HIMANSHI GAURAV DIMPLE 2019

GESTURES TO SPEECH CONVERSION USING FLEX SENSORS

A PROJECT REPORT

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE
OF

BACHELOR OF TECHNOLOGY
IN
ELECTRICAL AND ELECTRONICS

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CANDIDATE'S DECLARATION

We, Siddharth Gargava(2K15/EL/085), Himanshi Gupta(2K15/EL/30), Gaurav Saini(2K15/EL/25), Dimple(2K15/EL/018) students of B. Tech. (EEE), hereby declare that the project Dissertation titled "Gestures to Speech conversion using Flex Sensors" which is submitted by us to the Department of Electrical & Electronics, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship or other similar title or recognition.

Place: Delhi
Date:

Siddharth Gargava
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CERTIFICATE

I hereby certify that the Project Dissertation titled "Gestures to Speech conversion using Flex Sensors" which is submitted by Siddharth Gargava (2K15/EL/085), Himanshi Gupta (2K15/EL/030), Gaurav Saini (2K15/EL/025), Dimple(2K15/EL/018) Electrical and Electronics Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology/Bachelor of Technology, is a record of the project work carried out by the students under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place: Delhi
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ABSTRACT

Deaf and dumb people use sign language for communicating with others but sometimes people fail to understand what these deaf and dumb people are trying to say and the aim of our project is to remove this barrier only. Our project aims to develop an electronic device that can help these deaf and dumb people get rid of this communication barrier. It is based on evolving an electronic device that will convert the input gestures into speech output in order to make it a feasibility for deaf and dumb to communicate to general public at public places comfortably. A cloth glove will be used for this purpose. The glove will be fitted with the flex sensors. These flex sensors go on changing their resistance values when bended at particular angles and hence giving different speech outputs at different bends. The flex sensor will be connected to an Arduino UNO on which a code will be burned; the code which will be having the respective speech output corresponding to different combinations made by the flex sensors.

ACKNOWLEDGEMENT

We express our deep gratitude to our project mentor **Shri. D.C. Meena**, Department of Electrical Engineering for his valuable guidance and suggestions throughout our project work.

We are thankful to our professors for their help and encouragement during the development of this project. We admire their knowledge and experience through which they guided us in a field we had no previous experience in.

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INTRODUCTION

Sign language is a special language by which deaf and dumb people communicate with the general public. Sign language can include hand gestures, 1t can also include facial and body expressions, etc. A Gesture is a tool used for non-verbal communication in which body actions especially hand gestures communicate particular messages by making different combinations by movement of hands. Flex sensors can be used for this purpose because flex sensors give different resistance outputs by bending at different angles.

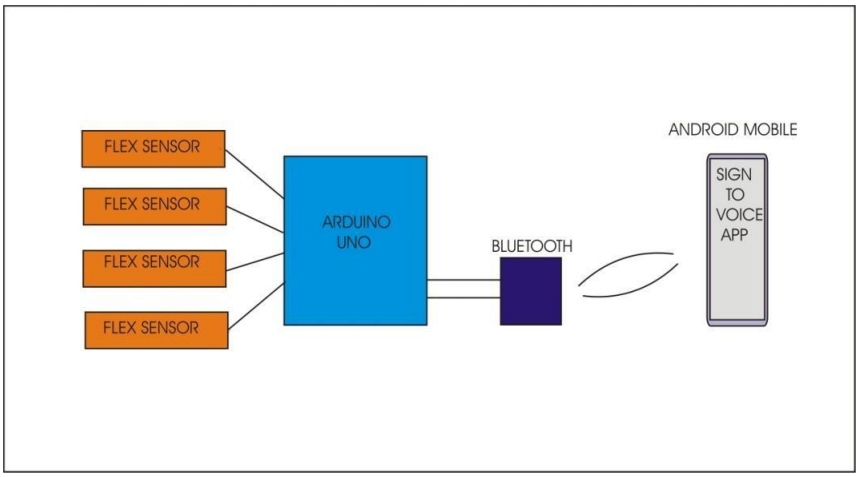

Figure 1.1 - Methodology

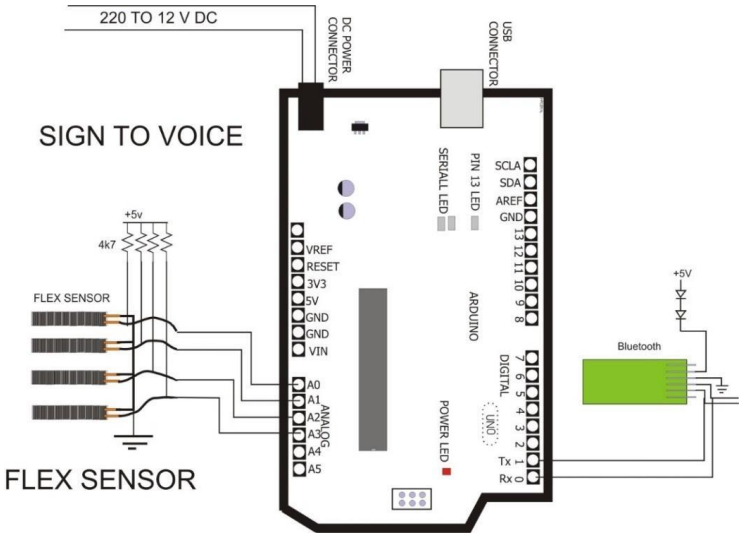

Figure 1.2 - Connections

1.1 GENERAL

A big section of people in our country are unable to verbally communicate. So, the most suitable form of communication for them is through sign language which as a method has proven effective for deaf and dumb people. [2] However, people not belonging to the specially challenged group are unable to comprehend sign language. This creates a barrier between them which hampers communication between them and decelerates their progress. Past methods to encounter these problems involved image processing concept. But this method has long been considered too expensive for public use.

In project, a wearable glove has been suggested for people who are not able to speak, so that with this device, they can exhibit their basic requirements via their gestures and those gestures will be converted to speech for the hearer to understand what is he or she trying to say.

1.2 LITERATURE SURVEY

Sign language as a communication method is prevalent in specially challenged groups with hearing and speaking disorders. Due to in general apathy amongst people and lack of importance attached to it, there's an inherent way of communication lacking between normal people and people having these hearing and speaking disorders. Therefore a better system is being proposed with the use of flex sensors and android technology. The experimental apparatus has presence of 2 modules. [10] First module is called flexi-glove which is essential glove attached to sensors and Atmel ATmega168 microprocessor which hand-movement signals to text and auditory messages. Second module is an Android App created containing Google Speech API.

1.3 CONCLUSION

In general, deaf people have difficulty in communicating with others who do not understand sign language. Even those who do speak aloud typically have a "deaf voice" of which they are self-conscious and that can make them reticent. The Hand

Talk glove is a normal, cloth driving glove fitted with flex sensors. The sensors output a stream of data that varies with degree of bend made by the fingers. Flex sensors are sensors that change in resistance depending on the amount of bend on the sensor. They convert the change in bend to electrical resistance - the more the bend, the more the resistance value. The output from the sensor is converted to digital and processed by using microcontroller and then it responds in the voice using speaker.

