SMART GESTURE DEVICE WITH SIGN LANGUAGE RECOGNITION

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

This is to certify that the project report entitled "**SMART GESTURE DEVICE WITH SIGN LANGUAGE RECOGNITION"** submitted by

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in partial fulfillment of the requirements for the award of the **Degree Bachelor of Technology** in "**Electronics and Communication** Engineering " is a bonafide record of the work carried out under my(our) guidance and supervision at Amrita School of Engineering, Bangalore.

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EXAMINER 1 EXAMINER 2

ACKNOWLEDGEMENT

We thank God through whom all things happen and with whose merciful blessings the project has reached completion. We offer our sincere pranams at the lotus feet of Universal guru, **MATA AMRITANANDAMAYI DEVI** who has been a driving force and a source of inspiration for all educational activities and blessed us with her grace to make this a successful project.

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Abstract

Communication is a very huge aspect of every person’s life. Without proper communication, people might face many difficulties. For individuals who live without sound, communication is a very challenging thing. Because of their disabilities, deaf and mute people generally use Sign Language as a medium of their communication. Sign Language communication will come in handy and make their lives easy and simple. However, there is no such budget-friendly device in the market that can understand all the signs and translate them into speech. The main aim of our project was to construct one such device. We wanted to build a device that can easily understand and analyze the signs used by the deaf and mute person and later convert them into speech using the software. This device translates sign language into text or speech. It can also be used to send messages using the cloud. For translating sign language into text, we made a glove to which we attached flex sensors, accelerometer, gyroscope, and Arduino UNO. These sensors will record the position and movement of the hand when the gesture is being made. We used American Sign Language as our standard medium for our whole application. In total, this device will help the deaf and mute to easily communicate with others hence removing the communication barrier

LIST OF FIGURES

List of abbreviations

TABLE OF CONTENTS

5. CONCLUSION AND FUTURE WORK

5.1. Conclusion

5.2. Future work

6. REFERENCES

CHAPTER 1

INTRODUCTION

1.1 Overall System

Sign Language is a language used by deaf people and mute people to communicate with others. Sign Language is solely dependent on gestures. It is completely based on positional and visual components. These might include the position of the hand, shape of fingers, arm movements, and finger movements. The structure of Sign Language has five elements. Generally, every gesture in sign language consists of these five elements. We can say that the combination of all these elements will give us any gesture. The five elements of sign language are:

- **Articulation point:** This consists of the areas on the hand which is used for sign language. Fingers joint, wrist joint, elbow joint, and shoulder joint come under the articulation point.

- **Hands Configuration:** It is the arrangement of parts of the hand. Hand configuration includes bending of fingers, movement in fingers, and bending of the palm.

- **Movements Type:** This speaks about the different movements which occur during gesture formation. Forward, backward, left and right are the types of movements that usually occur.

- **Hands Orientation:** This is nothing but the orientation of the hand at different angles. This includes palm up, palm down, palm inward and palm sloping.

- **Facial Expressions:** Even if the gesture is formed, it is always important for a person to have an expression such that it would be easy for the user to understand. This includes a happy face, angry face, lips movements, a sad face, and shaking the head.

To recognize the gestures and to understand the meaning of the gestures, we need Sign Language Recognition. There are three ways to recognize and understand a gesture. They are:

- **Sensor Based:** These systems use sensors to get the input values. The sensors measure the bend in fingers and orientation of the hand. These sensors-based systems use flex sensors, accelerometers, proximity sensors, etc., for measuring purposes.

- **Vision-Based:** Vision-based systems use cameras to take the input data. The camera captures the gesture and then processes it giving us the output. These are easily available due to less computation cost as cameras are very cheap. But there will be limited field view as a camera can only capture a portion of the screen.

- **Hybrid Based:** These are nothing, but the combination of vision-based, and sensor-based systems. These systems will have sensors that will measure the value, and these will also have an attached camera to give accurate outputs. The computational cost is very high.

Our project is a sensor-based system. We have used flex sensors, accelerometer, and gyroscopes which will sense the data which will be processed later.

1.2 Objectives

- To build a glove to detect sign language.
- To create a database that contains the American Sign Language alphabets. This database is used as a reference for the computer program while checking inputs.
- To write a code that checks input gestures.

- Arduino connection between computer and glove device. Use a minimal number of fingers such that all signs are covered.

1.3 Methodology

Flex sensors are used to detect the sign language. Gyroscopes are used for signs which need gestures and movement. Accelerometers are used to measure acceleration forces. The glove device is powered by batteries to avoid any risk of shocking users. The total project is divided into 3 phases as follows:

- The first phase consists of connecting the flex sensors to the glove and interfacing them with the Arduino UNO. The flex sensors will be given values in the code and when bent, these flex sensors will act accordingly and give us the output. Hence the calibration of flex sensors is done. Phase 1 Will be completed in our seventh semester.

- The second phase consists of interfacing the accelerometer with the Arduino and noting down the values for future reference. The gyroscope is then connected with the Arduino and the values are noted. Interfacing of both gyroscope and accelerometer with Arduino is hence completed. Phase 2 will be completed in our eighth semester.

- In the third part, we have to interface all three sensors, that is, flex sensors, accelerometer, and gyroscope to the Arduino and with the help of a software program, we have to connect the glove to the cloud so that the data is transferred to the cloud and output will be displayed in our mobile.

1.4 Expected Result/ Obtained Result

- When we calibrated the flex sensor values with the Arduino, we can get the resistance values for different angles. After the calibration is done, we programmed the Arduino to get sign values so that we can recognize the alphabets

1.5 Contents of the rest of the chapter

- Chapter 1: Deals with the overall system scenario, objective of the project, tools being used to generate the simulations, the results expected, and the timeline of the project.
- Chapter 2: Deals with a brief discussion of the basic background work and state of art
- Chapter 3: Deals with the design and hardware of the device. It explains the flowcharts of implementation and connections
- Chapter 4: Deals with the results which were obtained while simulating
- Chapter 5: Concludes the project by giving the future work which is going to be performed on the algorithm.

CHAPTER 2

STATE OF ART

2.1 INTRODUCTION

This chapter provides an overview of different techniques which helps in analyzing the flex sensor movements and its extended version and how the gyroscope and accelerometer working

2.2 Flex Sensor Based Hand Glove for Deaf and Mute People

Mamun, Abdullah & Alamgir, Mr. Fakir Mashuque. (2017). Flex Sensor Based Hand Glove for Deaf and Mute People. International Journal of Computer Networks and Communications Security. 5. 11

2.2.1 METHODOLOGY

In this project, they have used the Arduino IDE software to program the Arduino Mega 2560. Android studio is used to make the android app. For analyzing the data they used MATLAB, Simulink, and PLXDAQ. MATLAB is used to analyze the resistance of the Flex sensor. Simulink is used to analyze finger bending. And PLX-DAQ is used to analyze the gyro sensor data. This is the app layout. they used this app to build the communication between the mobile and the hand glove. Through this app, massage will be sent and received. they have connected this app with the hand glove using a Bluetooth communication system. This app shows “Your device is not connected” when there is no connection between the app and the hand glove. After connecting the app with the hand glove, all the messages which are coming from the hand glove will show in that place. This app has two options to send messages to the hand glove. One is text option and another is using voice API. In the text option, normally we write the text and then send it. For voice API, mobile needs to be connected to the internet. After pressing the voice button, the app user will talk. All the speech will be shown in the app and by pressing the send button, the message will be sent to the hand glove.

They have done real-time simulation using the MATLAB SIMULINK software for the alphabets. This helped us to analyze the finger bending and the output for the finger bending.

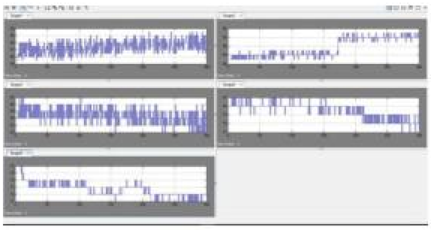


Fig. 3.12. English alphabet "F".

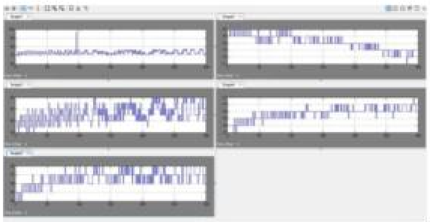


Fig. 3.13. English alphabet "G".

