FLEX SENSOR BASED GLOVE FOR DEAF AND DUMB PEOPLE

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ABSTRACT

Deaf and dumb individuals often face difficulties in communicating with general people who do not understand sign language. To address this issue, we present a flex sensor-based hand glove that recognizes and interprets hand gestures and translates them into text. In this report, we describe the design and development of the hand glove, including the hardware and software components used to implement the system. The hand glove is designed to be comfortable and easy to use. It is made from flexible and breathable materials that are ideal for prolonged wear. The flex sensors are placed strategically on the fingers to ensure accurate detection of finger movements. The hand glove uses flex sensors attached to the fingers, which detect the movements and flexion of the hand and fingers. The signals from the sensors are then transmitted to a microcontroller, which generates real-time feedback in the form of text output. The hand glove is able to recognize and interpret a wide range of hand gestures accurately and provide real-time text output, thereby improving communication for deaf and dumb individuals.

The Flex Sensor Based Hand Glove for Deaf and Dumb People has the potential to revolutionize the way in which people who are deaf and dumb communicate. It is a low-cost and accessible solution that can be used in a variety of sectors, including educational institutions, workplaces, and social gatherings. With this technology, people who are deaf and dumb can communicate more effectively and efficiently, thereby breaking down the barriers that limit their participation in society.

CCS CONCEPTS

• IoT• Hardware • Communication

KEYWORDS

IoT, Arduino UNO, FLEX Sensors, Bluetooth Module, Accelerometer, Sign Language, Mobile, LCD, Hand Glove

ACM Reference format:

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1 Introduction

Communication is a fundamental aspect of human interaction. Sign language is the only language used by individuals who are deaf and dumb. It is a visual language that uses a combination of hand gestures to convey meaning. In addition to hand gestures, sign languages also use facial expressions, head tilts, and body movements, to convey meaning. These markers can change the meaning of a sign or indicate a question, statement, or emotion. Sign language has been used by Deaf communities for centuries and has a rich history. The first attempt to document a standardized sign language was in the late 18^{th} century in France. It was done by a group of educators for the deaf and it was known as French Sign Language. Examples of sign language include American Sign Language (ASL) which is used in North America, British Sign Language(BSL) which is used in the United Kingdom and Australian Sign Language(AUSLAN) and Japanese Sign Language(JSL). There are many different sign languages around the world, each with its own unique signs and grammar. Despite technology growing rapidly, deaf and dumb people still use the same sign language to communicate with others. It is beneficial for them to communicate among themselves, but the problem arises when they want to communicate with ordinary people as the general people are not familiar with sign language and they do not understand it. The deaf and dumb people often experience significant difficulties in communicating with others who do not know sign language. Traditional methods of communication, such as writing or lip-reading, can be time-consuming, frustrating, and not always reliable. Address this issue, we have developed a flex sensor-based hand glove that recognizes and interprets hand gestures and translates them into text. The project involves several stages, including designing and fabricating the glove, programming the microcontroller to process the sensor data, and testing the glove for functionality and user-friendliness. The project also involves the usage of a mobile application to display the text generated by the receiver unit.

1.1 Problem Statement

Deaf and Dumb people lack social interaction due to several reasons. One of the main reasons they lack interaction is the communication barrier between them and normal people. The only language they use to communicate is sign language which can be understood by the deaf and dumb community people, but the problem here arises when they want to communicate with normal people. Because sign language cannot be understood by normal people, they feel insecure and don't try to communicate with the normal people and they feel socially isolated. They cannot share their feelings and opinions as normal people communicate daily and require some means of communication which can help them to stay socially connected with others.

2 Evaluation

2.1 Literature Survey

2.1.1 A real-time continuous gesture recognition system for sign language: In 1998, Liang and Ouhyoung presented their research in the Proceedings of the third IEEE international conference on autonomous face and gesture recognition.

A real-time system for continuous sign language gesture recognition is presented in the study.

The system comprises of a camera, a computer, and a digital signal processor.

The digital signal processor processes footage that is recorded by the camera of the user's hand motions in order to extract characteristics.

The hidden Markov model (HMM) based recognition system uses the characteristics as inputs and uses them to instantly detect the user's motions.

A broad range of sign language motions are recognized by the system.

For identifying 106 sign language motions made by 6 distinct users, the authors claim a recognition accuracy of 97.8%.

Real-time recognition of continuous phrases in sign language is possible.

Every move takes an average of 0.23 seconds to be recognized.

The device is a promising piece of technology that can help deaf individuals use sign language to communicate.

