Flex-O-Talk : An Embedded Wearable Tech Glove for Sign Language Interpretation

Varalatchoumy M[1], Sanjana Francis Xavier[2], Aishwarya A[3], Lumithra E[4], Meghana Mahajan[5]

[1] Associate Professor, *Department of Computer Science and Engineering, Cambridge Institute of Technology, Bengaluru, Karnataka, India*

[2,3,4,5] *UG Student, Department of Computer Science and Engineering, Cambridge Institute of Technology, Bengaluru, Karnataka, India*

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Abstract - Sign Language is a medium for communication for many physically challenged people. Availing oneself with sign language alone can have an impact in the communication between the disabled people and the rest of the world. Lack of understanding by the people without disabilities and environmental conditions such as darkness also affect communication when sign language is used. The sign language recognition is polymorphic including gesture controlled activities like human computer interaction, gesture controlled home appliances and other electronic devices and many applications whose operations are given as an input by the gesture. The most important practice of the product is it provides a communication aid for deaf, dumb and blind people. This hand sign gesture is converted to text and voice so as to develop a communication between normal and deaf and dumb people. The system converts sign language to text for deaf and dumb people to communicate with normal people and also to communicate with the blind people.

Key Words **:** Sign Language, disabled people, gesture, triggered input, communication, text, voice, American Sign Language.

1. INTRODUCTION

The project employs a novel method of recognizing sign language employed in an embedded hardware. The system is used for many applications including deaf, dumb and blind people communication. The project presents a new approach of recognizing hand sign that can be used by the deaf and dumb community to interact with the normal people. The system can also be used for many other applications including home automation, triggering audio systems in automobile etc. The system also includes an automatic speech recognition system. Normal people are completely unaware of the sign language that the deaf and dumb people use. Hence communication with them is not possible unless they took proper training to learn this sign language. Sign language recognition can be of two types based on the gestures used for communication. The gestures used for communication can be static or dynamic depending on the movement of dynamic hand gestures. Static signs are those with no motion. This provides only the 2-Dimensional information regarding the hand signs. Hence the sign language can be static hand poses or hand sign image. Mostly static symbols are shown to recognize alphabets and numbers. Dynamic gestures are shown corresponding to words that are either continuous string of alphabets or a gesture itself for a word. The sign language interpreter system developed is capable of recognizing the standard American Sign Language (ASL) symbols.

2. METHODOLOGY

The main methodology used is Gesture Identification and Conversion. The gesture performed is recognised and converted to their respective words. This is been implemented using these steps given below

2.1 Flex sensors Values

The gesture performed by the user is detected by the flex sensors and the corresponding angle values are noted.

2.2 Conversion to Analog

Once the angles values are notes the respective values are converted to analog values by implementing separate formulas for each.

2.3 Segmentation

Based on the gesture performed they are classified into static and dynamic gestures. Static gestures are 2-D gestures and Dynamic gestures are those gestures which require motion.

2.4 Pattern Matching

The segmented gestures are then matched with the gestures corresponding word that is provided in the database and the word is been sent in the further steps.

2.5 Displaying Text

The word that is been obtained after pattern matching is displayed on the LCD.

2.6 Audio

The corresponding text on the screen is been given out as an audio.