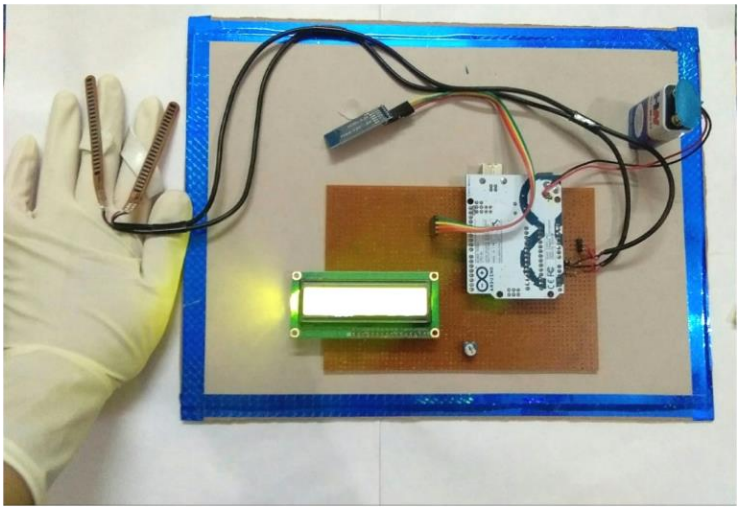

Figure 1.3: Our Project Hardware-Model

HARDWARE USED

Gestures to Speech Conversion device is a machine that converts hand movements that are detected through flexi-glove and converts it into real-time speech output for normal people to comprehend smoothly.

The proposed device is a light-weight and portable and has its foundation on a two-way communication. The major purpose of this device is to detect real time hand-finger movements and give out sensory signals to Arduino which sends out to Bluetooth signals to electronic communicating devices which in turn give us auditory speech for communication with specially challenged people.

There are 5 flex sensors that are used, 2 used for initial purposes. [4] Each flex sensor is connected to different ports of Arduino UNO which is the central controlling unit. Now the transfer (Tx) and reception (Rx) pins are joined to reception and transfer pin of the Bluetooth module HC05 respectively. Now, the Bluetooth module will send out signals to paired electronic communicating devices or cell-phone to give auditory output.

2.1 FOCUSSING ON FLEX SENSOR

2.1.1 Flex Sensor: Brief Description –

A flex sensor primarily acts as a variable resistor having high resistance. The amount of deflection or bend is measured in the flex-sensor. It's a sensor whose output varies when deflected which essentially means that as the sensor is bent, [5] there is a change in resistance across the sensor (increase in resistance) and when it comes back to its normal position i.e straight, it has lesser resistance as compared to the resistance value when it was bent. This change in resistance is one of the key features being used in our project.

Figure 2.1 – Flex sensor on gloves

Flex-Sensor can be stitched to the glove using a thread with the help of a needle. Flex sensor takes an input of 5 V and gives an output between 0 - 5 V. The resistivity of the flex sensor varies with the sensor's bending and output voltage alters accordingly. Flex are connected to the device through 3 pin connectors i.e. ground, live and output. Power consumption can be decreased by activating the sensors when they are at OFF mode, enabling them to switch OFF when not in use. Flex sensors only changes their resistance when bent in one direction. [7] The resistance of the un-flexed sensor is about 10Kilo ohms. When the flex sensor bends, its resistance increases to 30Kilo - 40kilo-ohms at an angle of 90 degree.

Flex sensors have multiple output wires and the resistance between these wires changes when the sensor undergoes deflection.

Figure 2.2 - Flex

2.1.2 Specifications

1. Resistance(Flat): 25Kilo Ohms

2. Resistance(Bend) Range : 45Kilo ohms – 125 Kilo ohms (depending upon degree of bending of flex)

3. Power Rating: Continuously 0.50 Watts and 1 Watt Peak.

2.1.3 Flex Sensor Working

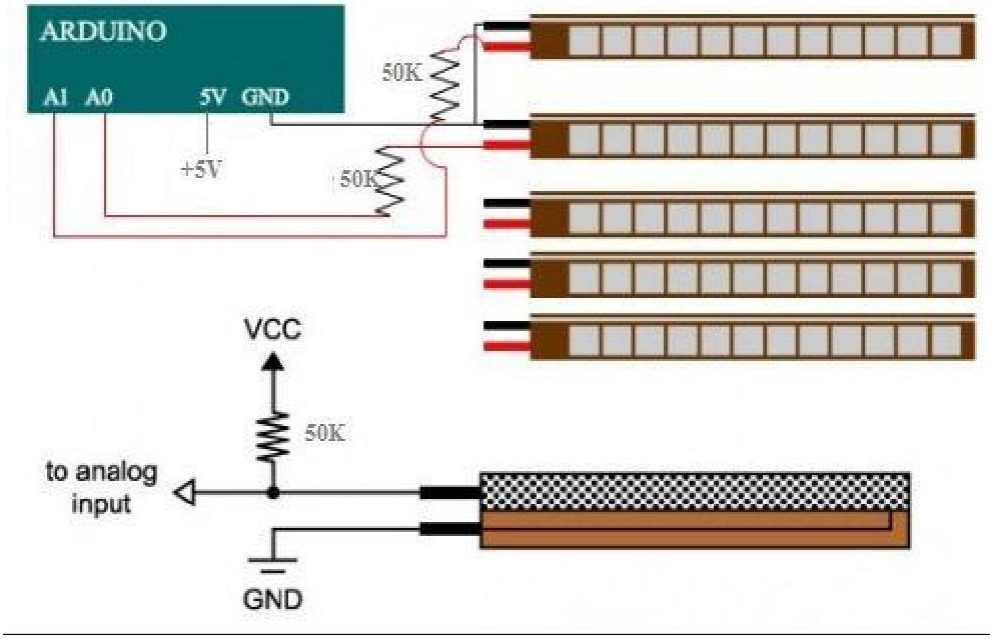

Figure 2.3- Flex Working

2.2 BLUETOOTH MODULE HC-05

It comprises of a master-slave unit. [8] In the flexi-glove, a single component can play multiple roles of the module, for Example- when the HC05 module is collecting its input from Arduino UNO Unit, at that particular time, it is playing the role of a SLAVE unit and when HC05 module is sending signal message to the speaker or mobile phone application, then it is participating as a MASTER unit.

Figure 2.4 - Bluetooth Component
HC05

2.2.1 Features

1. Input/Output voltage - 3.3 to 5V

2. Integrated antenna and edge connector.

3. Total Power Output : 3W

5. Signal to Noise Ratio : 76dB

6. Range : 10m

2.3 ARDUINO UNO–

It is essentially a microcontroller unit board with ATmega328 boarded. It has 14 computerized input/output pins, 6 analog data pins, a 16 MHz resonator, a USB connector, a power jack and a RESET button. [10] All major components are present which power the microcontroller and its various operations; basically associate it to a PC with a USB connector or power it with an AC-to-DC adaptors or battery. The Uno includes the Atmega16U2 (Atmega8U2 up to variant R2) customized as a USB-to-serial converter.

