Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 4, No. 6, April : 2024

ENHANCING COMMUNICATION ACCESSIBILITY THROUGH GESTURE VOCALIZATION

Vishant M. Lokhande, Department of Information Technology, Vidyalankar Institute of Technology, Mumbai, India
Avdhut Bashte, Department of Information Technology, Vidyalankar Institute of Technology, Mumbai, India
Prahlad Varma, Department of Information Technology, Vidyalankar Institute of Technology, Mumbai, India
Ajitkumar Khachane, Associate Professor, Department of Information Technology, Vidyalankar Institute of Technology, Mumbai, India

Abstract
This paper depicts a new approach for the facilitation of the deaf or speech-impaired people communication capability. Our intended research investigates the development of a Gesture Vocalizer system which is powered by wireless data gloves that contain flex sensors. These sensors capture hand movements, which are then converted into audible speech, and thus it becomes possible to communicate with hearing persons. The ultimate objective is to bridge the communication gap and help the voiceless access the latest technology through our project. Our research includes detailed testing and development aimed at demonstrating the possibility of the Gesture Vocalizer improving environments in which inclusivity is desirable and the interactions are smooth.

Keywords:
Gesture, Sign Language, Smart Glove, Flex Sensor, Bluetooth, Accelerometer.

I. INTRODUCTION

Speech is the primary tool of effective communication that helps people share their thoughts and feelings. However, it can be limiting for persons with speech impairments. An alternative medium is sign language yet this comes with difficulties such as complexity and risk of miscommunication.
To prevent miscommunication, we have made a sign to speech converter. The project enables a communication between a mute, deaf and dumb person and to a person who cannot understand sign language. The purpose of our mission is to make sure the flow of information between sign language users and those who do not know it is uninterrupted. In this assignment, flex sensors are involved that indicate finger bending or deflection movement. These sensors are very similar to goniometers that come with the ability to change resistance when bent.
With the help of flex sensors, our project converts sign language gestures into spoken words by developing a mechanism that facilitates communication for all. In addition, the converted output is displayed on a hand-held device, which somewhere helps communication between both parties.
Flex sensors respond to finger movements by bending with the finger. The sensor's resistance increasing to the degree of bending. Therefore, significant finger movements lead to more resistance levels.

II. LITERATURE REVIEW

Over the years, countless hours of research and numerous efforts have been put together to solve the communication gap between the deaf, dumb, and normal people. Here, we provide a summary of the previous research to improve the smart gloves by using a variety of technologies.
"A Glove-Based Gesture Recognition System for Vietnamese and American Sign Language" by Lam T Phil, Hung D. Nguyen2, T.T. Quyen Suil, Thang T. Vul: In this paper, a glove-based system for Vietnamese sign language gesture recognition is proposed. Finger curvature and hand motion have been detected, respectively, using flex sensors and accelerometers. For American Sign Language,

contact sensors have been used in addition to flex and accelerometers to detect any contact between two fingers. [1]
"Data Glove with a Force Sensor" by Tarchanidis, K. N., & Lygouras, J. N.: This paper presents a data glove equipped with a force sensor. The glove, made of rubber-coated cotton, can detect finger positions and the force applied by fingers, offering potential applications in robotics, biomechanics, and virtual reality. [2]
"A Static Hand Gesture Recognition Based on Local Contour Sequence" by A. Julka and S. Bhargava: This paper presents a system that recognizes static gestures from American Sign Language (ASL) using a data glove. The system is primarily database-oriented and works offline. The goal is to recognize most of the static characters from ASL with high accuracy. [3]
"Hand Gesture recognition System for Speech Impaired People: A Review" by Jadhav A J and Joshi M P: This paper discusses the importance of gestures in daily human activities and the role of gesture recognition in human-machine interfaces. The paper emphasizes the challenges faced by speech and hearing-impaired people in expressing themselves and how sign language, a well-structured code gesture, is their only means of communication. The authors propose a system that translates sign language into sound, using flex sensors and an accelerometer to sense hand gestures. [4]
"Smart Speaking Glove for Deaf and Dumb" by P. Mohan, M. Mohan Raj, M. Kathirvel, P. A. Kasthurirngan, S. Musharaff, T. Nirmal Kumar: This paper introduces a smart hand glove designed to help physically disabled people communicate. The glove can convert hand gestures into text or pre-recorded voice, enabling a normal person to understand what a mute person is trying to say. The glove also has home appliance control functionality, which can help a physically impaired person live independently. [5]