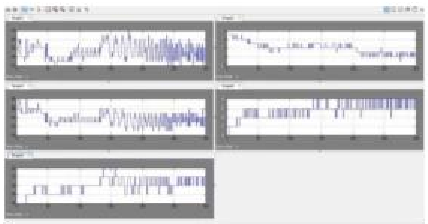


Fig. 3.14. English alphabet "H".

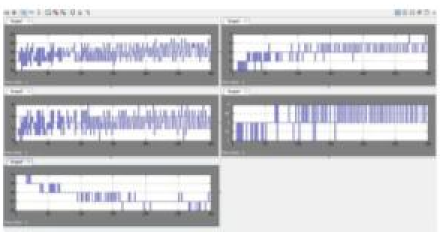


Fig. 3.15. English alphabet "I".

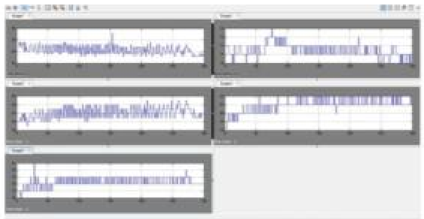


Fig. 3.17. English alphabet "L".

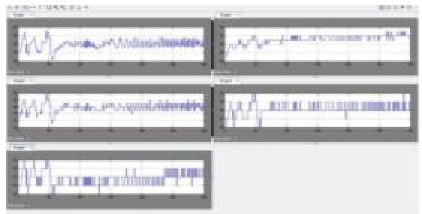


Fig. 3.18. English alphabet "M"

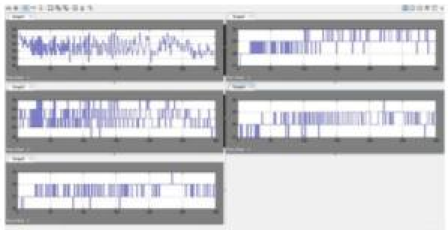


Fig. 3.19. English alphabet "N".

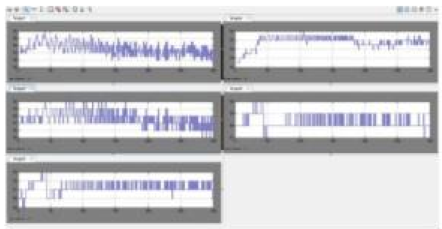


Fig. 3.20. English alphabet "O".

Fig 2.1 single letter sensors data

From the above graphs, it is clearly shown that for a single letter sensor data is varying over time. So, an algorithm needs to be added to ensure the proper use of the sensor data.

In the graph of roll, pitch, and yaw, it is clearly shown how the data is varying. Data is fluctuating more than (+-1). Though, we did not move the gyro sensor. So, in this situation, it is difficult to take any decision using the gyro sensor data, then we have to add the data to calibrating algorithm

2.2.2 ADVANTAGES

For analyzing the data we used MATLAB, Simulink, and PLXDAQ. MATLAB is used to analyze the resistance of the Flex sensor. Simulink is used to analyze finger bending. And PLX-DAQ is used to analyze the gyro sensor data.

2.2.3 DISADVANTAGES

It is difficult to analyze concerning system aspects for implementation and not easy to code for the application usability. The difference between the letter “U” and “V” is sign language is very small. So there is a small contradiction between “U” and “V” for detecting. Decoding all the sign language needs a lot of research. We did not decode all the words. A very few words were decoded

2.3 Sign Language Conversion and Training by Machine Learning with an IoT Approach

Rezoan Ahmed, Tanvir Ahmed, “Sign Language Conversion and Training by Machine Leaning with an IoT approach”(2017). Department of Computer Science and Engineering BRAC University

2.3.1 METHODOLOGY

In this project, we use the glove that has four flex sensors each sitting on each finger. The microcontroller consistently checks the bowing of the flex sensor. At the point when the signal of the letters makes a particular word based on the sequence that appeared in the LCD. The glove includes a few contact sensors, which help in recognizing a couple of comparable motions like "U" and "V". The precision of each flex sensor is constrained past a specific point. Smaller hands will bring about a bigger level of twist. Therefore, the contrast is very high. Since all correspondence is done through links, our gadget does not meddle with different plans. Any individual who fits into it can utilize the glove; they would just need to prepare on it and create new datasets on the off chance that they wish for a higher forecast precision than the standard or to consolidate new signs. we can understand, this framework can be utilized for changing over gesture-based communication to voice and voice to communication via gestures. A movement catch framework is utilized for communication via gestures transformation and a voice acknowledgment framework for voice change. It catches the signs and directs on the screen as composing

Force sensors were integrated at this stage. The force sensors were used for various purposes. Here 3 force sensors were integrated into the total. One force sensor is attached to the finger which was used to differentiate some alphabets mainly it was to differentiate between “U” and “V” The force sensor is placed on the upper side of the ring finger. Force sensors as Switches The rest of the two force sensors are used as switches. One is used to contact the letters to form a string of letters and another one is used to send the classified data to the Wi-Fi module. Both of the force sensors worked as a switch for the threshold value over 600.

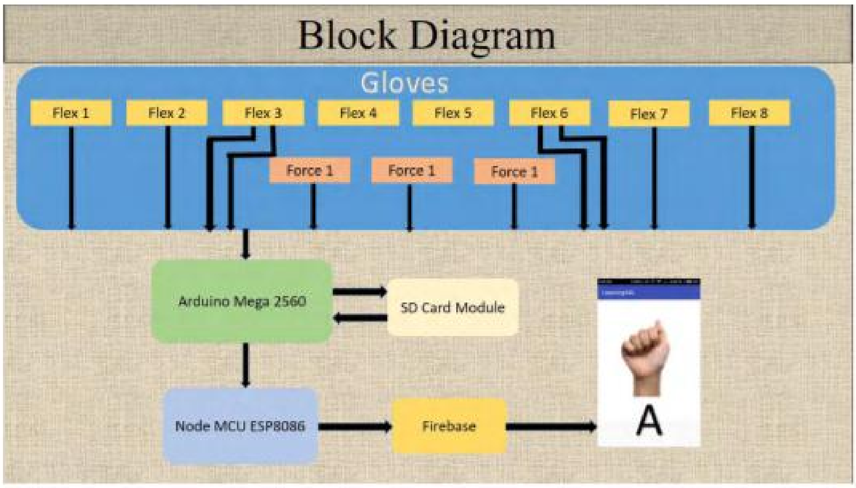


Fig 2.2 block diagram of sign language conversion with an IoT approach

Here we have also used the built-in firebase library for android to get the pushed or set data in real-time. Then we used our logic to process the data in our app. whenever a new child is added to the firebase the value-Added Listener is called and the mobile application gets to know about the new pushed data. Depending on the data, the mobile app takes his decision

2.3.2 ADVANTAGES

The messaging app shows the message a deaf person wants to show via the gloves. If he shows a sign of the alphabet, he needs to show the consecutive alphabets to make a word. The word is passed if a force sensor switch is pressed, and the word goes to the node MCU and the node MCU sends it to the firebase server.

2.3.3 DISADVANTAGES

to remove the gyro from the project as we switched from BSL (Bangla Sign language) to ASL (American Sign Language). If we could correctly classify ASL we need not use a gyro sensor as ASL has a lot more simple signs than BSL

2.4 SIGN LANGUAGE GLOVE TEACHING DEVICE

Reebbhaa Mehta ,Daniel Fong , Mayapati Tiwari &Mr. Igor Fedorov(2013). Sign Language Glove Teaching Device

2.4.1 METHODOLOGY

The goal of this project is to create a glove device that detects sign language gestures for letters used in American Sign Language, and inputs them into a computer, where a computer program checks the gesture. If the character is wrong the program will indicate, with the help of LED’s and haptic feedback what was wrong with the gesture