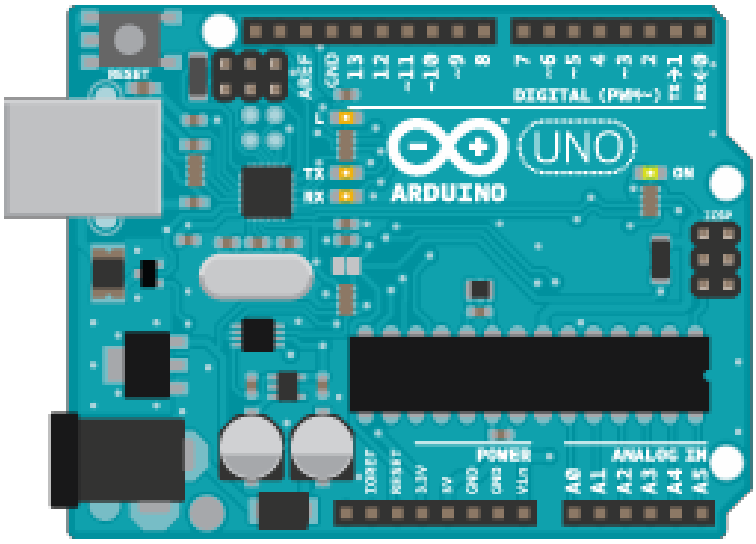

Figure 2.5 - Arduino UNO

Synopsis of Microcontroller ATmega328:

Operating Voltage:5V, Input Voltage (suggested): 7-12V, Input Voltage (limits): 6-20V, Digital I/O Pins: 14, Analog Input Pins: 6, DC Current for each I/O Pin: 40 mA, DC Current for 3.3V Pin: 50 mA, Flash Memory: 32 KB (ATmega328) of which 0.5 KB utilized by bootloader, SRAM: 2 KB (ATmega328), EEPROM: 1 KB (ATmega328), Clock Speed: 16 MHz, Schematic and Reference Design EAGLE documents: arduino-uno-Rev3-reference- design.zip [1] The Arduino reference configuration can utilize an Atmega8, 168, or 328, Current models utilize an ATmega328, however an Atmega8 is appeared in the schematic for reference. The stick design is indistinguishable on every one of the three processors. The Arduino Uno can be fueled by means of the USB association or with an outer power supply. Information and Output Each of the 14 advanced sticks on the Uno can be utilized as an info or yield, utilizing pinMode(), digitalWrite(), and digitalRead() capacities. These pins can be designed to trigger a hinder on a low esteem, a rising/falling crest, or mere adjusting of esteem. The attachInterrupt() having multiple points of interest. PWM: 3, 5, 6, 9, 10, and 11. Furnish 8-bit PWM yield with the analogWrite() function.• SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins bolster SPI communication• utilizing the SPI library. There is a worked in LED associated with advanced stick 13. The Arduino programming comprises of a specific Wire library to disengage I2C.

2.3.1 Serial communication

In this report, we talk about set of protocols for communication purpose. Gadgets are in constant communication with one another other to hand-off data about the ongoing communication, take note of different states, or demand helper activities to be performed. With working of any genuine gadgets, it will undoubtedly keep running into at least one of the principle correspondence conventions being used, whether it is the resistance change and coordination within various sensors, and modules, for example, the ESP8266. Through this experiment, we have put out the standard correspondence conventions that electronic gadgets utilize and clarify each one of them in detailing of Arduino Uno.

Gadget correspondence happens over computerized signals. Before we talk about correspondence conventions, we'll initially examine how these signs are transmitted.

In Advanced flags, HIGH to LOW or LOW to HIGH arrangements which happen momentously are the keys behind efficient delivery of information. The corresponding HIGHs and LOWs in a flag express the message to 0 separately which when assembled in a particular arrangement, give out a specific data which is in turn decoded by microcontrollers. Independently, these 0s are basic unit of binary called bits and on their further collection in multiples of 8, are termed as bytes.

Incidentally, this denomination of eight enunciates to a number in a similar way a number like 1976 speaks to One thousand Nine hundred and seventy six. Each one place values of the digits has similarly its own place-esteem, and the 1 or 0 in that place-esteem demonstrates how frequently the place-esteem is checked.

Presently, we look at our number 10001001. We can comprehend its binary framework which requires place esteem 0 to 1.

As you can envision, you can have number frameworks available for practically all numbers. Basic ones known are base 2, base 8, base 10, and base 16. Mathematicians have presented these number frameworks for clarity, ease and straightness. Each number framework takes after a similar foremost thought: every digit speaks to various circumstances as energy of that base is checked, and the estimation of every digit must be in the vicinity of 0 and base-1.

Information of various base number frameworks is helpful in light of the fact that bytes and information are regularly spoken to in various ways. As we have noticed, it is much easier to work out A7 (hexadecimal framework number) than 10100111 (its binary counterpart). In programming, twofold numbers are preceded by 0 b, octal numbers are pre-fixed with a 0, and hexadecimal numbers are prefixed with a 0 x. However, Decimal numbers are not pre-fixed.

Change over numbers between bases is valuable can be highlighted by the fact that numbers can be paired regularly for math traps. For the motivations behind this instructional exercise, notwithstanding, we'll abandon it at simply that.

Major convention: U A R T

The electrical building group chose to institutionalize gadgets around three correspondence conventions to guarantee gadget similarity. Revolving gadgets around a couple of conventions implied that planners would have the capacity to cooperate with any gadget by knowing a couple of essential ideas about every correspondence conventions. This convention, at the end of the day fills a similar need: exchanging information at high speed to any perfect gadget.

2.3.2 UART: Serial Communication

The primary communication protocol tool required for this device is the Universal Asynchronous Receiver-Transmitter (U A R T). U A R T is a type of serial correspondence since information is transmitted as successive bits. The wiring needed for positioning UART correspondence is perhaps its biggest strength, that is- it's in a linear straightforward manner: single line for sending information (TX) and single line for receiving information (RX). [10] The TX communication channel is utilized to for the information to send to the gadget, and the RX communication channel is used to get information. Together, both these lines of a gadget utilize serial correspondence frame.