III. PROPOSED SYSTEM

Throughout the years, people have made many attempts to deal with the problems of the communication failure between people with muteness, deafness, or speech impendence and the rest of the society. For instance, translating exact motions has proved challenging. Previous speaking devices for the deaf and the mute were based on microcontrollers.
In the process of making our system, we discovered that the resistance value from flex sensors changes very easily even if only a minor change occurs in the sensor length. The Arduino Nano based system uses a Veroboard in our design helps in making the system compact and allows the backup and restoration of codes simple.

A. Planning of the Project

The project is to implement a sign to text/ speech converter using Flex Sensors (5), HC-05 module, Arduino Nano, 1k ohm resistors and MPU6050 (accelerometer). The flex sensors are placed on the surface that will continue to increase the resistance level as the finger bends further, from the initial position. The sensors detect the movements and sends a signal to the Arduino Nano which then reads it, converts it into analog signals and transmits them through the HC-05 module to the phone app which is linked to the system and displays the trained text for a particular sign.

B. Working of the Project

The project works on the bending strip principle which states that the resistance of a strip will change when it is twisted and serves as a foundation for the flex sensors. The flex sensors have variable resistance that varies with different angles. For example, the resistance offered by the material at the angle of 300 degrees would be substantially different from that at an angle of 800 degrees. The measured resistance helps us to train a sign using the Arduino Nano. The output of the flex sensors combined with the output of MPU6050 helps us in training various types of signs easily. The combined output of the flex sensors and MPU6050 is converted by the Arduino into analog signals which are transmitted using HC-05 module to the connected system and displays the text. The MPU6050 module has built-in motion processing algorithms which combines data from the 3-axis accelerometer and 3-axis gyroscope. This simplifies the motion tracking and orientation of the developed smart glove.