2.1.2 Sign Language Recognition Using Efficient Convolutional Networks and Extreme Learning Machines: Using 3D Convolutional Neural Networks (CNNs) with spatial and channel attention modules, the research suggests a novel method for detecting Korean Sign Language (KSL).

The suggested model uses a series of depth maps created from RGB-D recordings of hand motions in KSL as its input.

The model is made up of a number of 3D convolutional layers, which are followed by spatial and channel attention modules that let the model concentrate on key areas and characteristics in the input data.

The authors additionally solve the class imbalance issue in the KSL dataset by using a novel training technique known as "class-balanced loss."

The suggested model performs at the cutting edge on the KSL dataset, with a mean F1 score of 0.996 and a test set accuracy of 99.7%.

The performance of the suggested model on various subsets of the KSL dataset is evaluated by the authors through comprehensive tests, and it is compared to other cutting-edge approaches.

The results of the studies demonstrate that the suggested model performs better than previous approaches in terms of accuracy and F1 score, and it is also more resistant to changes in illumination, hand position, and camera angle.

The model can accurately identify the key areas in the input data, according to the authors' qualitative examination of the attention maps produced by the spatial and channel attention modules.

The suggested approach may be used to create assistive devices for those who have hearing loss and to improve human-computer interaction.

The study adds to the increasing body of knowledge on deep learning-based sign language recognition by showing how attention mechanisms and class-balanced loss may boost 3D CNN performance when it comes to identifying sign language movements.

2.1.3 A real-time hand gesture recognition approach based on motion features of feature points: The study was presented in New York at the 17th IEEE International Conference on Computational Science and Engineering.

The authors suggested a method for real-time hand gesture recognition that is based on feature point motion characteristics.

The three primary steps of the suggested method are feature point extraction, motion feature computation, and recognition using an SVM classifier.

Scale-invariant feature transform (SIFT) is used to extract the feature points from the hand area.

By following the feature points across frames and figuring out their optical flow, the motion features are computed.

A collection of user-generated hand gestures is used to train the SVM classifier.

The authors tested the suggested methodology using a dataset comprising 3000 hand gestures made by 20 users, and they were able to achieve an overall identification rate of 95.5%.

Two different hand gesture detection methods—one based on SIFT and SVM and the other on form context and SVM—were compared to the suggested method.

In terms of recognition accuracy and speed, the suggested strategy fared better than the other two alternatives.

The authors claim that their suggested method may be used in virtual reality, sign language recognition, and human-computer interaction.

2.1.4Hand Gesture Recognition System for Deaf and Dumb: Systems for recognizing hand gestures are being created to help those who have trouble speaking communicate.

Techniques for recognizing sign language can be either vision-based or not.

The glove-based, non-vision-based method detects and understands hand motions using sensors and a microprocessor.
The suggested technique includes building an artificial mouth and employs American Sign Language for communication.
The accurate smart glove is not impacted by magnetic, electric, or light fields.
Flex sensors, an accelerometer, an Arduino Nano serving as an A/D converter, a Raspberry Pi 3B+, an OLED display, and a speaker module are all used in the system.
The flex sensors provide distinct values for each created sign, which are then recorded in a database.
The microcontroller generates text on the OLED display and audio through the speaker module by comparing the values with the recorded values.
The system's brain, the Raspberry Pi 3B+, analyses data input and generates text and audio output.
The glove's accelerometer and flex sensors are included in the final prototype.

2.2 Existing System

There are now two types of gesture recognition methods, vision-based and non-vision-based. The vision-based solutions use markers and a web camera to identify signs. Whereas the signers' or users' gestures need to be identified and localized in image frames for gesture identification.
Here, the detection requires sufficient illumination in order to correctly record the gesture. The non-vision-based method, however, primarily makes use of electrical devices, particularly sensors.

3 Proposed System

We are proposing a non-vision based system which uses electronic devices like microcontroller board and other devices which are to be programmed in a language chosen based on the project requirement. By using of the flex sensors and the gyroscopic device the result will be produced when hand gesture is made in sign language and the output is shown on the lcd screen connected and programmed to the Arduino and along in the mobile phone connected to the Arduino using a Bluetooth device. This system will not require any illumination or any particular light to get the output and it does not need any capturing moments exactly for the result. It is easy to carry and has more accuracy.