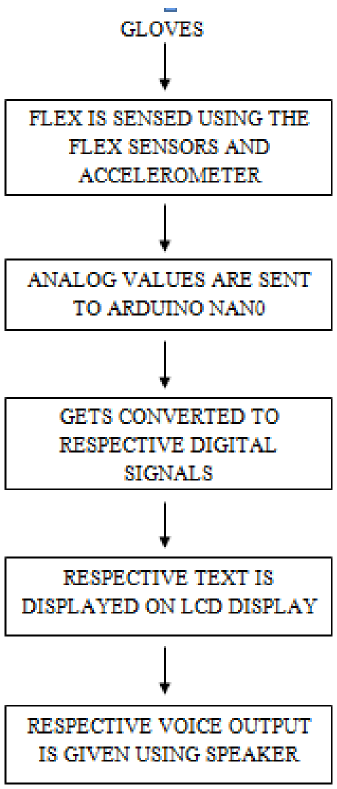

Fig-1 : Methodology

3. MODELLING

3.1 System Design:

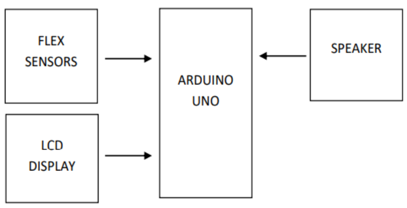

Fig-2: Architecture

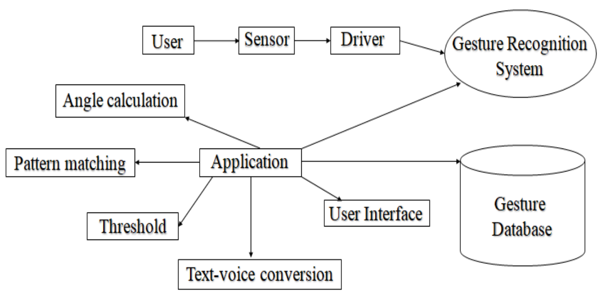

Fig-3: Block diagram

The user will perform the gesture. After that the sensor will accept the gesture, sense the gesture and send it to the driver. Driver acts as a translator between hardware device and application. In angle calculation the angle values are obtained by performing particular code and once the angle values are obtained pattern matching will be done.

Pattern matching (angle values) check the angle value with the threshold and once the data is matched with the threshold it'll take the gesture from the database and display on LCD.

Text and voice:-

The gesture will be converted into text and displayed on LCD from text it'll be converted into voice.

User interface, which is used for the interaction between the user and the application.

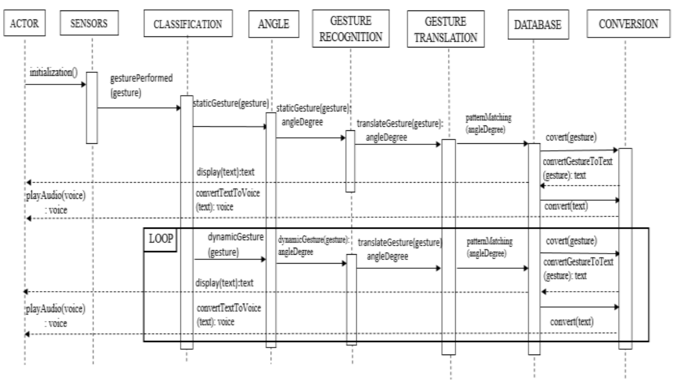

Fig-4: Sequence diagram

3.2 Hardware components:

3.2.1 : Arduino Nano:

The Arduino Nano is a breadboard friendly board based on the ATmega328P released together in 2008.It is a small and complete. It also offers the same connectivity and specifications of the Arduino UNO board whose form factor is smaller than UNO. It is equipped with 30 main I/O headers in a dip-like configuration, which can be programmed using the Arduino software integrated development environment (IDE), which is common to all Arduino boards and running both offline and online.

This board can be powered through a type-B micro-USB cable or through a 9V battery. In 2019, a pin equivalent evolution of the Nano was released known as the Arduino Nano Every. It's features were the most powerful ATmega4809 processor, and twice the RAM. Here, in this project it is used to integrate all components.

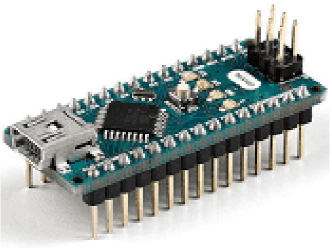

Fig-5: Arduino Nano

3.2.2 : Flex Sensor:

A flex sensor or also known as a bend sensor is a sensor that measures the amount of deflection or bending. The sensor is usually stuck to the surface, and resistance of sensor element is varied by bending the surface. It is also used as a goniometer since the resistance is directly proportional to the amount of bend and are often called as flexible potentiometer.

The different types of flex sensors are:

- Fibre optic flex sensor
- Conductive ink based flex sensor
- Capacitive flex sensor
- Velostat flex sensor (popular among hobbyists)

The type of flex sensor that is used here is Conductive ink based flex sensor, which is used to capture the angle values by the deflect of the sensor.

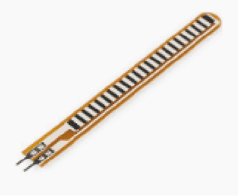

Fig-6: Flex Sensor

3.2.3 : ADXL345 Accelerometer:

An accelerometer is used to compute proper acceleration. The acceleration, that is the rate of change of velocity of the body in its own instantaneous rest frame is known as proper acceleration. This is different from coordinate acceleration, where coordinate acceleration is an acceleration in a fixed coordinate system. For instance, an accelerometer at rest on the surface of the Earth will measure an acceleration due to Earth's gravity, straight upwards of g~9.81 m/s2. Conversely, accelerometers falling toward the center of the Earth at a rate of about 9.81 m/s2 that is free fall, will measure zero.