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 4, No. 6, April : 2024

C. Block Diagram and Flow Chart

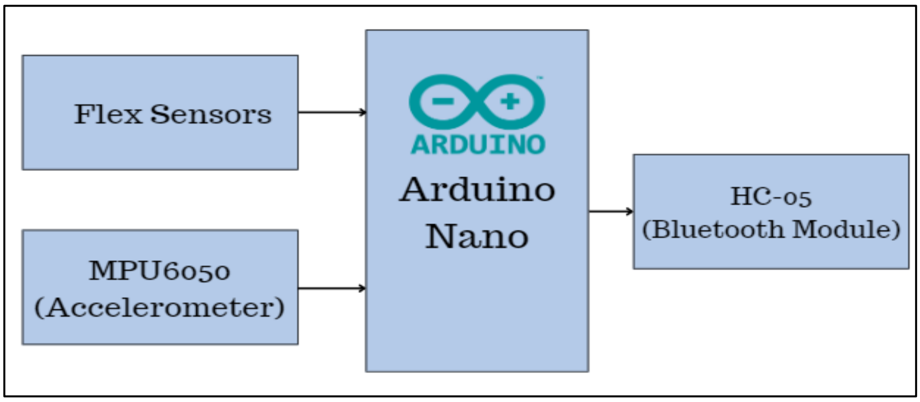

Fig. 1.1: Block Diagram of the Proposed System

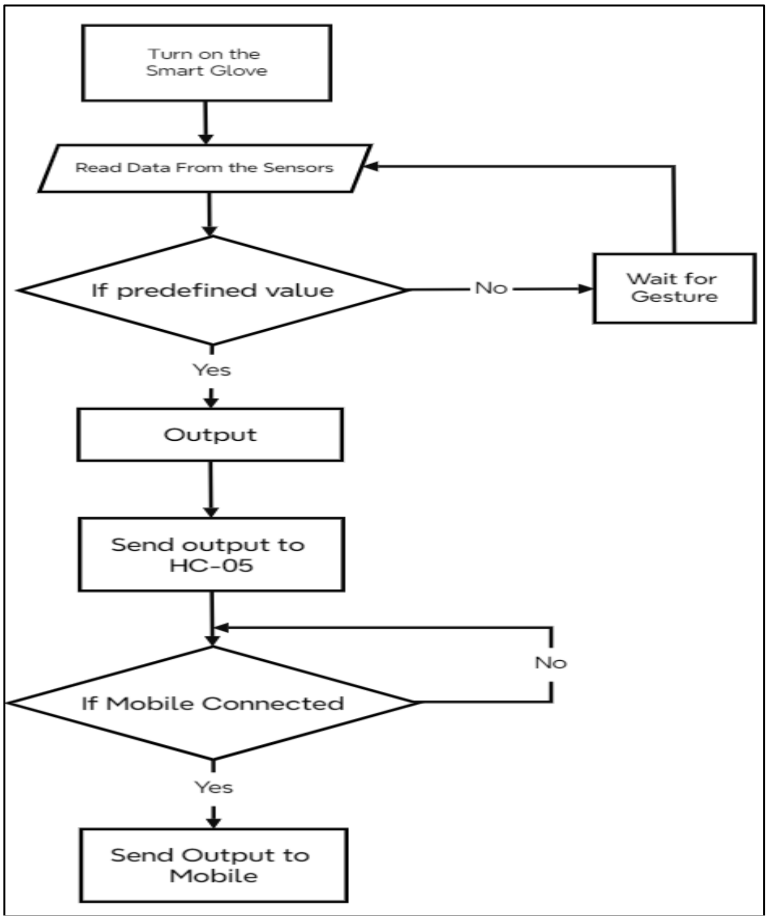

Fig. 1.2: Flow Chart of the smart Glove

IV. HARDWARE IMPLEMENTATION OF THE PROJECT

All the components used to build the project are mounted on the sensor board. The components required on the sensor board are:

1. Flex Sensors
2. MPU6050 (Accelerometer)
3. Bluetooth Module (HC-05)
4. Resistors
5. Arduino Nano

A. Flex Sensors

A flex sensor, also known as a bend sensor is a device that measures the amount of deflection or bending. They function as easy-to-use variable resistors. When the sensors are flat, its resistance is at the lowest. However, when the sensors are bend at an angle of 90 degrees the resistance of the sensors reaches its peak value. The output of the flex sensor is linked to the analog pin input on an Arduino. The bending action, which changes the bend, is translated into an electrical resistance value. As the bend increases, so does the resistance value. These thin strips, whose resistance varies, come in lengths ranging from 1 to 4 inches. Both unidirectional and bidirectional versions of these sensors are available.