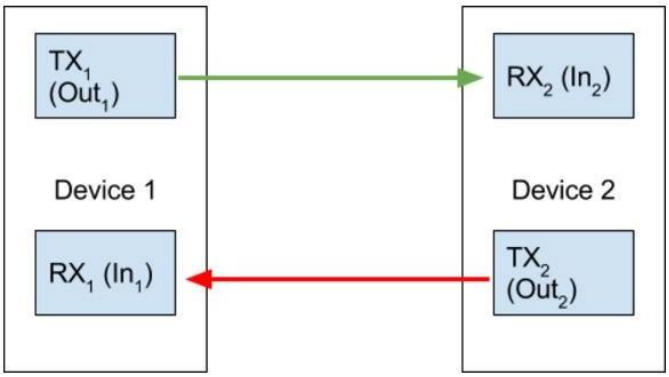

Figure 2.6- UART Connections

UART as a module connection refers to on-board equipment dealing with the bundling and interpretation of serial information. For a gadget to have the capacity to impart by means of the UART convention, it has to have Arduino UNO having one serial communication pin dedicated for connection with the Electronic Output Device the Arduino UNO is associated with. USB is a serial port. This USB connection is divided into locally available equipment into binary pins, general-pins 0 and 1, and they have been utilized as a part of ventures that include serial correspondence with gadgets other than the PC.

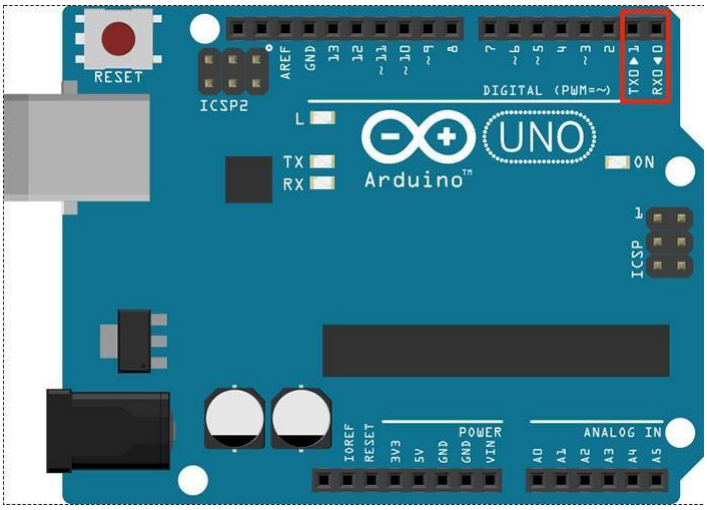

Figure 2.7 - GPIO 0 and 1 are for reception and transmission.

Any pin can be utilized as a receiver or transmitting pin with the use of Software Serial library.

You can likewise utilize the Software Serial Arduino library (Software Serial) to make use of different pins for sending and receiving purposes.

UART considered a non-concurrent in light of the fact that the correspondence does not rely upon in-sync clock movement between different gadgets endeavoring to send and receive signals with one another. Since the correspondence motion isn't characterized by means of this consistent flag, the "sender" gadget can't be sure that the "collector" acquires the right information. Hence, the gadgets break information into settled size pieces to guarantee that the information got happens to be similar.

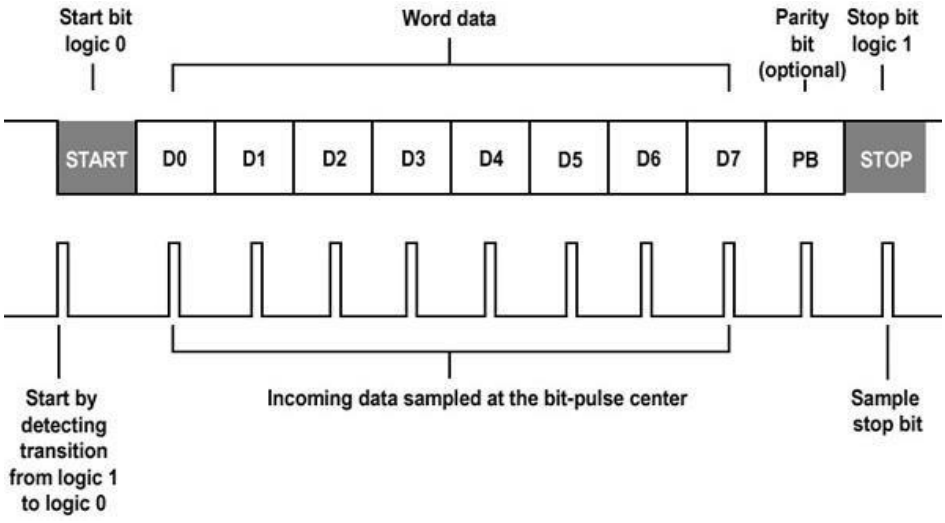

Figure 2.8 - Data packet of UART

Gadgets that communicate by means of UART send bundles of pre-characterized estimate that contain extra data in regards to the beginning of the signal along with the ending and affirmation of received message effectively. For Example, when starting with the correspondence, the communicating gadget operates the transmit line at LOW condition, showing the beginning of an information parcel. UART is slower contrasted with a synchronized type of correspondence on the grounds that lone a bit of the information transmitted is for the gadgets' applications.

While actualizing UART serial correspondence on most implanted stages, for example, the ATMega328 Microprocessor has no requirement of liaising with others at bit stage. In fact, Stage frequently gives larger amount programming libraries that are the main part of the correspondence procedure the client needs to manage. During the INO Coding, clients can utilize the Software Serial libraries while executing U A R T correspondence for their undertakings.

One imperative angle to note about U A R T correspondence is that it is intended for correspondence between just two gadgets at once. [11] The followed algorithm includes beginning of message, ending of message and message content being sent, so effectively there is no technique for separating various transmitting and accepting gadgets on a similar line. On the off chance that in excess of one gadget endeavors to transmit information on a similar line, transport dispute happens, and the accepting gadgets will in all probability get rubbish unusable information!

Moreover, U A R T is half-duplex, which implies that despite the fact that correspondence can happen bidirectional, there’s no exchange of information in a bidirectional sense. In many applications, be that as it may, this reality is moderately insignificant and not disadvantageous at all.

2.4 CONCLUSION

In this project we have used a microcontroller, a speech IC and also speaker to produce the output. Hardware Components used are Microcontroller (AT89S52), LCD display (16x2), flex sensors, Power supply and Voice IC.

SOFTWARES USED

3.1 MIT App Inventor

The App Inventor lets you to create software applications for your Android Operating System. This uses block interface allowing its users to simply drag drop the required visual objects to create a user friendly application that can be made ideal to be run on All Android devices.

The projects on which App Inventor is based were 1nformed by certain learning theories, which emphasized on programming be the vehicle for expressing powerful ideas through actively learning.

Firebase database extension also supports the MIT App Inventor and th1s allows people to store data on firebase by Google.

The app got freely available on I2th July, 2010 and was publicly relased on 15th December, 2010. Mark Friedman and Hal Abelson did lead the App Inventor team. In March 2012, MIT version was launched.

