WEARABLE COMMUNICATION AID FOR PHYSICALLY HANDICAPPED PEOPLE USING HAND GESTURES

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ABSTRACT

Wearable Communication Aid for Physically Handicapped Using Hand Gestures is an assistive communication solution designed to help individuals with speech impairments express their thoughts through intuitive hand movements. The proposed system translates predefined hand gestures into audible speech using embedded electronics and sensor-based gesture recognition. An Arduino microcontroller acts as the core processing unit, interfacing with flex sensors mounted on a glove to capture finger movements, along with MEMS and IR sensors to detect hand orientation and motion. The sensed data is analyzed in real time and mapped to corresponding voice messages stored in an APR33A3 voice module. This portable and user-friendly device offers an effective means of communication for mute individuals, enhancing social interaction and independence in daily activities.

Keywords: Hand Gesture Recognition, Assistive Communication System, Voice Output Module, Arduino-Based Embedded System, Wearable Technology

I. INTRODUCTION

Effective communication is indispensable for social interaction, personal expression, and active participation in society. Individuals who are mute or suffer from severe speech impairments often encounter substantial obstacles in conveying their thoughts, needs, and emotions. This can lead to feelings of frustration, isolation, and a diminished quality of life. While various assistive communication technologies exist, many are characterized by high costs, complex operation, or a lack of adaptability to diverse communication contexts. This project seeks to address this critical need by developing and implementing a low-cost, user-friendly, and adaptable speaking system specifically designed for mute individuals, utilizing the Raspberry Pi Pico microcontroller as its core component.

The fundamental concept underlying this system is the translation of non-verbal cues and environmental interactions into both audible speech and visual information. By integrating a combination of sensor technologies, the system aims to offer a more comprehensive and contextually relevant communication solution compared to systems that rely on a single input method. The flex sensor is employed to detect bending or flexing movements, which can be associated with various gestures or body movements. The MEMS ADXL335 accelerometer is utilized to interpret specific hand movements, orientations, or changes in motion, providing another layer of gestural communication. The infrared (IR) sensor is incorporated to respond to proximity or the presence of objects, enabling the system to be triggered by environmental cues or intentional actions.

When any of these sensors is activated in a predefined manner, the Raspberry Pi Pico processes the incoming signal and triggers the APR33A3 voice playback module to play a corresponding pre-recorded message. Simultaneously, the I2C LCD provides immediate visual feedback, displaying information related to the triggered message or the specific sensor that initiated the action. The selection of the Raspberry Pi Pico is driven by its numerous advantages, including its affordability, compact form factor, low power consumption, and powerful processing capabilities.