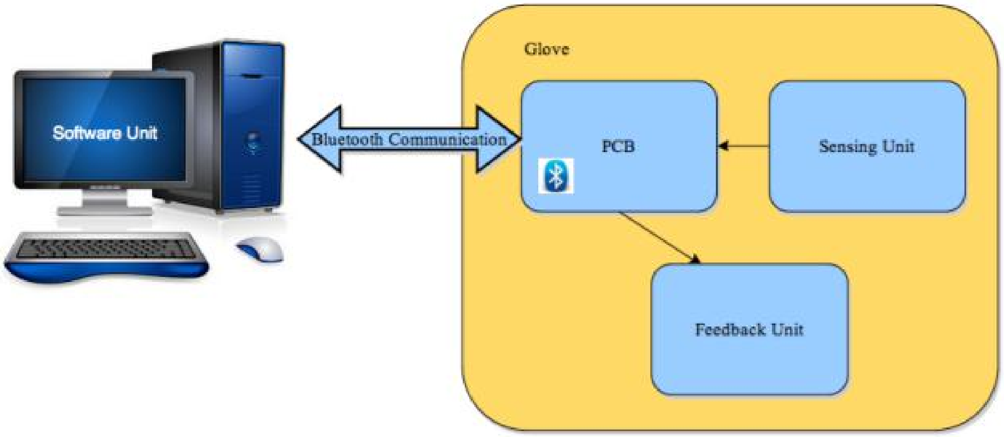


Fig 2.3 block diagram of sign language conversion device using PCB

The PCB consists of the power supply, Bluetooth module, Microcontroller DSP Chip, and the Voltage Divider circuit placed upon the PCB board. The power supply powers all the other units with the appropriate voltages. The Microcontroller DSP will compare the data gathered from the sensors with the data from the computer and send out the feedback signals. The Bluetooth Chip provides the communication between the Microcontroller DSP and the computer. The computer software's purpose is to allow users to become adept at signing quickly by signing the necessary letters. For every letter they sign, the user's data is recorded. The Microcontroller will collect the information from the accelerometers, gyroscopes, and the flex sensors/ voltage divider after the outputs from the sensing unit have gone through the Analog to Digital converter chip, and it will be programmed to implement a Kalman Filter to estimate the movements and locations of the fingers and that of the glove. Then, it will compare the result with the data sent from the computer ADC & DAC: The analog to digital and digital to analog converter is required to convert the analog data from the sensing unit to digital so that our microcontroller can process it. Similarly, for the feedback mechanism, we require digital to analog data conversion to drive our feedback unit The voltage divider will divide the voltage using one high resistance resistor and the flex sensor acting as a variable resistor. As the flex sensor bends, the resistance will increase and the output voltage increases The sensing unit consists of six gyroscopes; six flex sensors, and three accelerometers to detect the position of the hand and each finger for a particular gesture The feedback unit consists of haptic feedback, using five vibration motors, and five LEDs, placed on each fingertip. The feedback unit is used to alert the user what is incorrect with the position of the fingers for a particular gesture.

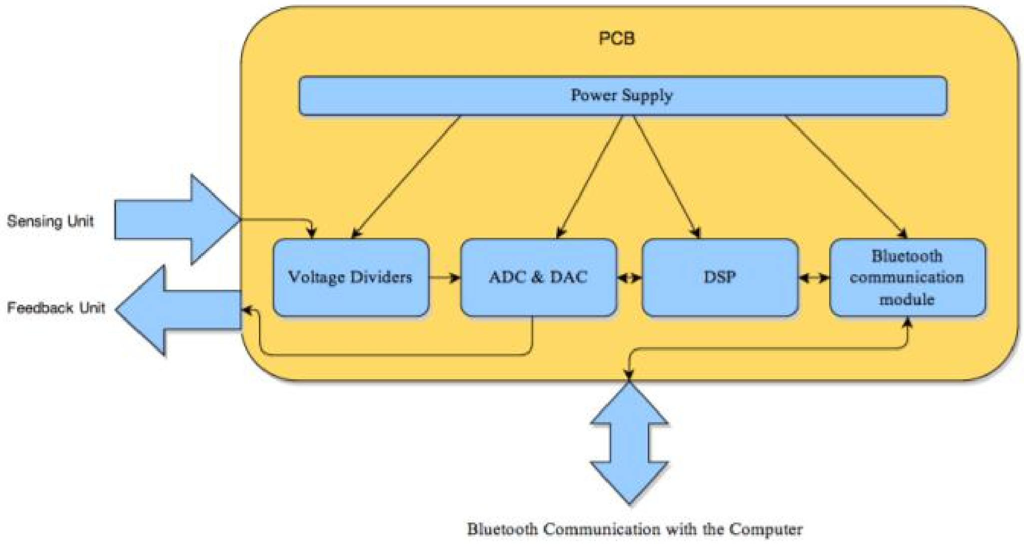


Fig 2.4 block diagram of sign language conversion device using microcontroller

2.4.2 ADVANTAGES

If for a gesture one 6 finger is in an incorrect position then the vibration motor for that finger will vibrate and the LED will flash red to inform the user of the wrong positioning of the finger

2.4.3 DISADVANTAGES

As they were using the PCB which is not like breadboard The device should be carefully made to not expose the user to any current from the circuit. During the development process, safety precautions must be taken while soldering and using the hot glue gun.

2.5A Review on Systems-Based Sensory Gloves for Sign Language Recognition State of the Art between 2007 and 2017

Mohamed Aktham Ahmed , Bilal Bahaa Zaidan , Aws Alaa Zaidan, Mahmood Maher Salih and Muhammad Modi bin Lakulu(2018) Department of Computing, Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak 35900, Malaysia

2.5.1 METHODOLOGY

The use of a certain type of instrumented gloves that are fitted with various sensors, namely, flexion (or bend) sensors, accelerometers (ACCs), proximity sensors, and abduction sensors, is an alternative approach with which to acquire gesture-related data. These sensors are used to measure the bend angles for fingers, the abduction between fingers, and the orientation (roll, pitch, and yaw) of the wrist. Degrees of freedom (DoF) that can be realized using such gloves vary from 5 to 22, depending on the number of sensors embedded in the glove. A major advantage of glove-based systems over vision-based systems is that gloves can directly report relevant and required data (degree of bend, pitch, etc.) in terms of voltage values to the computing device, thus eliminating the need to process raw data into meaningful values. By contrast, vision-based systems need to apply specific tracking and feature extraction algorithms to raw video streams, thereby increasing the computational overhead. Later, we will review the articles related to this approach in detail. hird method of collecting raw gesture data employs a hybrid approach that combines glove and camera-based systems. This approach uses mutual error elimination to enhance the overall accuracy and precision. However, not much work has been carried out in this direction due to the cost and computational overheads of the entire

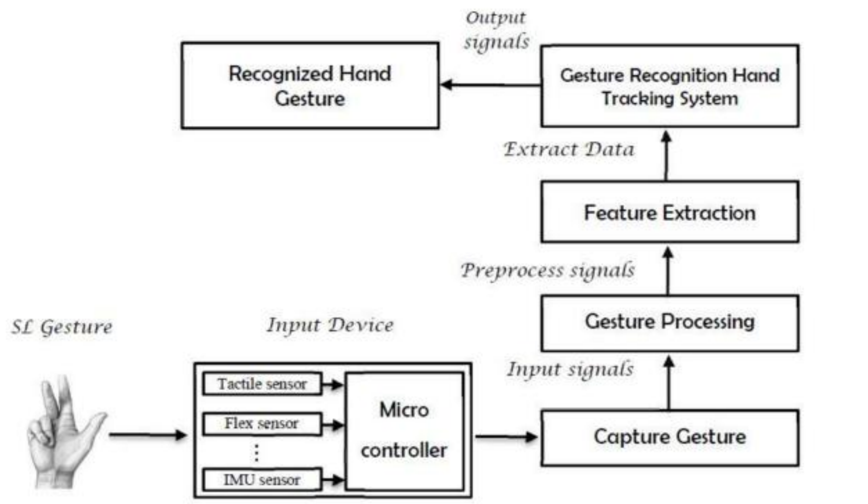


Figure 4. The main phases with regard to collecting and recognizing SL gestures data using the glove-based system.

Fig 2.5 main phases about collecting and recognizing SL gestures data using glove based system

setup. Nevertheless, augmented reality systems produce promising results when used with hybrid tracking methodology

The microcontroller is the system's mind that is accountable for gathering the data from the sensors provided by the glove and performing the required processing of these data to recognize and transfer the sign to the output port to be presented in the final stage. A high-performance microcontroller with a microchip with 8-bit AVR microcontrollers based on reduced instruction set computer (RISC), which combines 32KB in-system programming (ISP) flash memory with read-write capabilities called ATmega. A micro-controller MSP430G2553 (TEXAS INSTRUMENTS, Dallas, TX, USA), with an 8-channel, 10-bit (analog to digital converter) ADC was used. The central processor modules ARM7 and ARM9 are used by, respectively. Furthermore, as found in the literature, an open-source electronics platform called Arduino has been used. Several Arduino boards are available on the market such as Arduino Nano, Uno, Mega, etc.; for instance, Arduino Uno (Arduino, Italy), (Figure 13c) is based on the ATmega328P microcontroller and has 14 digital inputs/outputs, 6 analog inputs, a 16 MHz quartz crystal, and USB connection. Odroid XU4 (Hardkernel2, Anyang, South

Korea), produced by Hardkernel2, uses a Samsung Exynos5 Octa 5410 processor that consists of 4 CPU cores each with Cortex™-A15 cores; it was used for the development of the data glove.