Figure 3.1 - MIT app inventor logo

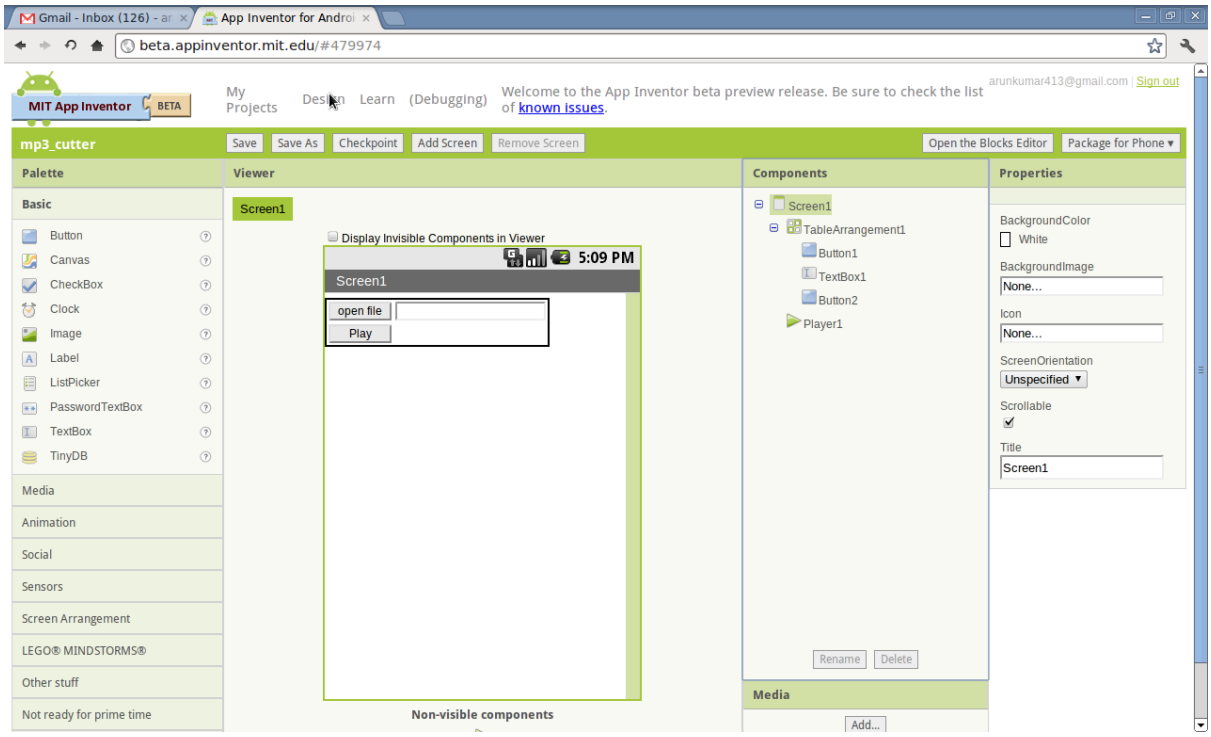

Figure 3.2 – MIT app inventor interface 1

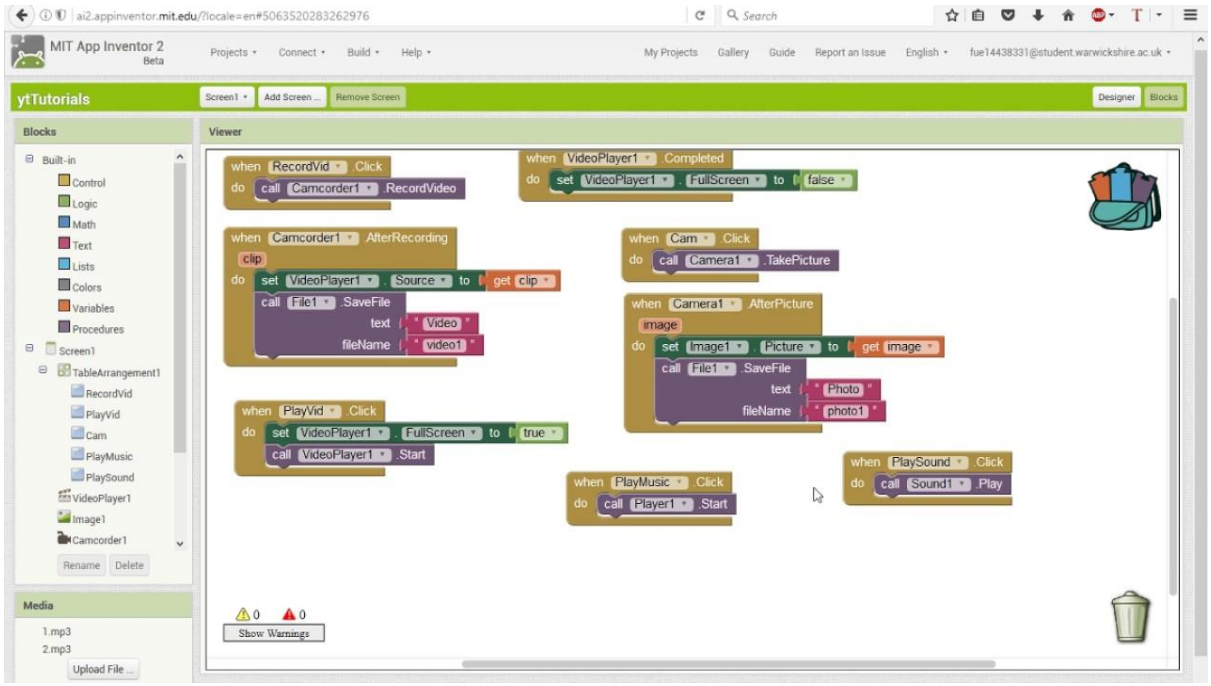

Figure 3.3 – MIT app inventor interface 2

3.2 ARDUINO IDE

Arduino ide is an open source integrated development environment (IDE) that provides an interface for all the Arduino boards as well as other development kits.

Figure 3.4 – INO Integrated Development Environment

It can run on Windows, Mac OS X, and Linux. [8] The entire development environment is coded in Java-7 and based on prominent open-source softwares. The Development kit contains has various components including - For writing code: Efficient Text Editor, For display: Message Area, For internal changes: Text Console, and most importantly a toolbar with buttons having large number of common functions and Series of menus. Connection with the Arduino or Genuino hardware is required to upload programs and effectively communicate.

It provides a very easy to use human friendly interface for easy use. The programs are called sketches and are saved with a ".ino" extension. It is compatible with computers with less powerful processors.