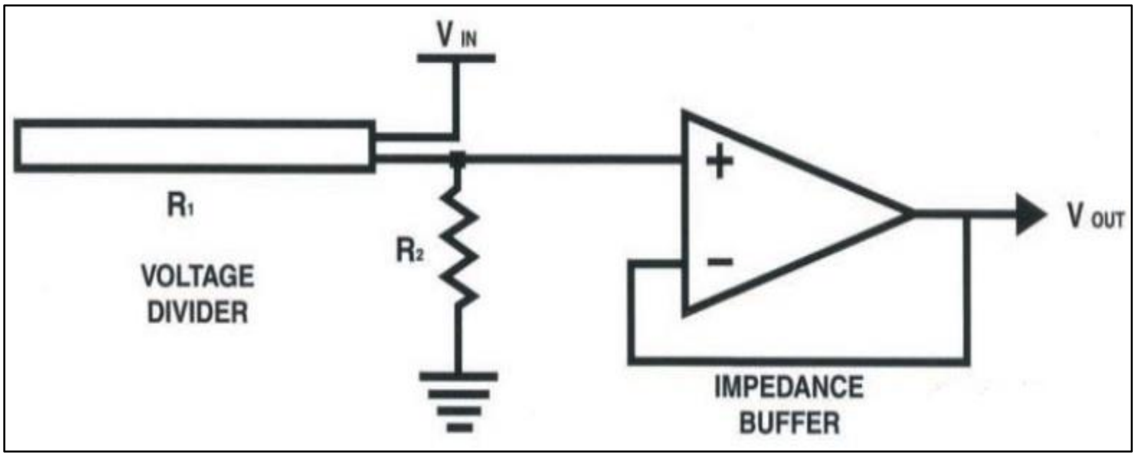

Fig. 1.3: Circuit Diagram of a Flex Sensor

B. Accelerometer (MPU6050)

The Accelerometer is a Micro-Electro-Mechanical System (MEMS) device that includes 3-axis accelerometer and a 3-axis gyroscope. It measures acceleration, velocity, orientation, and other motion related parameters. The sensor operates on power supply of 3-5V and communicates via the I^2C protocol.

C. Bluetooth Module (HC-05)

The HC-05 module is used for communication in the Bluetooth Spectrum. It operates on a power supply of 4-6V and communicates via the Serial Port Protocol (SSP), making it easy to interface with microcontrollers. The module supports various baud rates and operates in Master, Slave or Master/Slave mode. It is typically used to full-duplex wireless functionalities to projects, enabling communication between two microcontrollers or between a microcontroller and a Bluetooth enabled device.

D. Arduino Nano

The Arduino Nano is a compact, breadboard-friendly microcontroller board based on the ATmega328P. It offers the same connectivity and specs as the Arduino Uno but in a smaller form factor. It lacks a DC power jack and works with a Mini-B USB cable instead of a standard one. The Nano is programmed using the Arduino Software (IDE), making it flexible for a wide variety of applications

V. SOFTWARE IMPLEMENTATION OF THE PROJECT

The Arduino IDE is an open-source software used for writing, compiling, and uploading code to Arduino boards, including the Arduino Nano. It supports the Serial Port Protocol (SPP) and includes a serial monitor for faster data input. The IDE also has two LEDs per circuit that flash when data is sent through USB. It allows for full customization of microcontrollers using the C and C++ programming languages. The Arduino IDE can be installed on various operating systems and also offers an online version.

VI. CONNECTIONS AND CIRCUIT DIAGRAM

The data from the flex sensors and accelerometer is processed by the Arduino Nano and the Arduino Nano sends the processed data as output to the HC-05 module which sends the final output to the mobile. The flex sensors are connected to the Arduino Nano using 1k ohm resistors. This helps in improving the accuracy of the flex sensors and to avoid garbage value from the sensors. The flex sensors are connected to the analog pins A0, A1, A2, A3, A4 of the Arduino Nano. The accelerometer's SDA and SCL pins are connected to the A4 and A5 pins because of the I2C communication. The Bluetooth module's transmitter and receiver pins are connected to the Arduino's transmitter and receiver pins, respectively.

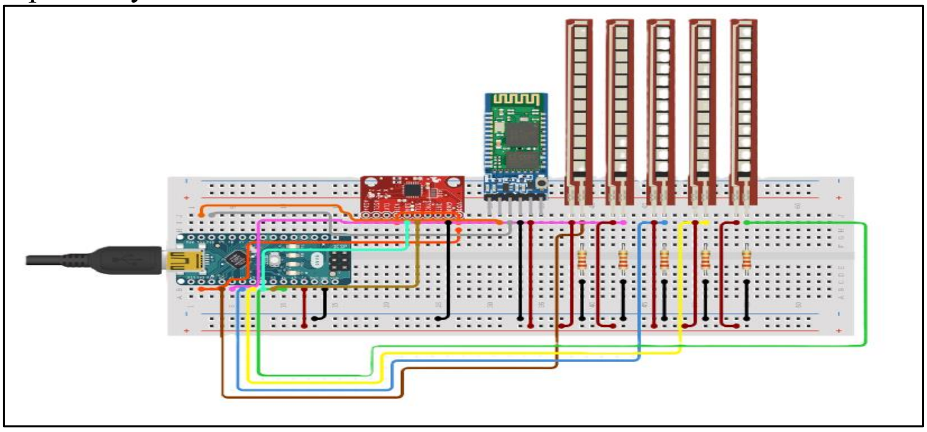

Fig. 1.3: Circuit Diagram of the Proposed System
(Note: The actual system was built using a Veroboard)