They are also versatile in industries and science.

An accelerometer on a spring, is a damped mass, a proof mass. When it experiences an acceleration, the mass is moved to the point where the spring can push the mass at the same speed as the casing. The spring's compression computes the acceleration. The system is damped so that oscillations of the mass and spring do not affect the needed measurements. Because of the damping, the accelerometers always respond in different ways to different frequencies of acceleration. This is called the "frequency response".

The ADXL345 accelerometer is a small, 3-axis accelerometer which measures the static acceleration of gravity in tilt sensing application, as well as dynamic acceleration resulting from motion or shock. Power consumption is scaled automatically with bandwidth.

Fig-7: ADXL345 Accelerometer

3.2.4 : LCD Display:

A Liquid Crystal Display is a flat-panel display, that uses the light-modulating properties of liquid crystals which is integrated with polarizers. Liquid-crystals do not emit light directly, they either use backlight or a reflector to produce images in color or monochrome.

Before connecting the LCD screen to your Arduino board it is recommended to solder a pin header strip to the 14 or 16 pin count connector of the LCD screen. To lace your LCD screen to your Arduino board, connect the following pins:

LCD's RS pin to digital pin 12. LCD's enable pin to digital pin 11.

It displays 4 lines that displays 20 characters each. The characters is displayed in a 5x7 pixel matrix. This consists of two registers, namely-command and data. The LCD display displays the segmented gestures that are converted into text.

Fig-8: LCD Display

3.2.5 : Speaker

The Arduino creates tones of different frequencies and plays it through the speaker connected to it. The variation of the frequency in the tone , i.e. pitch, with correct timings, i.e. rhythm, creates music. The Arduino generates a signal and sends it to the digital pin 3. The speaker is used to obtaining the voice output that is converted from the text output.

Fig-9: Speaker

3.2.6: Glove:

The flex sensors are mounted on the fingers of the glove, the accelerometer is mounted on the palm or back of the palm, the Arduino nano, battery, speaker and LCD display are also mounted on top of the glove.

It is used by the user to perform the gestures.

Fig-10: Glove

3.2.7: 47K ohm Resistors:

The resistors utilized in this product are of 47K ohm resistance. The universally recognizable color code for this resistor is yellow, violet, orange, gold.

The resistor is of class carbon film. The maximum operating voltage for this resistor is 350V. These resistors are used for the fluctuating voltage values that are produced by the flex sensors when they are deflected while performing the gestures.

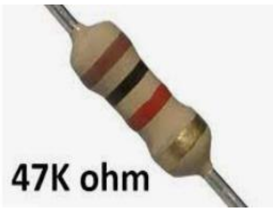

Fig-11: 47K ohm Resistors

3.2.8: Battery:

A battery is a power source consisting of one or more electrochemical cells with external connections for powering electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electricity, its positive terminal is considered as cathode and its negative terminal is considered as anode.

Primary batteries are used once and are later discarded, as the electrode materials are irreversibly changed during discharge. A common example are alkaline batteries used for flashlights and a multitude of portable devices. Secondary batteries can be discharged and can be recharged multiple times using an applied electric current. Example of this type includes the lead-acid battery..

Battery lifetime has two meanings for rechargeable batteries. For rechargeable, it means either the length of time a device can run on a fully charged battery or the number of charge/discharge cycles possible before the cells fail to finish the required task. For a non-rechargeable these lives are equal because the cells last for only one cycle by.

Here we have used primary batteries which is of 9V.

Fig-12: 9V Battery

3.3 Software requirements:

3.3.1 : Arduino IDE :

The Arduino Software (IDE) is an open-source software which makes it easy to program the code and upload it to the board. This software can be employed with any Arduino board.

There is also a beta 2.0 version of the software accessible. The software is still in beta status, which means that it’s almost complete but there might be minor issues that are to be rectified.

4. RESULTS AND DISCUSSION

4.1 :Dataset:

In this paper, datasets have been created and are used for evaluating the efficiency and effectiveness of the proposed method. This includes all the alphabets, numbers and few common words that are very much needed for communication.

4.2 :Analog values:

Each of the analog values obtained from the 5 flex sensors that are mounted on each finger of the glove worn by the user while performing the gesture is noted.