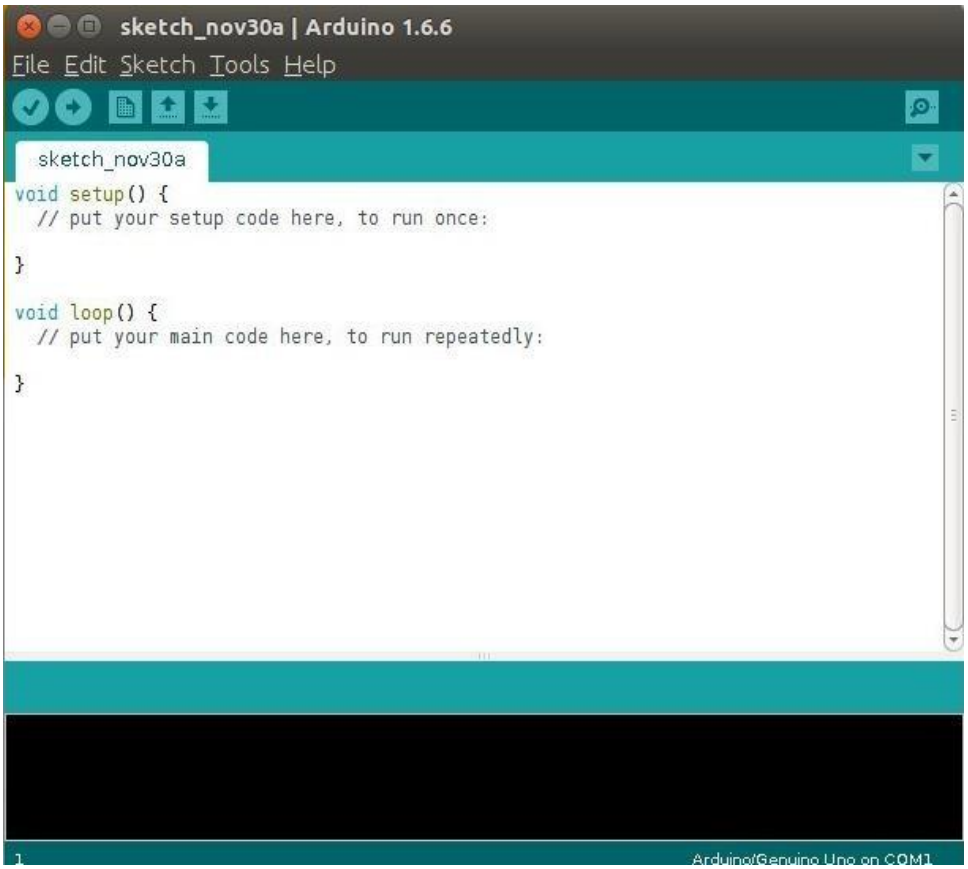

Figure 3.5 – Arduino IDE interface

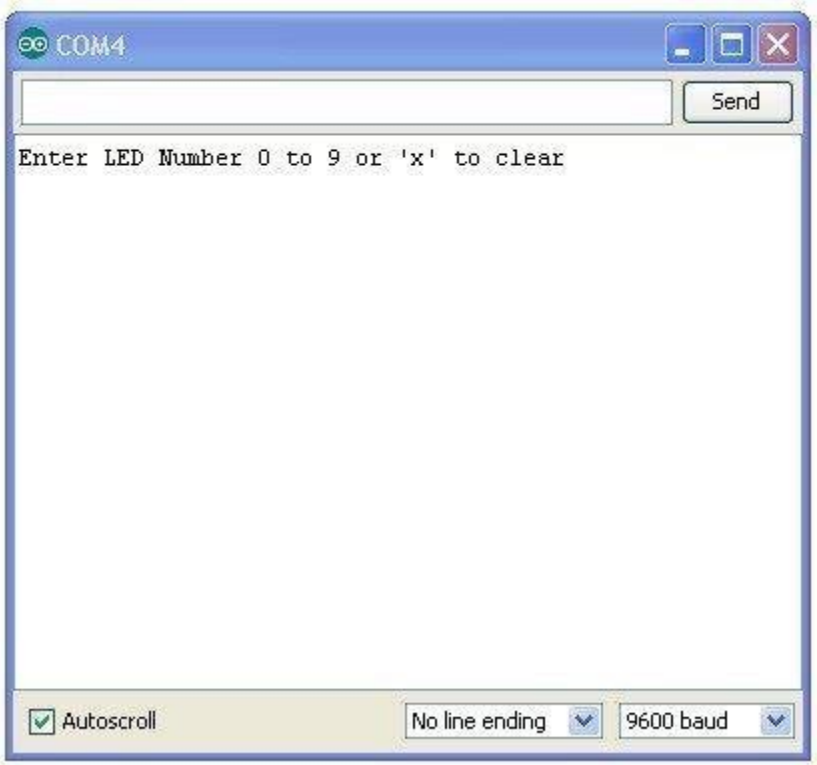

Figure 3.6 – Arduino IDE serial monitor

3.3 CODES

3.3.1 Arduino

```
#include<LiquidCrystal.h>
LiquidCrystal
lcd(7,6,5,4,3,2);

int flax1 =0;
int flax2 =0;
void setup()
{


lcd.begin(16,2);

pinMode(A0,INP
UT);// voltage
divider value input

pinMode(A1,INP
UT);// voltage
divider value input

lcd.setCursor(0,0);
  lcd.print("masses
display ");

lcd.setCursor(0,1);
  lcd.print("
System      ");
  delay(3000);

}
void loop()
{
          flax1 =
analgRead(A0);
//read analog value
from sensor
          flax2 =
analgRead(A1);
//read analog value
from sensor



if(flax1>200)
         {
```

```
lcd.setCursor(0,0);

lcd.print("medicin
e");

lcd.setCursor(0,1);
        lcd.print("
");

Serial.println("me
dicine");

        }


if(flax1<200)
        {

lcd.setCursor(0,0);

lcd.print("Water
");

lcd.setCursor(0,1);
        lcd.print("
");

Serial.println("Wat
er");

        }


if(flax2<200)
        {

lcd.setCursor(0,0);

lcd.print("Food
");

lcd.setCursor(0,1);
        lcd.print("
");

Serial.println("Foo
d    ");

        }
```

```
if(flax2>200)
        {

lcd.setCursor(0,0);

lcd.print("message
");

lcd.setCursor(0,1);
        lcd.print("
");
        }
        }
```

Description of functions used in code

Setup:- The f unction is called when a sketch starts. It is used to initialize variables, p1n modes, start using libraries, etc. The function will run once only.

Loop:- The function runs repeatedly, allowing your program to change and respond. It is used to actively control the Arduino code functioning.

Serial.begin:- It sets the data rate for serial data transmission. One can, however, specify other rates - for example, to communicate over pins with a component that requires a particular baud rate.

Software Serial (Receiver Pin, Transmitter Pin, Inverse_logic) –
It is used for the purpose of creating an instance of a Software Serial object. The inverse_logic is optional and its default value is 'False'. Multiple Software Serial objects can be created but only one can be activated at a time. So are Serial softwares

Parameters Involved :

- Transmitter/ Tx Pin - This pin is used for transmitting the serial data.
- Receiver/ Rx Pin - This pin is used for receiving the serial data.

Read:-Reads incoming serial data.

AnalogRead:- It gets the value from the predetermined analog pins. The Arduino board contains a 6 channel, 10-bit simple to computerized converter. This implies it will delineate voltages in the vicinity of 0 and 5 volts into whole number

esteems in the vicinity of 0 and 1023. It takes around 100 microseconds (0.0001 s) to peruse a simple info, so the most extreme perusing rate is around 10,000 times each second. .