2.6 Sign Language Detection and Translation in Speech

S.N. Shelke, Ashutosh Porwal, Ashish Oswal, Nihal Mehta & Probal Das, Asian Journal of Convergence in Technology

2.6.1 METHODOLOGY

In the proposed system, flex sensors are used to measure the degree to which the fingers are bent. Accelerometer within the gesture recognition system is used as a tilt sensing element, which in turn finds the degree to which the finger is tilted. A tactile sensor is used to sense the physical interaction between the fingers. The outputs from the sensor systems are sent to the Arduino microcontroller unit. In the Arduino microcontroller unit, data derived from the sensor output is then compared with the pre-defined values. The corresponding gestures (matched gestures) are sent to the text-to-speech conversion module in the form of text. The output of the text-to-speech synthesis system is heard via a speaker. The main features of this system include its applicability in day-to-day life, portability, and low cost.

Block Diagram

The steps involved in sign language to speech conversion are described as follows:
Step1: The flex sensors are mounted on the glove and are fitted along the length of each of the fingers along with a tactile sensor on the tip of each finger.
Step2: Depending upon the bend of hand movement different signals corresponding to the x-axis, y-axis and z-axis are generated.
Step3: Flex sensors outputs the data stream depending on the degree and amount of bend produced when a sign is gestured.

Step4: The output data stream from the flex sensor, tactile sensor, and accelerometer are fed to the Arduino microcontroller, where it is processed and then converted to its corresponding digital values.
Step5: The microcontroller unit will compare these readings with the pre-defined threshold values the corresponding gestures are recognized and the corresponding text is displayed.
Step6: The text output obtained from the sensor-based system is sent to the text-to-speech synthesis module.
Step7: The TTS system converts the text output into speech and the synthesized speech is played through a speaker.

Tactile Sensors

A tactile sensor is a device that measures information arising from physical interaction with its environment. Tactile sensors are generally modeled after the biological sense of cutaneous touch which can detect stimuli resulting from mechanical stimulation, temperature, and pain (Although pain-sensing is not common in artificial tactile sensors). A resistive contact sensor was fixed to the tip of each finger, to measure contact against the fingers. It is important for gesture recognition, as touch is one of the key mechanics of ASL gestures.

CHAPTER 3
DESIGN AND ANALYSIS

3.1 INTRODUCTION

List of Hardware Components

The following is the complete list of hardware components that are used in the project:

1. Arduino UNO
2. Flex sensors
3. Accelerometer
4. Gyroscope
5. Jumper wires
6. Glove
7. Resistors
8. Connecting wires
9. Breadboard

3.2 SYSTEM ARCHITECTURE

3.2.1 Arduino UNO

Arduino UNO is a microcontroller that is based on the ATmega 328. Arduino UNO consists of 20 digital input pins and output pins. In these 20 digital pins, 6 pins are used as analog input pins and the other 6 pins are used as PWM output pins. Arduino also consists of a 16 MHz resonator and a power jack with a USB connection. It also consists of a reset button which helps in resetting the program whenever required. The Arduino language is a set of C/C++ functions that can be called from the code. It comes with an open supply of hardware features that permits users to develop their kit.

Fig 3.1: Arduino UNO

3.2.2 Flex Sensors

A flex sensor also called a bend sensor is a sensor that measures the amount of deflection or bending. The resistance of the flex sensor is inversely proportional to the bending radius of the flex sensor. It has a high level of reliability, consistency, repeatability. There are an infinite number of resistance possibilities and bend ratios. Flex sensors are used in a wide range of research from computer interfaces, rehabilitation, and even security systems.

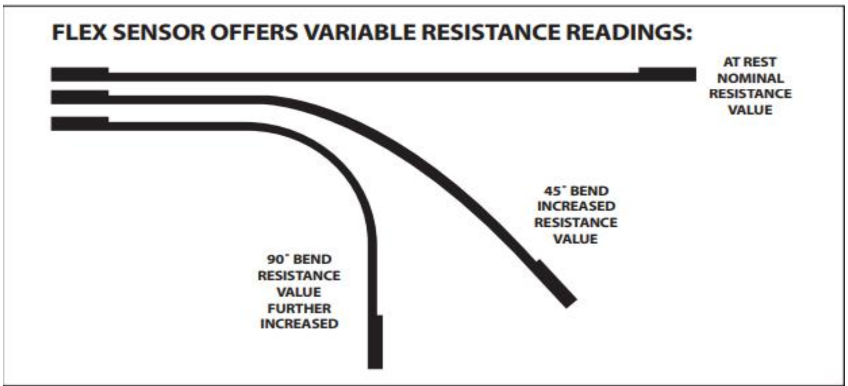


Fig3.2: Variable resistance readings

3.2.2 Interfacing with Arduino

We connected the Arduino microcontroller with the flex sensors using jumper wires which were then soldered by metal. The other required connections were given to the Arduino and with the help of connecting wires and breadboard, the setup was ready. The flex sensor needs a voltage divider circuit to measure the change in the resistance when bent. In this project, we will be using five flex sensors for each finger. Each flex sensor is connected to a voltage divider circuit and a resistor on the breadboard. The resistors of 1 kΩ are used in the voltage divider circuit. The Arduino is then connected to the computer and programming of the Arduino is done. In this entire project, we used Arduino IDE for writing and compiling the codes.

The voltage divider circuit is given below:

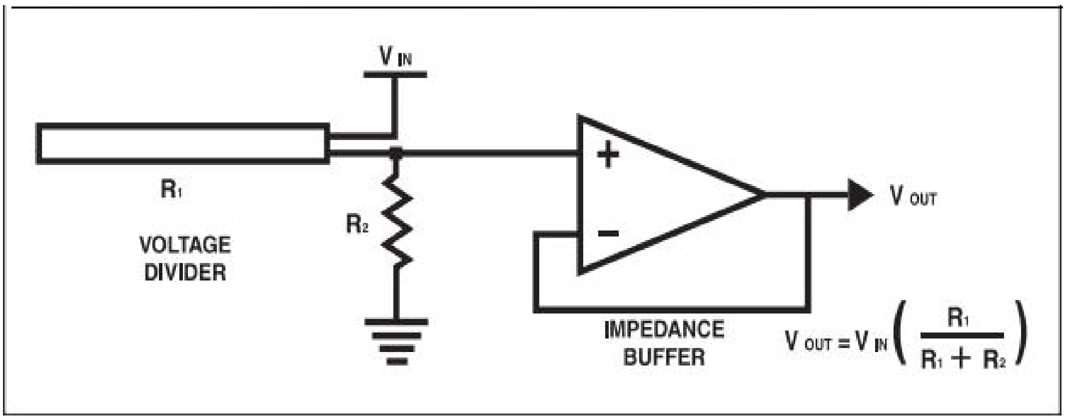


Fig3.3: Basic Voltage Divider circuit

3.2.3 Calibrating flex sensors with values

In the first stage of our project, we took the raw values for flex sensors. Firstly, we have to calibrate the flex sensors using the voltage divider circuit and Arduino. Once we get the values from the flex sensors, we must program the microcontroller in such a way that if we put the sign using our sensors, we have to get the name of that particular sign displayed on the screen. We connected the circuit, and we bent the fingers with flex sensors attached in specified directions. For each bend, a particular resistance value and its respective finger angles are recorded. These are stored in the code for compilation. These values will be used for our reference initially. For a sign in American Sign Language, each finger has to bend at a specified angle. These fingers when bent will make an angle that will be compared to our reference values. Therefore, the sign will be displayed on the screen.