4 HARDWARE COMPONENTS:

ARDUINO UNO:
A popular microcontroller board known as Arduino Uno is based on the ATmega328P microcontroller processor. It is an open-source electronics platform that enables you to connect numerous electrical components, including sensors, LEDs, motors, and displays, to build interactive projects.
The Arduino Uno board has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB port, a power connector, an ICSP header, and a reset button. The Arduino IDE (Integrated Development Environment), which is available for Windows, Mac, and Linux operating systems, may be used to program it.

PCB BOARD:
Printed circuit boards (PCBs) are flat boards having conductive pathways carved onto their surfaces. They are often constructed of non-conductive materials like fiberglass. Electronic components are supported physically and electrically by employing traces, pads, and other features carved from copper sheets bonded onto the substrate.
Computers, cellphones, and other electrical gadgets frequently employ PCBs. They contribute to a smaller, lighter gadget and a more straightforward production process.
A PCB is designed by drawing a schematic layout of the circuit, placing the components on the board, and then routing the traces to link the components in accordance with the schematic. Several processes, including etching, milling, and other techniques, can be used to create the completed board.

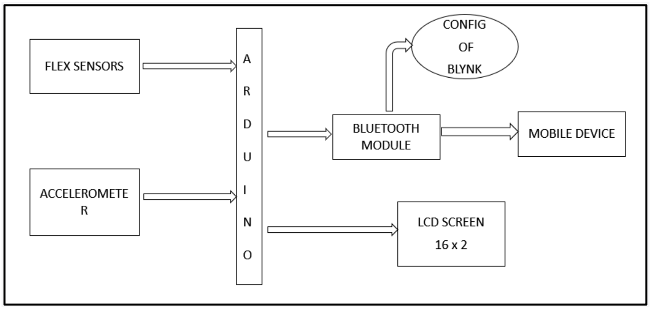
ACCELEROMETER MPU 6050:
To detect the angle of bend in the sensors, combine the MPU-6050 sensor with flex sensors.
The MPU-6050 offers 6-axis motion tracking, and the raw data generated from the device may be analyzed to determine the angle at which the flex sensors bend.
The MPU-6050 can detect motion and provide information on the degree of bend by connecting the flex sensors to a device's or wearable's moving components. This allows the wearer to control the gadget by moving while wearing it.
Motion-capturing gloves, smart fabrics, and gesture-controlled gadgets are just a few examples of the cutting-edge products that may be made with the MPU-6050 and flex sensors.

FLEX SENSORS:
A flex sensor is a sort of variable resistor that becomes more resistant when bent. Typically, these sensors are positioned on the fingers, and when a hand motion is made, the associated fingers bend, resulting in a specified resistance value. This resistance value, together with accelerometer measurements, is forwarded to the Arduino nano for additional processing.

LCD:
LCD screens may be linked to microcontrollers like the Arduino to show data and information in real time. The 16x2 and 20x4 character LCDs are popular Arduino LCD modules. It displays the text output of the Arduino.

BLUETOOTH MODULE:
A Bluetooth module may be added to a glove project that uses flex sensors to enable wireless communication between the glove and other gadgets like computers, tablets, and smartphones.
The data from the flex sensor may be remotely transferred to other devices by pairing the Bluetooth module with a microcontroller like an Arduino, providing real-time monitoring and control.

Block Diagram:



5 Design & Analysis

Five flex sensors are attached to the glove, each for a finger in such a way that they measure the degree of bending of each finger. The glove should be light weight and should integrate all sensors in it. When signs are made with fingers to communicate, the sensors will measure the bend values and those values are stored.

The microcontroller such as Arduino Board should be attached to the glove and all flex sensors are connected to the Arduino. The Arduino board should accurately analyze the data from the flex sensors, and it should give the correct output.

An accelerometer is installed along with the sensors to make sure that the values are measured accurately when the hand movement or rotation is done.

A small LCD screen of size (16 x 2) and a Bluetooth hc-05 module are also connected to the Arduino board. The output value generated by the Arduino board are displayed using lcd screen and the Bluetooth module helps to display those values in the connected mobile device.

All the components and the board are integrated and soldered so the glove can be easily used.

A software program code is written to program the Arduino board with the other components that are used in this project and made sure that the program recognizes correct hand gestures and displays the correct output.

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6 Implementation

6.1 Flex sensor:

In our project five flex sensors are used (one for a finger) to record the change value given by the sensor when the appropriate signs are made and this change is compared to the stored data in the code, When the value is matched with the compared data then the text coded for the sign is displayed.

The flex sensor produces the pressure values in resistance(ohms) when the bend is made, so to convert this resistance into corresponding voltage value the resistors are used. Resistors will create a voltage-divider circuit and convert the resistance values into voltage because the voltage units are preferred when connected to the microcontroller board.