If/else :- The if/else permits more prominent control over the stream of code than the essential if articulation, by enabling different tests to be assembled together. An else provision will be executed if the condition in the 'if' proclamation brings about false. The else can continue another 'if' test, with the goal that various tests can be kept running in the meantime.

Each test will continue to the following one until the point when a genuine test is experienced. At the point when a genuine test is discovered, its related piece of code is run, and the program at that point skips to the line following the whole if/else development.

Delay:- Pauses the program for the measure of time determined as parameter. (1000 milliseconds in a second).

3.3.2 MIT App Inventor Code

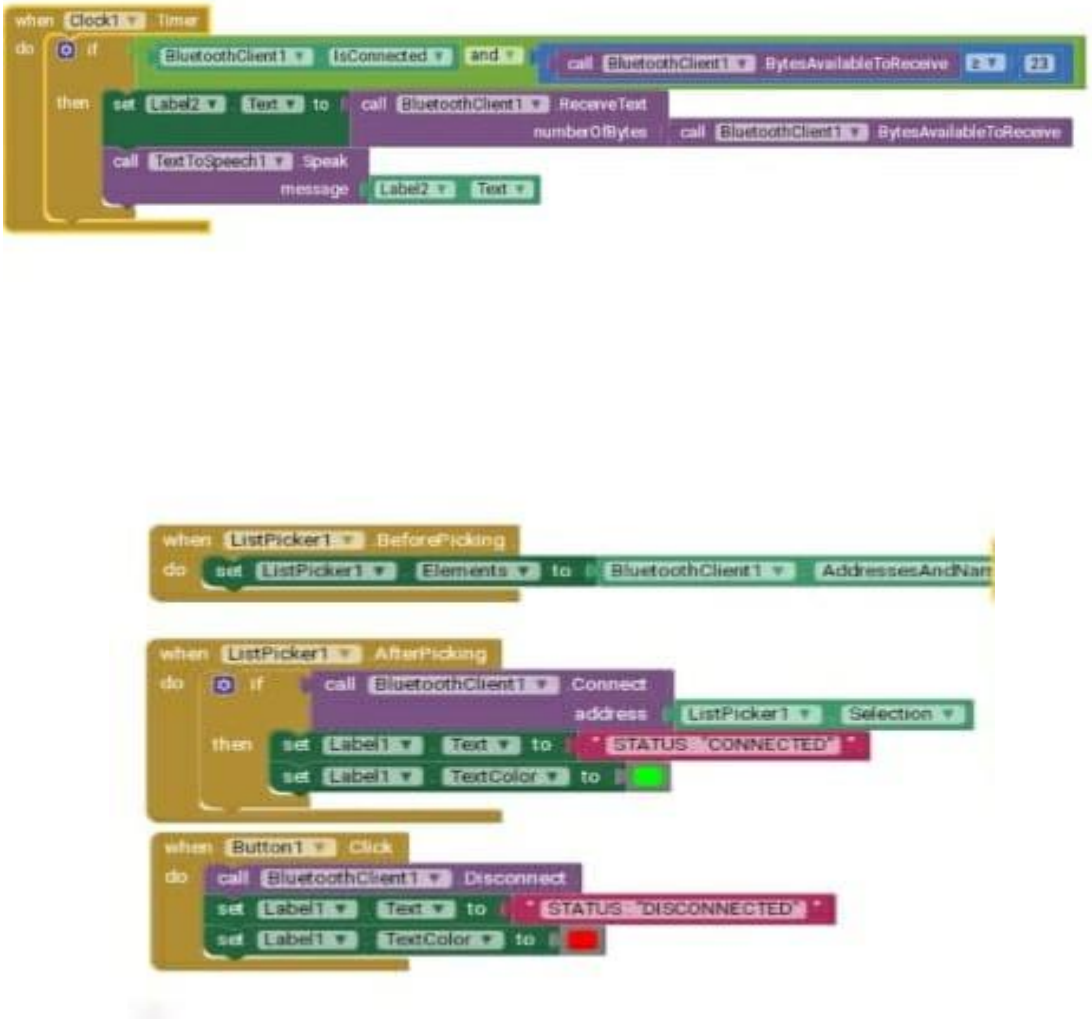

Figure 3.7 - Blocks used in app

About the blocks used in MIT App

ListPicker:- Various options of text are displayed when clicking the ListPicker button.

Button:- Button with the ability to detect clicks.

Label:- Predefined texts are shown as per what the creator wants when using a label.

TextToSpeech:- This in-built function of MIT app inventor converts the received text or any text to speech output.

Description:-To communicate with the Bluetooth module i.e HC-05, we first need to get its address. After getting the address, we need to select the device from the phone from the list of all the paired devices. After selecting the device and successful connection between Bluetooth module and the mobile phone, there is a text box to show the status which on successful connection, turns green and shows connected status. While on unsuccessful connection or when user disconnects from the app, the status turns to red and shoes disconnected. There is a clock (of by default 1 sec), that fetches data from the arduino through bluetooth after cycle of every 1 second. Whenever a gesture is made by the user, a corresponding text to that gesture is sent to the app from adruino by Bluetooth and the in-built function “text-to-speech” converts that user text to speech output.

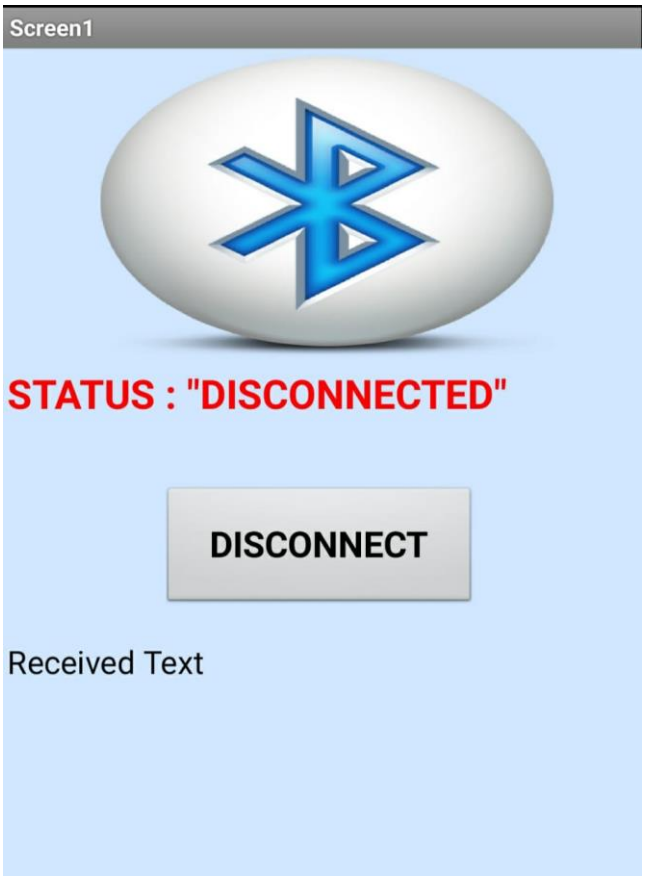

Figure 3.8 – User Interface of Flexi-Glove App

WORKING PRINCIPLE OF DEVICE-

Once the flexi-glove containing the flex-sensors is attached to the User, communication by the user doesn't take place verbally but rather he/she moves his fingers attached to the flex sensors which bend giving out communication signals. This results in different combinations of bending of flex-sensors which in turn give diverse variable resistances which are inputted to the Arduino containing ATMega328 microprocessor. The Bluetooth component HC05 is in serial connection with the Arduino; which is also in connection with Electronic Display Device or Mobile phone app(as shown in the model). The flex-sensors having sent input signals to the jointly attached Arduino-UNO recognises the different changes in angles due to multiple combination of finger movements which in turn gives out specific resistance variations which will then allow the ATMega328 microprocessor to seek the relevant output as per the coding we have done.