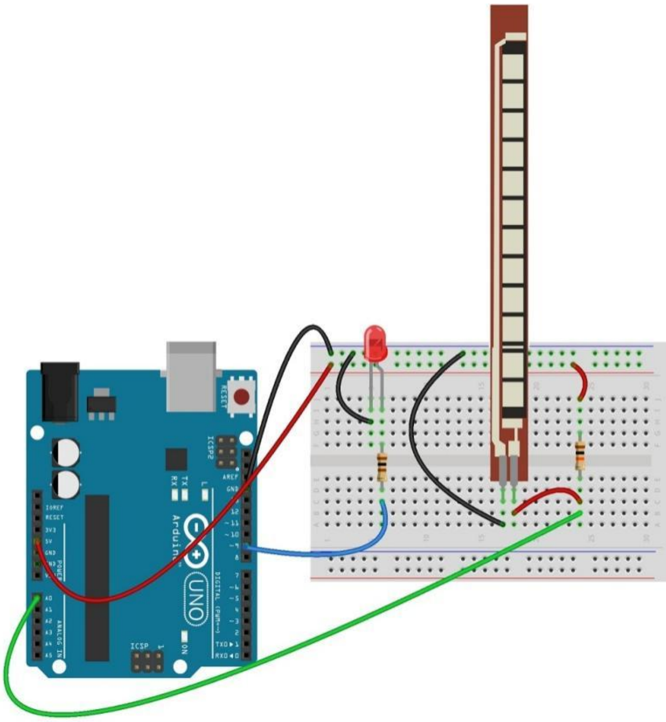


Fig 3.4: Arduino connected with Flex sensors

3.2.4 Accelerometer

Accelerometer is nothing but an electromechanical device that measures the force of acceleration due to gravity. The accelerometer we used in our project is ADXL335. We are using an accelerometer in our project because not all signs can be detected using flex sensors. Some signs in American Sign Language like the alphabets “I” and “J” look alike but, there is a difference of angle. Alphabet “J” is tilted while showing. If we use flex sensors this difference is impossible to find. So, we used an accelerometer that will detect the change in angle and will give us an accurate value. Accelerometer measures acceleration in g units. It is used for tilt sensing applications.

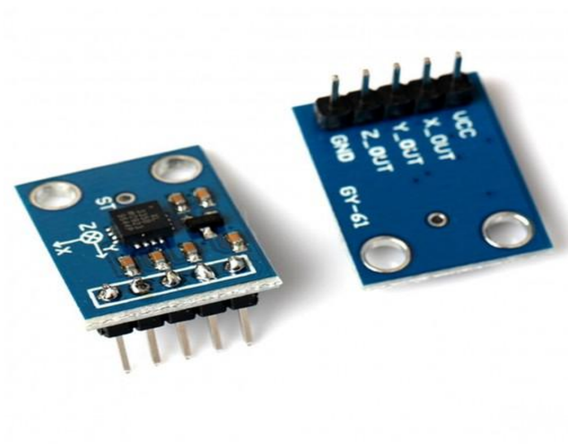


Fig 3.5: Accelerometer ADXL335

Accelerometer ADXL335 provides a complete 3-axis, that is X, Y, and Z-axis acceleration measurement. To measure the acceleration using an accelerometer we have to first calculate the angle of rotation and angle of inclination. ADXL335 gives analog voltage at all the output X, Y, Z pins.

The angle of Inclination:

Angle of inclination is nothing but the angle with which the device is tilted from its plane of the surface.

Angle of Rotation:

Angle of rotation is nothing but the angle with which the device is rotated from a fixed point.

There are 3 components for the angle of rotation. They are Roll, Pitch, and Yaw.
Roll: Rotation angle along X-axis.
Yaw: Rotation angle along Z-axis.
Pitch: Rotation angle along Y-axis.

3.2.5 Interfacing of Accelerometer

We have to interface the Accelerometer with the Arduino by making necessary connections. The accelerometer is used to measure the tilt in the angle. Connect the accelerometer with the Arduino UNO using male or male to female jumper wires. An accelerometer measures the acceleration along all three (X, Y & Z) axis. It also gives analog voltage output proportional to the acceleration measured along the axis. The Arduino converts these voltages into digital signals using ADC (Analog Digital Converter). After the connections are made, code the Arduino using Arduino IDE software and the formulae required to calculate and convert roll, pitch, and yaw. Now put on the glove and attach the accelerometer to the palm. Run the code and make every sign and note down the values for every sign.

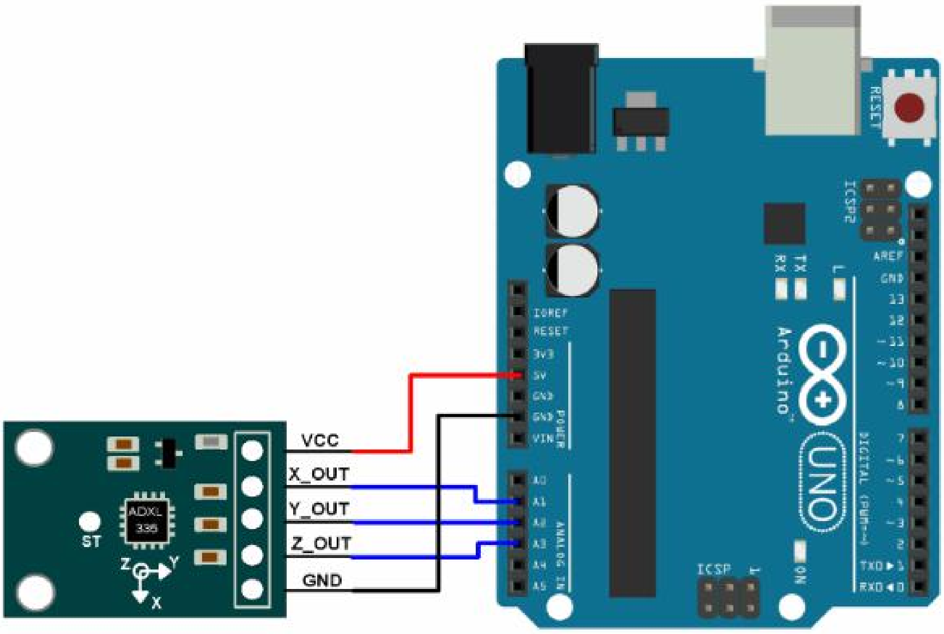


Fig 3.6: Interfacing ADXL335 accelerometer module with Arduino UNO

3.2.5 Gyroscope

The gyroscope is used to determine the orientation with the help of the earth's gravity. It can also measure the angular velocity of the object. A gyroscope sensor is much more advanced than an accelerometer. In our project, we used the gyroscope sensor MPU6050. Unlike accelerometers which can only measure linear motion, gyroscopes can also find the lateral orientation of the object. The angular velocity of an object is defined as the change in rotational angle per unit of time. These gyroscope sensors can also measure the motion of the object. In our project, for more accurate results, we used the accelerometer along with the gyroscope. The Arduino is interfaced with the gyroscope and coded accordingly.

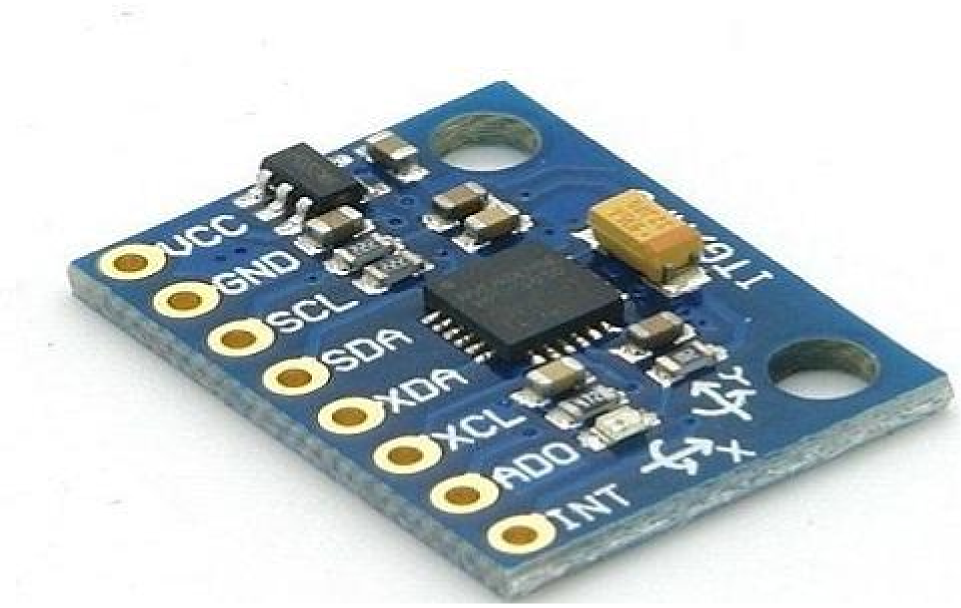


Fig 3.7: Gyroscope Sensor

3.2.6 Interfacing Gyroscope with Arduino

The required connections are made to the gyroscope from the Arduino using the jumper wires. After that, the code is dumped into the Arduino. We have to put on the glove and attach the gyroscope sensor to our palm. Start making the signs and move the palm to which the gyroscope has been attached. The values will be displayed on the screen. A gyroscope measures the motion of the palm. The accelerometer is used when there is movement or change in direction of the palm. The values are noted down for further references. The connections required for interfacing gyroscope and Arduino are given below,