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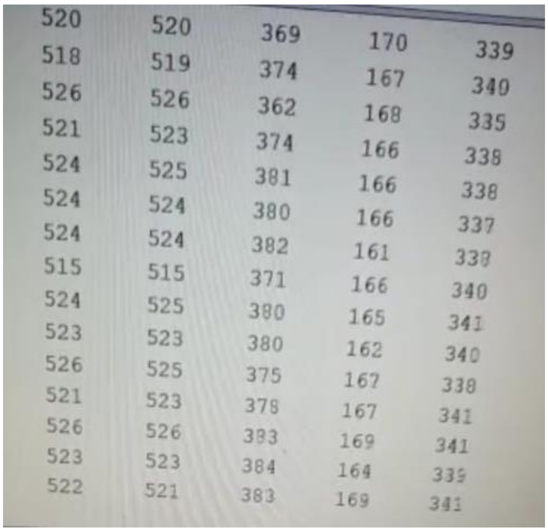


520	520	369	170	339
518	519	374	167	340
526	526	362	168	335
521	523	374	166	338
524	525	381	166	338
524	524	380	166	337
524	524	382	161	339
515	515	371	166	340
524	525	380	165	341
523	523	380	162	340
526	525	375	167	338
521	523	378	167	341
526	526	383	169	341
523	523	384	164	339
522	521	383	169	341

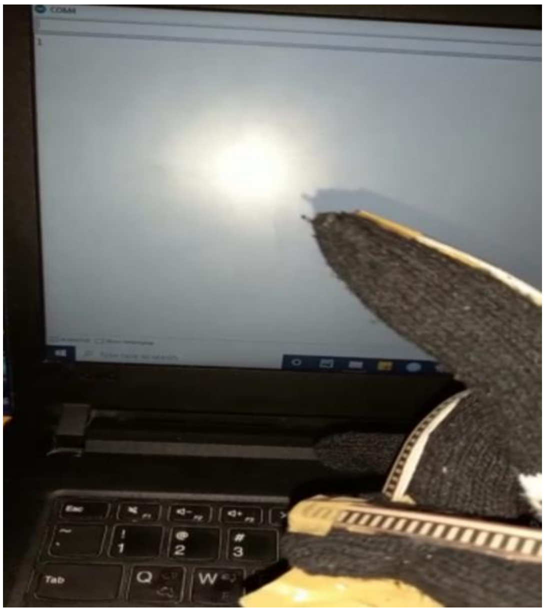
Fig-13: Analog values

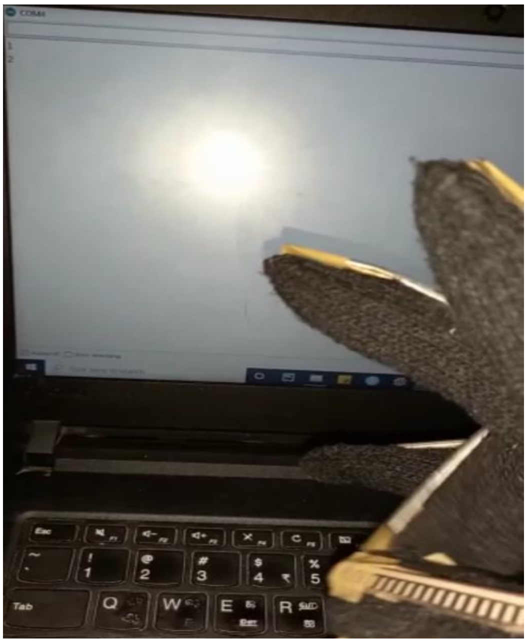
These are the analog values that are obtained from the flex sensor's which produced the angle's which are then sent to the Arduino nano which will process these values by implementing the required code on them.

The analog value undergo pattern matching with the database to convert the sign language performed into their respective alphabet, digit or word output.

4.3 :Text output on serial monitor:

After the segmentation and pattern matching process is complete, the respective words are displayed on the serial monitor for reference.





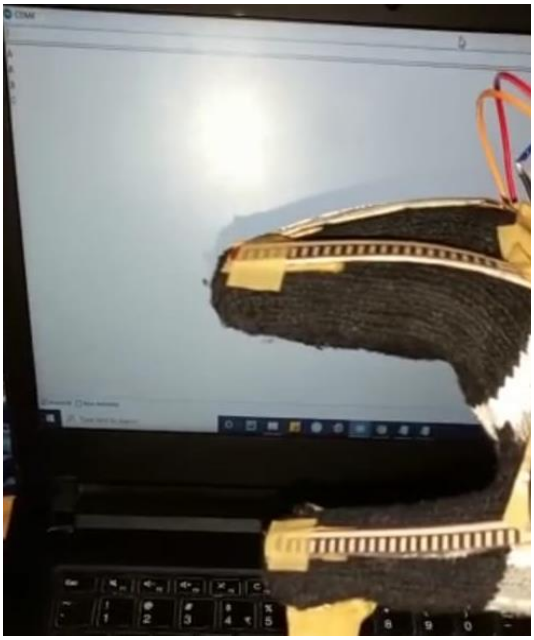


Fig-14: Recognized gestures

4.4 :Text and voice output:

When the user performs the gesture it is recognized and translated by the Arduino which is then displayed on the serial monitor. The values that are displayed on the serial monitor that is, Fig-14 is then displayed on the LCD display and at the same time gives the voice output from the speaker.