The flex sensors are programmed using Arduino programming language which then further connected to Arduino UNO board.

6.2 CONNECTIONS:

- Connections are made using jumper wires.
- One end of flex sensor has voltage-divider circuit which has three connections:
- First connection is given to the analog pins(Analog to digital converter) in Arduino.
- From that connection is given to the resistor
- From the other end of the resistor the connection goes to GND pin in Arduino
- The other end of flex sensor is connected to +5V pin in Arduino.

6.2.1 Accelerometer and Gyroscope (MPU – 6050):

In our project we are using accelerometer to measure the direction of hand and to get the accurate values. This will eliminate the overlapping issue of flex sensors.

Calibration means adjusting its sensor readings to compensate for any inherent biases or errors. This helps in improving the readability and accuracy in sensor values. The calibration helps in mainly removing the offset error or g-bias error. When the sensor is placed on a flat surface which is not moving then the offsets should be zero or close to zero, if not it is known as offset error. By doing the calibration we can achieve this.

6.2.2 Connecting accelerometer to Arduino:

- First the accelerometer should be calibrated depend on the project requirement and sensitivity settings should be adjusted to give the values accurately.
- After calibration the accelerometer is connected to the Arduino and programmed based on the requirements.

6.2.3 Accelerometer has 4 pins:

- GND: Connected to the GND pin on Arduino board. To stabilize the voltage input given to the Arduino board we will use a common GND pin for maximum hardware devices.
- VCC: Connected to +5V pin on Arduino board. This pin is used to give the power supply to the device connected.
- SCL: Connected to A5 pin on Arduino board. The SCL pin generates a clock to synchronize the data process between the board and the device. The clock pulses on the SCL line determine the timing of data bits on the SDA line. The SCL line is controlled by the device acting as the master on the bus.

- SDA: Connected to A4 pin on Arduino board. Responsible for receiving and transmit the data between the Arduino and the device. Devices connected to the bus take turns using the SDA line to transmit or receive data.

After giving connections, based on signs the acceleration values are being measured and coded accordingly to get the desired output.

6.3 LCD 16X2 with I2C Interface:

Refers to liquid crystal display that has 16-character and 2-line configuration and uses the I2C (Inter-Integrated Circuit) communication protocol for interfacing with microcontrollers or other devices. The use of this device is to show the output which is getting from the sensors.

6.3.1 Connections with Arduino:

- GND: Connected to the GND pin on Arduino board. To stabilize the voltage input given to the Arduino board we will use a common GND pin for maximum hardware devices.
- VCC: Connected to +5V pin on Arduino board. This pin is used to give the power supply to the device connected.
- SCL: Connected to A5 pin on Arduino board. The SCL pin generates a clock to synchronize the data process between the board and the device. The clock pulses on the SCL line determine the timing of data bits on the SDA line. The SCL line is controlled by the device acting as the master on the bus.
- SDA: Connected to A4 pin on Arduino board. Responsible for receiving and transmitting the data between the Arduino and the device. Devices connected to the bus take turns using the SDA line to transmit or receive data.

6.4 Bluetooth Module HC-05:

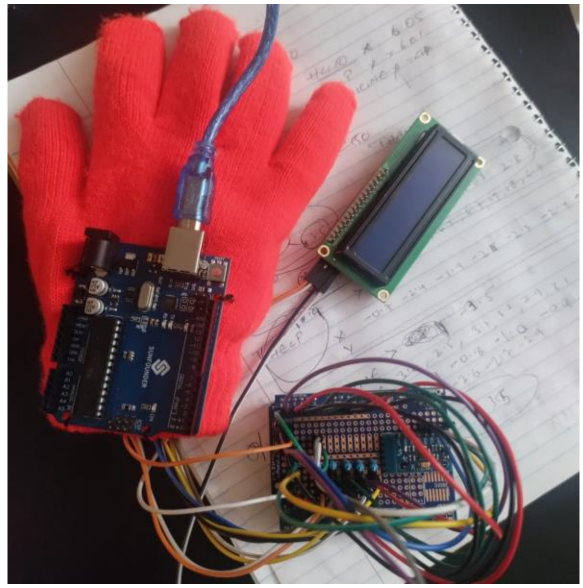
This module enables wireless communication to connect with devices like mobile phones and other wireless devices. The HC-05 module is based on Bluetooth 2.0+EDR (Enhanced Data Rate) technology, which supports both the Classic Bluetooth and Enhanced Data Rate modes. Used as an output device to connect with phone and display the output text in that mobile with an application. Programmed in Arduino and used a third-party application.