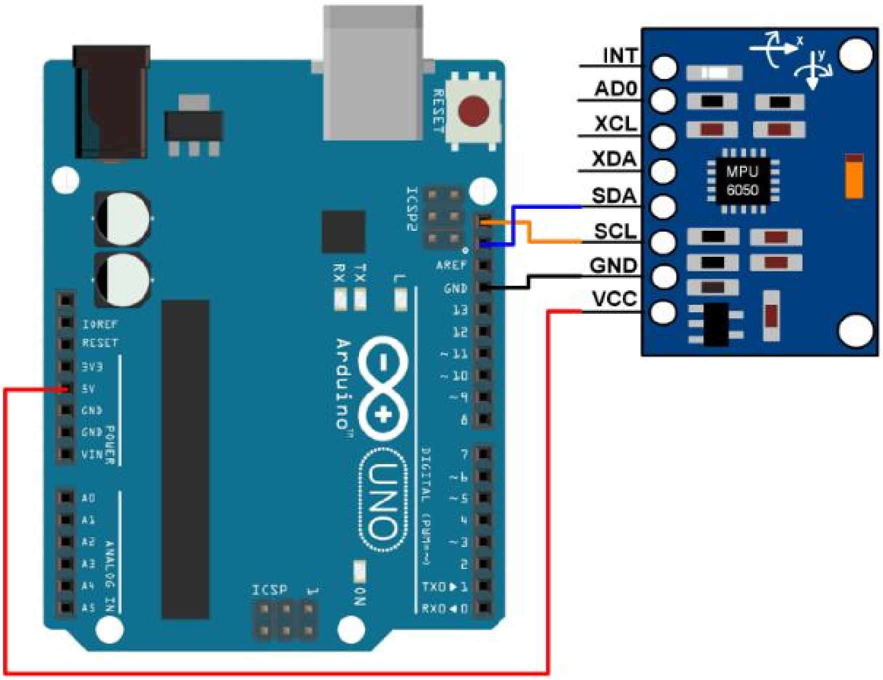


Fig 3.8: Interfacing Gyroscope with Arduino

3.3 DESIGN AND ANALYSIS

3.3.2 Sensing

The purpose of this unit is to detect every gesture that is performed. The sensing unit mostly consists of flex sensors as they play a very important role in sensing the gestures. Flex sensors, like strain gauges, measure the degree to which an object is bent. These devices work on the material's resistance and how it is changing when bent. As we know, the resistance of any material depends on its length, cross-sectional area, charge carrier density, and charge carrier mobility. Resistance is increased when an object is stretched, and it is decreased when the cross-section object gets compressed. Strain gauge is used to measure the change in resistance for much bigger objects. Flex sensors are used to measure the change in resistance of much smaller objects. In sign language, the most important thing is to know how to differentiate between the fingers which are bent and which are not. Each gesture depends upon the orientation, position, and movement of each finger. We connected one flex sensor to each finger. These flex sensors are soldered and connected to the Arduino UNO which is interfaced with the gyroscope. When the gestures are performed, the flex sensors will measure the bent in each finger which will be sent to the Arduino UNO. Two sign language gestures in American Sign Language “J” and “Z” are difficult to sense as they require finger movements in the air. For these two particular signs, we use a Gyroscope that detects the movement and processes the data with the help of Arduino. Gyroscopes are also helpful in knowing the orientation of the glove.

3.3.3 Processing

The purpose of this unit is to take all the gestures that were given by the sensing unit and process them using Arduino UNO. As each gesture is performed by the user, the flex sensors measure the bend in each finger using a change in resistance. These values are sent to the Arduino which has been interfaced with the flex sensors and gyroscope. The Arduino is connected to a laptop with the help of a USB cable. The code required to process the data sent by the flex sensors are dumped in the Arduino UNO using the software Arduino IDE. Once the code is dumped, we have to compile and run the code. The database consists of values that were stored before for each sign to compare them with the currently performed gesture. Once the gesture is performed, the code runs and it compares the performed gesture values with the ones which are already present in the database. If the range of values present in the database match with the one performed, then it displays the sign which has been previously stored in the database along with its value. Initially, we thought of connecting a speaker to the output pin of the Arduino microcontroller. In this way, the user will be able to communicate with anyone using the glove. We also thought of making the glove user-friendly by changing the basic signs so that the user can create his or her database. In that way, the user will be able to change it whenever he wants.

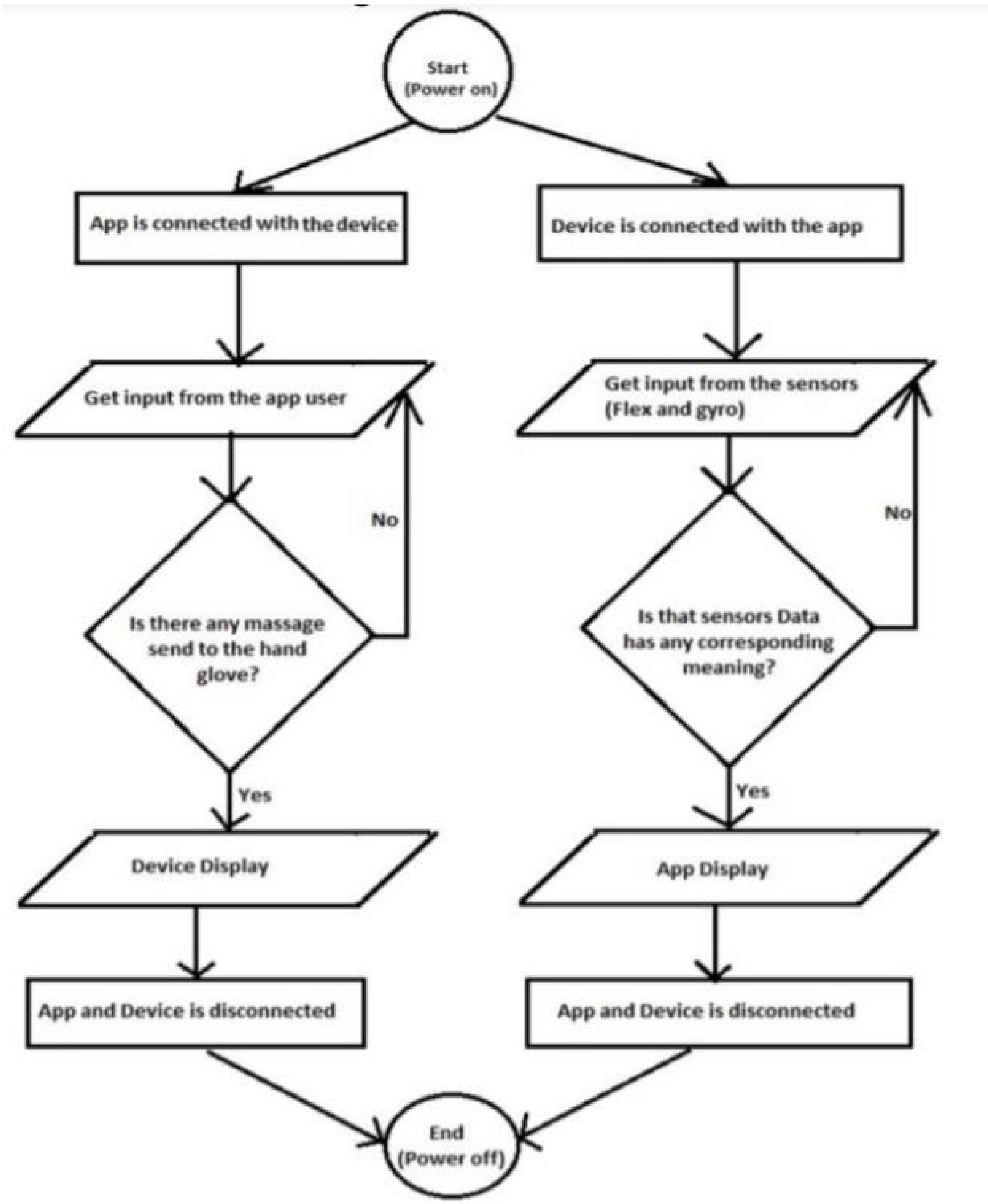


Fig 3.9 block diagram

3.4 SIGN LANGUAGE

Sign Language is a completely natural language, which has a structure that differs from proper English syntax and grammar. The syntax of Sign Language uses symbols to express different topics. We are using Sign Language in our project as a reference language because it is used everywhere across the whole world. The difference between English and SL (Sign Language) syntax is visible when communicating between SL speakers and SL non-speakers. The signs in SL include the flexion of various fingers, contact between the fingers, the motion of hands concerning each other, and also the finger. It is the primary language of many people who are deaf and dumb. The following are the signs used for alphabets in ASL:

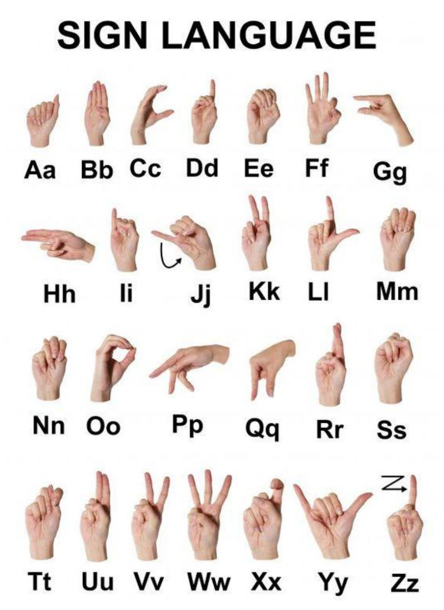


Fig3.10: Gestures in Sign Language

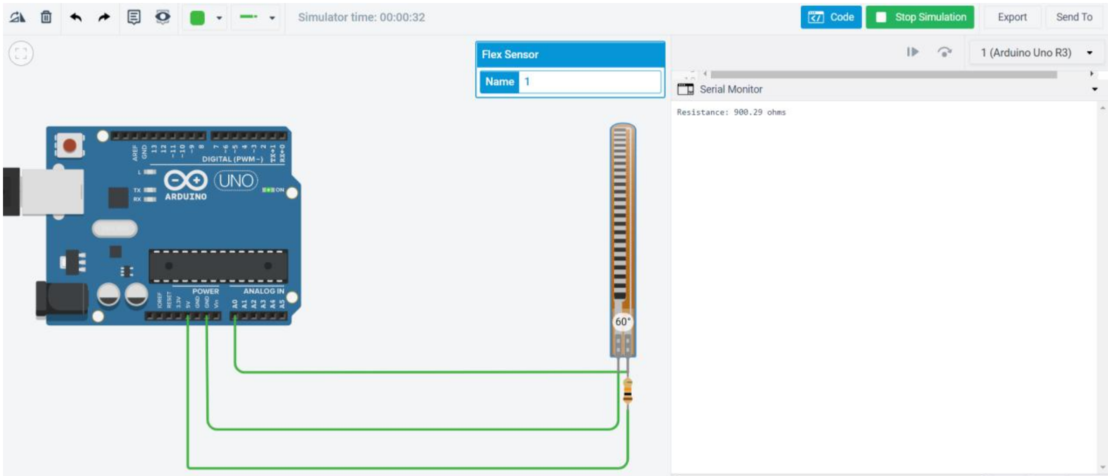
CHAPTER 4
RESULTS AND DISCUSSION

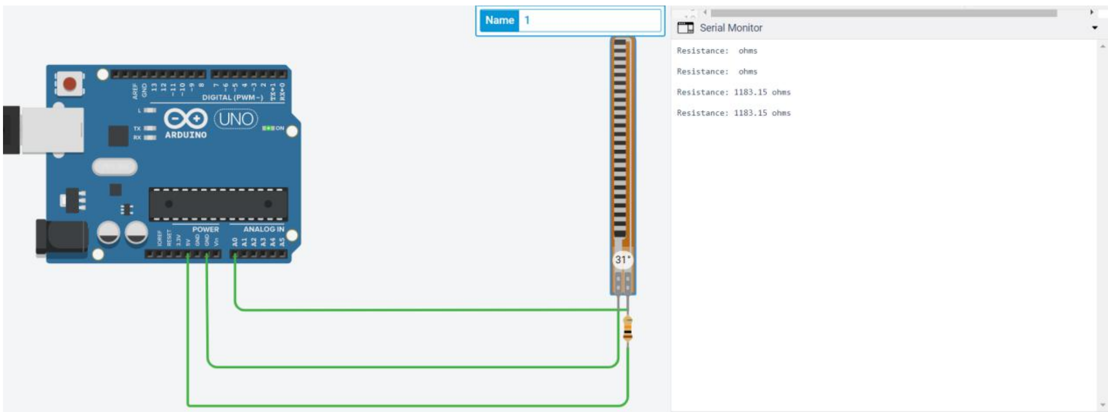
4.1 ACCOMPLISHMENTS

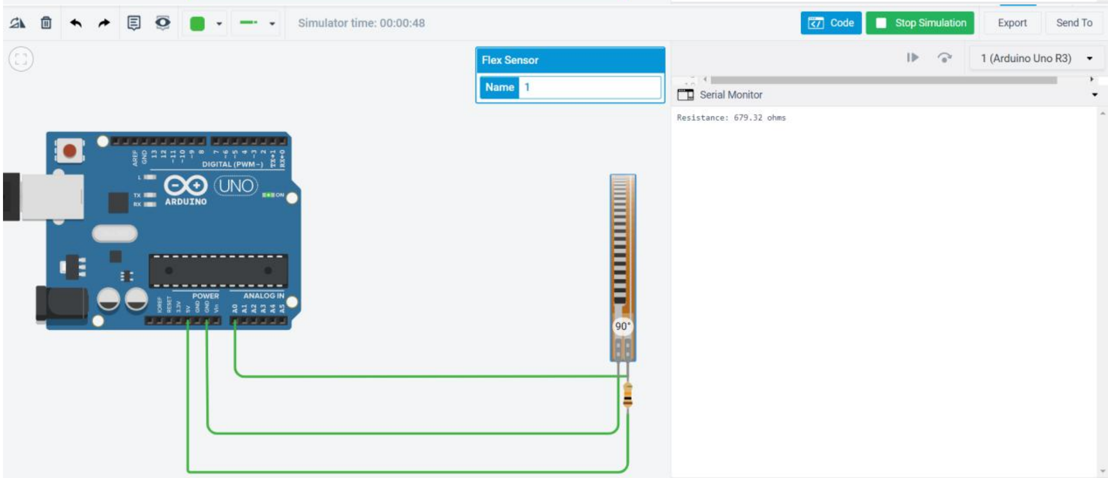
The device was successfully able to get the optimum amount of data from the flex sensors. We were able to successfully implement the algorithm written in embedded C language to check the gestures. We also calibrated the flex sensor raw values. We were able to interface the Arduino UNO with the Flex sensors.

We were efficiently able to detect and differentiate most of the gestures depending upon the angle of flex sensors

After dumping the code in the Arduino, run the code and start making signs. Outputs of a few signs that we have made are attached below When we calibrated the flex sensor values with the Arduino, we got the following resistance values for different angles







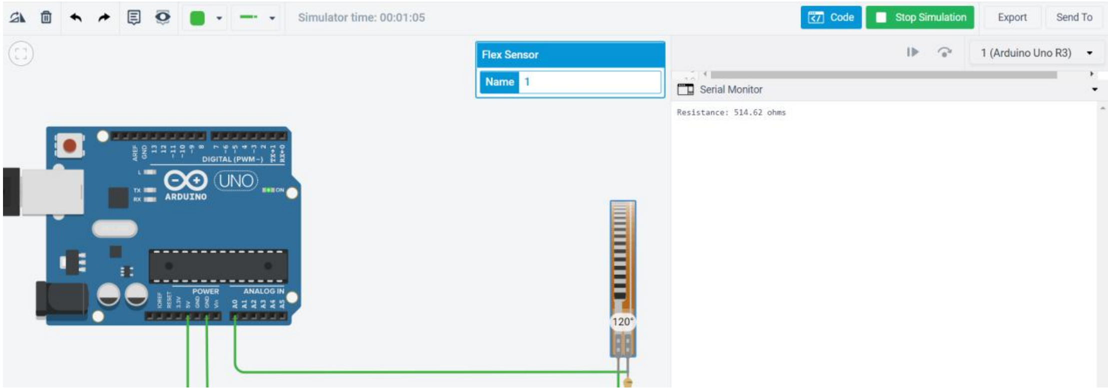


Fig 4.1 Calibaration Of Flexsensors

The accelerometer is used to measure the tilt in the angle. Connect the accelerometer with the Arduino UNO using male or male to female jumper wires. An accelerometer basically measures the acceleration along all three (X, Y & Z) axis. It also gives analog voltage output proportional to the acceleration measured along the axis. The Arduino converts these voltages into digital signals using ADC (Analog Digital Converter). After the connections are made, code the Arduino using Arduino IDE software and the formulae required to calculate and convert roll, pitch and yaw.