VII. CONCLUSION

Gesture Vocalizers represent a major advancement in facilitating communication between individuals who are deaf or mute and normal people. The system and algorithm we have developed and put into practice are instrumental in interpreting sign language. This algorithm is capable of identifying and authenticating the gestures performed by the user, and then providing an accurate response.
This technology not only aids in understanding sign language but also plays a crucial role in fostering inclusivity and breaking down communication barriers. It allows for more seamless interaction and understanding, thereby enhancing the quality of communication and interaction between different groups of people.
Looking ahead, users will have the opportunity to program their own gestures and integrate personal voice assistants such as Google Assistant or Alexa. This will facilitate basic home automation and a personalized user experience. The incorporation of Deep Learning Algorithms can assist in gesture recognition and user experience personalization.
Another potential development could be the creation of a wristband linked to smart rings. This device would be capable of detecting the user's gestures and hand movements, and then producing a predefined response or personalized response. The system could also be designed to operate a wheelchair using the movement of the hands and to control home appliances using personalized gestures. These advancements would further enhance the system's ability to facilitate communication and interaction, paving for a more inclusive future.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the faculty members of the Department of Information Technology, Vidyalankar Institute of Technology.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Lam T. Phil, Hung D. Nguyen2, T.T. Quyen Suil, Thang T. Vul. "A Glove-Based Gesture Recognition System for Vietnamese and American Sign Language," 2015 15th International Conference on Control, Automation and Systems (ICCAS), Busan, South Korea,2015.
[2] Tarchanidis, K. N., & Lygouras, J. N. (2003). Data glove with a force sensor. IEEE Transactions on Instrumentation and Measurement, 52(3), 984-989.
[3] A. Julka, S. Bhargava "A Static Hand Gesture Recognition Based on Local Contour Sequence", International Journal of Advanced Research in Computer Science and Software Engineering, vol. 3, no 7, 2013, pp. 918-924.
[4] Jadhav, A. J., & Joshi, M. P. (2016). Hand Gesture recognition System for Speech Impaired People: A Review. International Research Journal of Engineering and Technology (IRJET), 3(7), 1171-1175.
[5] Mohan, P., Raj, M. M., Kathirvel, M., Kasthurirngan, P. A., Musharaff, S., & Kumar, T. N. (2020). Smart Speaking Glove for Deaf and Dumb. International Journal of Engineering Research & Technology (IJERT), NCFTET – 2020 (Volume 8 – Issue 06).
[6] Tameemsultana, S., & Saranya, N. K. (2011). Implementation of Head and Finger Movement Based Automatic Wheel Chair. Bonfring International Journal of Power Systems and Integrated Circuits, 1(December), 48-51.
[7] Manandhar, S. et al. (2022). Gesture Vocalizer for Deaf and Dumb. International Journal of Engineering Research & Technology (IJERT).
[8] Palsule, R. P., Bomdre, R. R., Attar, M. I., & Kapase, N. B. (2021). Hand Gesture Vocalizer for Deaf and Mute People. International Journal of Scientific Development and Research (IJSDR).
[9] Harivardhagini, S. (2022). A Novel Approach to Vocalize the Hand Gesture Movement for Speech Disabled. CVR Journal of Science and Technology.
[10] Ail, S., Chauhan, B., Dabhi, H., Darji, V., & Bandi, Y. (2020). Hand Gesture-Based Vocalizer for the Speech Impaired. In: Vasudevan, H., Gajic, Z., Deshmukh, A. (eds) Proceedings of International Conference on Wireless Communication.