4.5: Final prototype of the product:

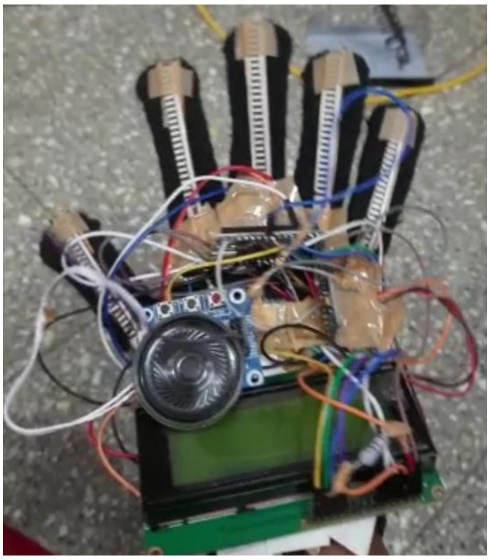


Fig-15: Final product

Discussion:

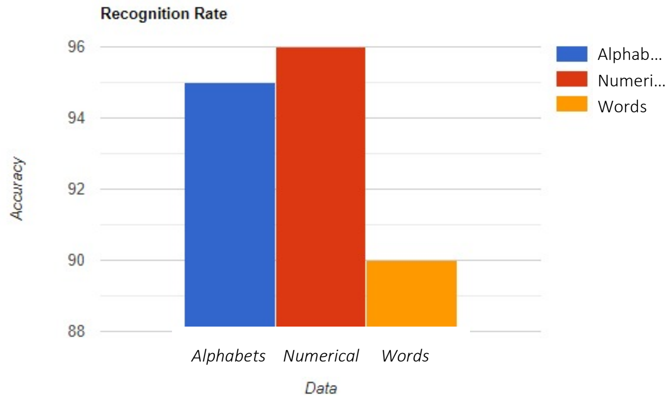


Fig-16: Recognition percentage

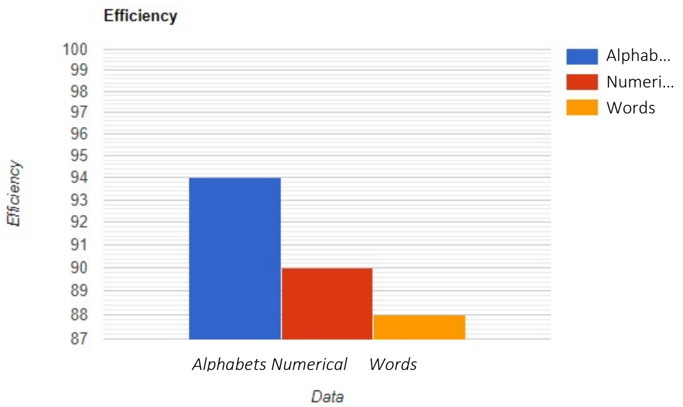


Fig-17: Efficiency percentage

5. CONCLUSION

To make a communication bridge of highly accurate, cost effective and an independent glove for deaf, dumb and blind community to enable them to communicate. Successfully designed and implemented a Sign Language Interpretation system that allows translation of single handed signs or gestures using sensors and Arduino. Provides a social compatibility to the user who is blind, speech and aurally challenged. Our hope is that this opens up an easy way for people who use sign language to communicate directly with non-signers without needing someone else to translate for them. The system can assist deaf and dumb people to convey their messages to normal people without the assistance of an interpreter. It also helps the dumb community to communicate with the blind. This system can be used for a variety of applications including assistance to deaf and mute people. The device can be used as a sign language learning aid. The system along with the application is capable of recognizing speech. Hence it can be used for many applications like gesture controlled robot for physically challenged, gesture controlled doors and vehicles, gesture controlled keyboard and mouse to interact with computer, gesture controlled appliances like air conditioner. The areas of application include Sign language for deaf and dumb, Controller less video gaming, Smart TV, Video surveillance, Human robot interaction, Biometrics.

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