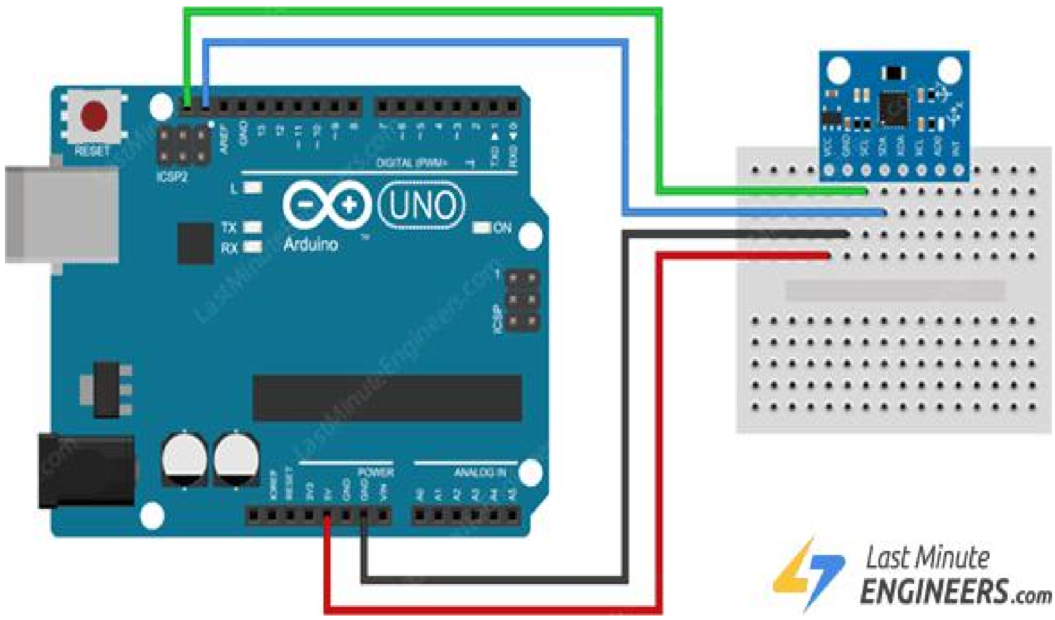


Fig 4.2 Interfacing mpu6050 with Arduino

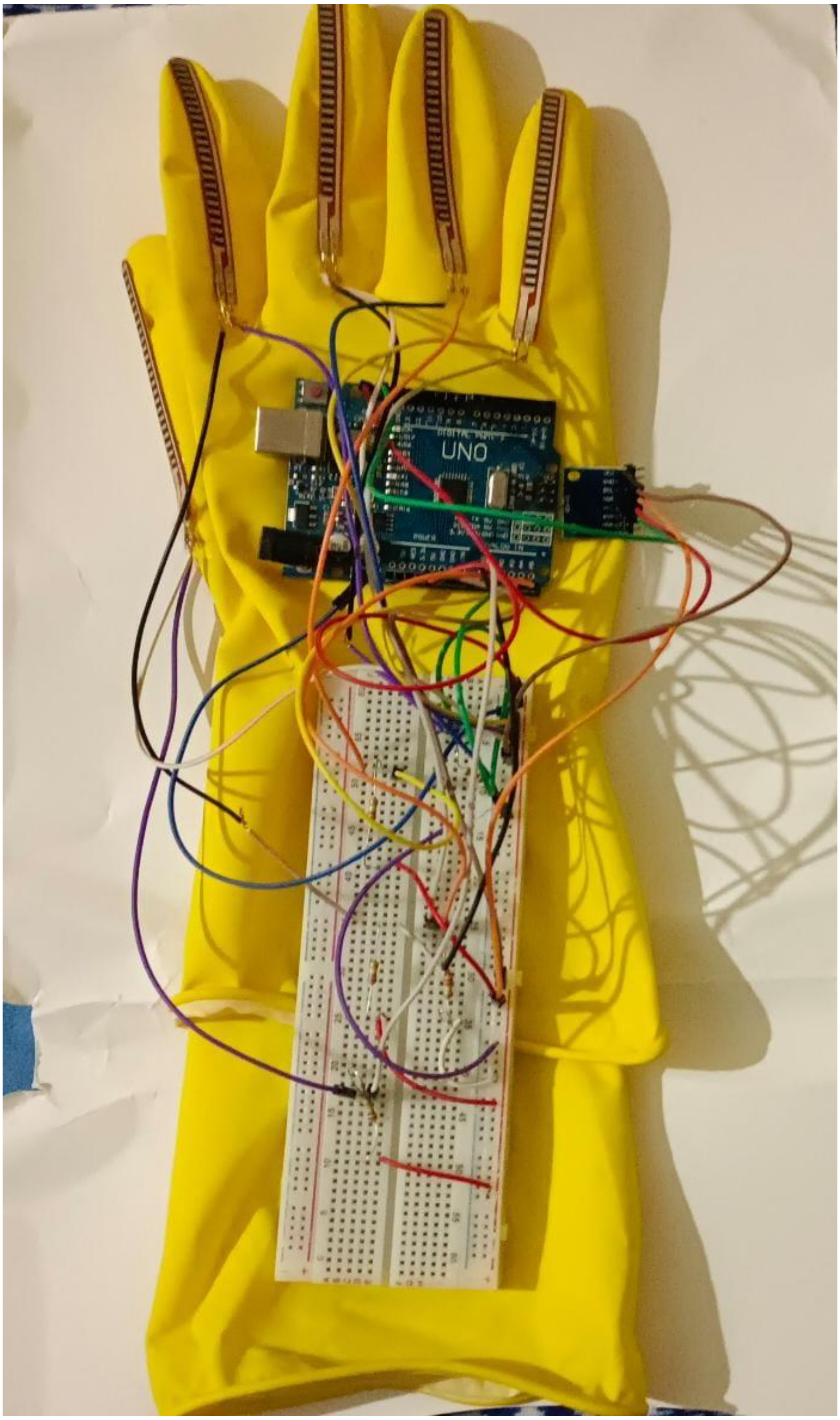


Fig 4.3 hardware implementation

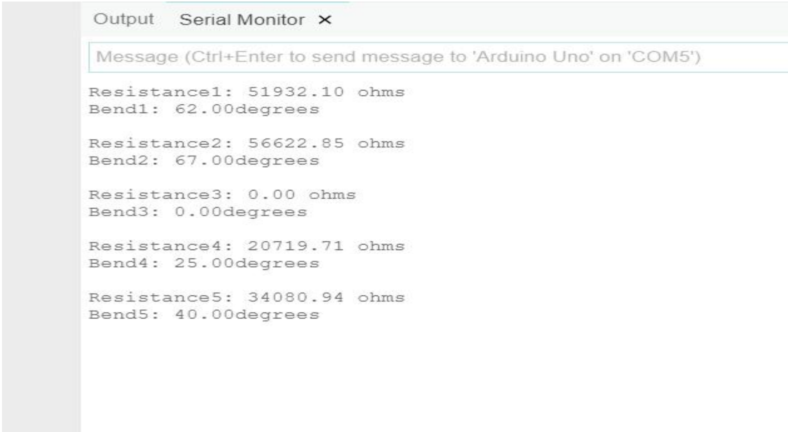


Fig 4.4 output

We were able to send some messages to the receiver without hardware components by using some information stored in the database

CHAPTER 5

5.1 Conclusion

In the project, we have used modern technologies and efficient algorithms to not just give a solution for the problem, but to make a whole system, where the communication barrier will be bridged in reality. At the end of the project, The user can use this device by just wearing it in his hand and he or she will be able to communicate with anyone efficiently. The glove is also cost-friendly and user-defined. This is the most efficient system for closing the communication gap of the mute and deaf society which will not only have a good impact on the personal life of a mute and deaf person but the whole socio-economic factors will see good progress.

5.2 Future Works

As of now, we have interfaced the flex sensors with Arduino. we have to interface the gyroscope and accelerometer with Arduino. We have to run the algorithm to get the output using the cloud. We can also make the device user-friendly by changing the algorithm and making our language. We wanted to make the glove in such a way that the user should be able to use it without the need for a smartphone. Also, we wanted to make two-way communication possible using Twilio.

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