Connections with Arduino:

- RXD: Connected to the TXD pin on Arduino board. The receiver in the Bluetooth device will receive any data transmitted from the Arduino board.
- TXD: Connected to RXD pin on Arduino board. The transmitter in the Bluetooth device will transmit the data to the Arduino board.
- GND: Connected to the GND pin on Arduino board. To stabilize the voltage input given to the Arduino board we will use a common GND pin for maximum hardware devices.
- VCC: Connected to +5V pin on Arduino board. This pin is used to give the power supply to the device connected.

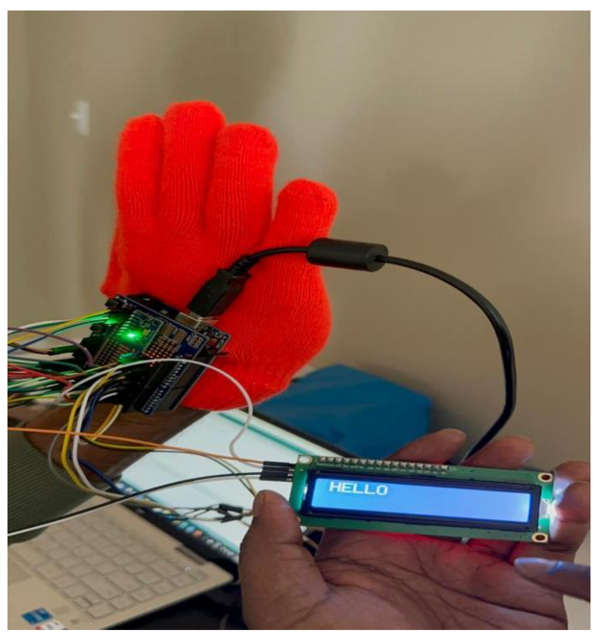
7 RESULTS:

Below is the **physical prototype** of our project flex sensors are inserted into each finger inside the glove.



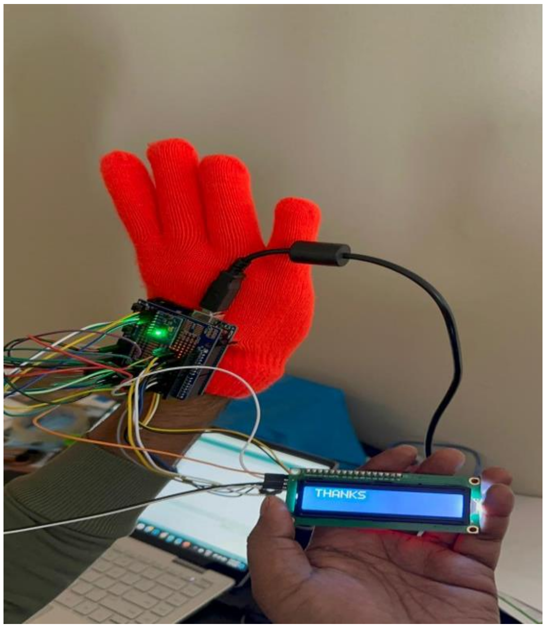
Output sample 1:

Below is the symbol for **Hello** in sign language the output is displayed on the LCD.



Output Sample2:

Below symbol indicates Thanks in sign language which is displayed by using LCD screen.



8 TEAM MEMBERS ROLES AND RESPONSIBILITIES:

- Every team member has specific roles but the implementation and execution of the project is done by the team together.
- Vinay Gaddagolla: Installing the flex sensors and assembling circuit on UNO circuit board.
- Pranay Bhargav Yegolam: Writing the code for the flex sensors using Arduino programming language in IDE.
- Bheem Reddy Gopanpally: Bluetooth circuitry and the mobile application and LCD Monitor integration with Arduino board.
- Mary Spoorthy Allam: end-to-end application testing.

9 CONCLUSION:

We were successful in creating an effective gesture detection system that facilitates communication and makes it more user- and budget-friendly. Flex sensors can successfully and precisely translate ASL to text and voice when used with an accelerometer, an A/D converter, and an Arduino UNO. An extremely practical wearable that is not only effective but also comfortable to use in daily life is created by putting these sensors on a glove. Between dumb and deaf people and hearing people, it offers an effective means of communication. It gives these folks more voice and enables them to communicate more effectively.

It is clear that while the creation of our prototype benefited from the use of existing techniques, the introduction of new technologies will undoubtedly have a significant influence in this area.

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