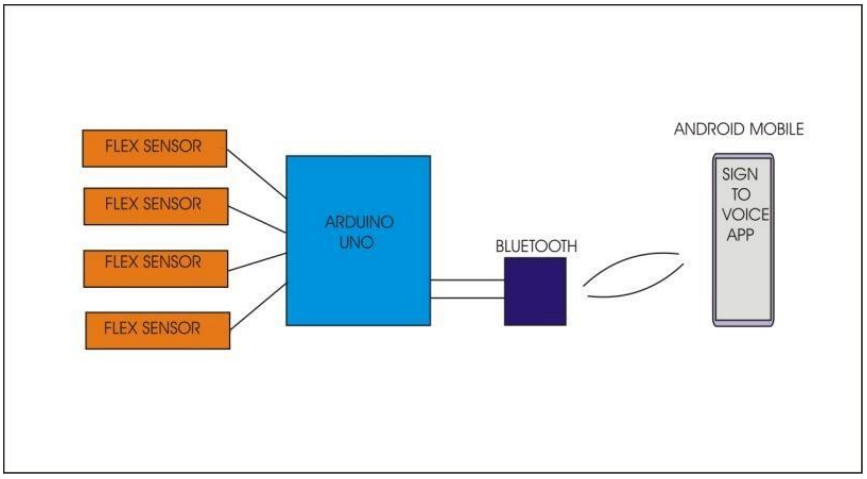

Figure 4.1- Explanation of working

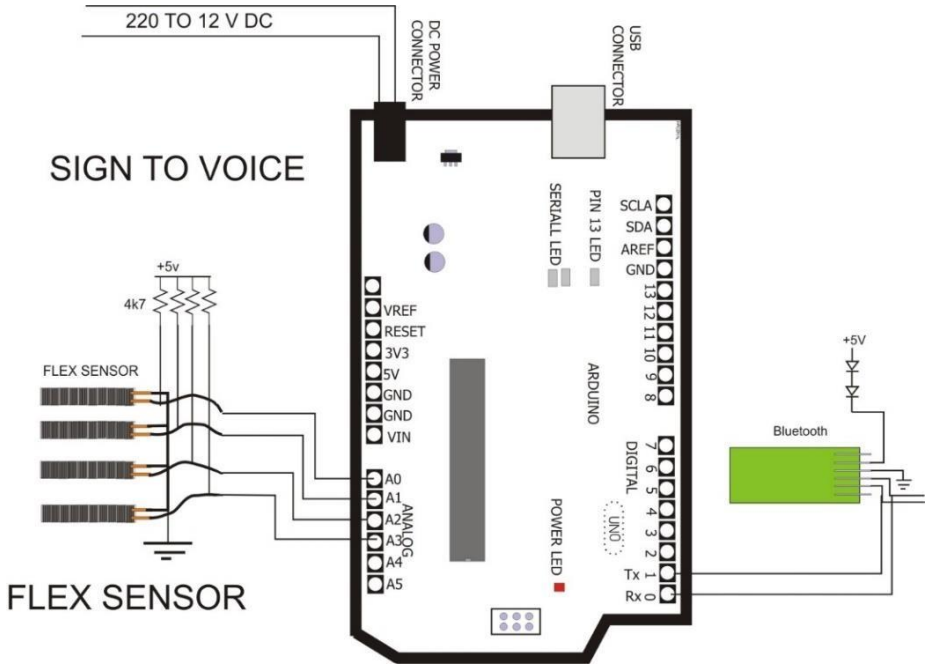

Figure 4.2 – Circuit diagram

APPLICABILITY OF FLEX SENSOR DEVICE

5.1 PRACTICAL NEED OF THE DEVICE

Communication is a very important aspect of each and everyone's life. Understanding this urgent need, for differently-abled people, gestures are one of the best mediums to communicate.

Let's take an example:-

Suppose a person who is mute, is having a severe headache and goes to the chemist to buy medicines for reducing the pain. Now, communication here plays a very crucial role. What will happen if the person is not able to convey his message? Or what if the chemist is not able to understand the message that the mute person is trying to give? This is a barrier to the effective communication that needs to be solved.

Now, let us imagine that another mute person arrives at the same time at the same shop with a same problem. The only difference is that he is wearing our glove that has a predefined gesture for emergency and he can easily convey his message by performing that specific gesture. By this way, it is easier for both the parties to

convey and understand each other's message.

5.2 LIMITATIONS

- Power supply to the Arduino board.
- To make it as compact it can be.
- More compact will be more easier to wear.
- Waterproofing of the system as all the components can easily get damaged.
- Consistency in resistance values of the flex sensor with time.
- Reducing time delay between the gesture and speech output that we get.
- Wires on the gloves are hard to handle.
- The system is easily damageable.
- As the app is used that runs on phones, it will consume more battery power of the phones. However, Bluetooth technology is upgrading like BLE that consumes less power.

5.3 CONCLUSION

During this project we face various types of challenges. We have tried to minimize the problem. Since this was a prototype our focus was to build a model, which can solve or minimize the communication problem for the disable people.

MAIN CONCLUSION AND FUTURE SCOPE

This glove and its effective use can prove to be a boon as it has the ability to give speech message from Output Electronic Devices for people having hearing and speaking disorders to communicate at public places. For example, this device could be very helpful when buying coffee from a restaurant and instead of making attendant understand your order through gestures, one can easily use the flexi-glove for effective comprehension. This device can also be used in Hospitals for patients who are too weak to speak and have energy only for finger movements. Hence, this device uses the principle of Flex-sensors and Serial communication to solve a practical problem encountered by people in their day to day lives.

The future scope and further development of this technology may involve-

- The whole invention could be waterproof.
- The data transfer can be done directly from the flex sensors to mobile phones through Bluetooth and the app has the code to generate specific speech output on a specific gesture (removing Arduino).
- To make the speech outputs more consistent and error free.
- Smooth functioning of the whole system.
- Making the system more accurate (no random speech outputs).

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