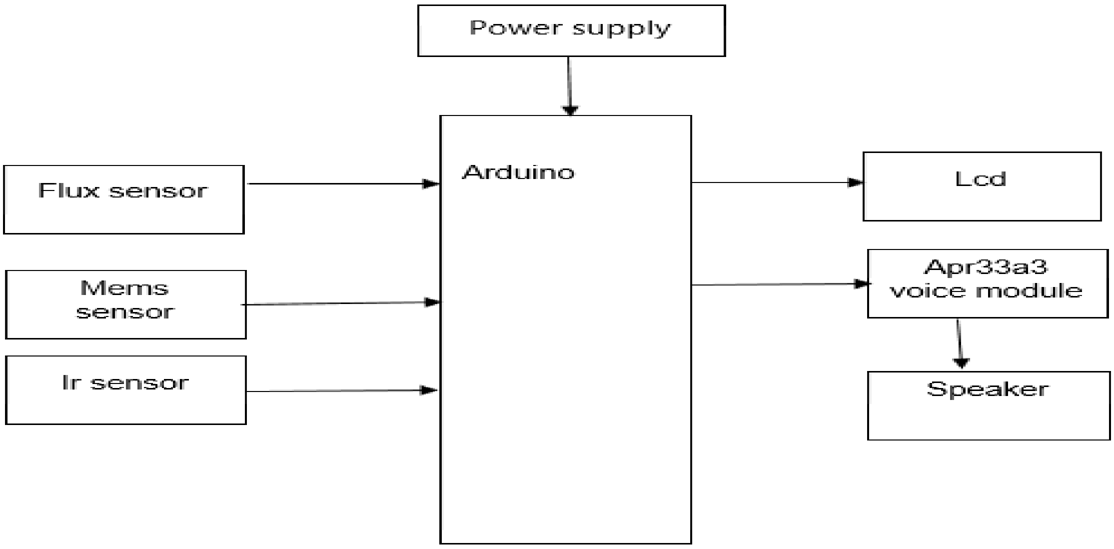
II. LITERATURE SURVEY

Safayet Ahmed; Rafiqul Islam [1]: Motivation of this project is to help the speech impaired communities by developing an electronic speaking system. Arduino is main control unit for this system. Arduino was programmed in such way that configuration settings can readily change without changing the entire program code. B. G. Lee and S. M. Lee [2]: Gesturing is an instinctive way of communication to present a specific meaning or intent. In this paper, sign language interpretation system using a wearable hand glove is proposed. This wearable system uses five flex-sensors, two pressure sensors, and a threeaxis inertial motion sensor to differentiate the characters in the American Sign Language alphabet. P Vijayalakshmi; M Aarthi [3]: The aim behind this work is to develop a system for recognizing the sign language, which provides communication between people with speech impairment and normal people, thereby reducing the communication gap between them. Jinsu Kunjumon; Rajesh Kannan Megalingam[4]: The proposed system will recognize Indian Sign language and convert it into speech and text in 2 languages English and Malayalam and display it on Android phone. T. Shanableh[5]: for recognizing isolated Arabic sign language gestures in a user independent mode. In this method the signers wore gloves to simplify the process of segmenting out the hands of the signer via colour segmentation. The effectiveness of the proposed user-independent feature extraction scheme was assessed by two different classification techniques; namely, K-NN and polynomial networks. Many researchers utilized special devices to recognize the Sign Language. Byung - woo min et al.,[6]: presented the visual recognition of static gesture or dynamic gesture, in which recognized hand gestures obtained from the visual images on a 2D image plane, without any external devices. Gestures were spotted by a task specific state transition based on natural human articulation.

III. PROPOSED METHOD

The proposed system is a wearable, sensor-based communication aid designed to translate hand gestures into real-time audible speech, enabling mute individuals to communicate effectively without external assistance. The system is built around a smart glove embedded with multiple sensors, including flex sensors to detect finger bending, MEMS sensors to capture hand orientation and motion, and IR sensors to enhance gesture accuracy by identifying specific finger positions and movements. These sensors continuously generate analog signals corresponding to different hand gestures, which are then fed into an Arduino Uno for processing. The microcontroller analyzes the incoming sensor data and compares it with predefined gesture patterns stored in its program memory. Once a gesture is recognized, the system triggers the corresponding voice output using an APR33A3 voice module, which stores pre-recorded speech messages. The selected audio message is then played through a connected speaker, allowing the user’s intended message to be heard clearly in real time. Simultaneously, an LCD display provides visual feedback by showing the recognized gesture or corresponding text, ensuring confirmation and reducing communication errors. The entire system is powered by a regulated 12V power supply, ensuring stable operation and portability. By eliminating the need for cameras or complex image processing, the proposed model reduces computational requirements, cost, and latency, making it a practical, efficient, and user-friendly solution for assisting speech-impaired individuals in daily communication scenarios.

Finally, the proposed wearable system proves to be an efficient and practical solution for converting hand gestures into real-time speech, enabling better communication for mute individuals. With its simple design, low cost, and reliable performance using an Arduino Uno and APR33A3 voice module, it is well-suited for everyday use, while also offering scope for future enhancements.



IV. SYSYEM ARCHITECTURE AND COMPONENTS

1. System Overview:

The system is a wearable glove-based communication device that converts hand gestures into speech in real time. It uses flex, MEMS, and IR sensors to detect finger movements and hand orientation, which are processed by an Arduino Uno. The recognized gesture is then matched with stored commands, and the corresponding audio is played through an APR33A3 voice module and speaker. An LCD display provides visual feedback, making the system simple, portable, and effective for helping mute individuals communicate.

2. Core Components:

i) Arduino:

Acts as the main controller of the system. It processes sensor inputs, recognizes gestures, and controls the output devices.

ii) Flex Sensor:

Detect bending of fingers. The resistance changes based on finger movement, allowing gesture identification.

iii) MEMS Sensor:

Measures hand orientation and motion (tilt and acceleration), improving gesture accuracy.

iv) IR Sensor:

Help in detecting finger positions and proximity, enhancing precision in gesture recognition.

v) APR33A3 Voice Module:

Stores pre-recorded voice messages and plays the appropriate audio based on detected gestures.

vi) Speaker:

Outputs the audio message corresponding to the recognized gesture.

vii) LCD Display:

Shows the identified gesture or message for visual confirmation.

viii) Power Supply:

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 04 | April - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

Provides stable power to all components, ensuring smooth system operation.

3. Software Initialization:

The system software is developed using Embedded C in the Arduino IDE. Embedded C is used to write the program that reads sensor data, processes hand gestures, and controls the overall system. The Arduino Uno executes this program, compares sensor inputs with predefined values, and triggers the APR33A3 voice module and LCD display. This ensures real-time gesture recognition and smooth communication between hardware components.

V. RESULT

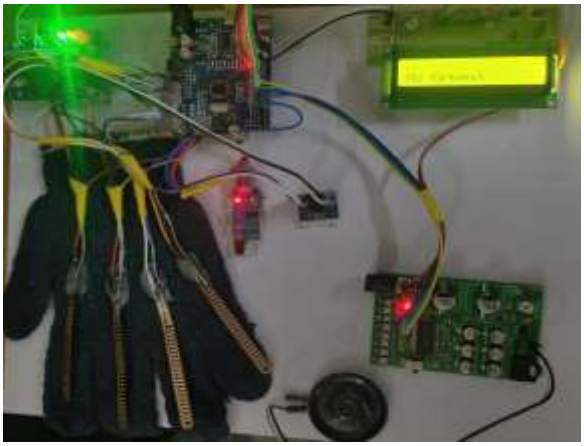


Fig: Prototype of Wearable Gesture

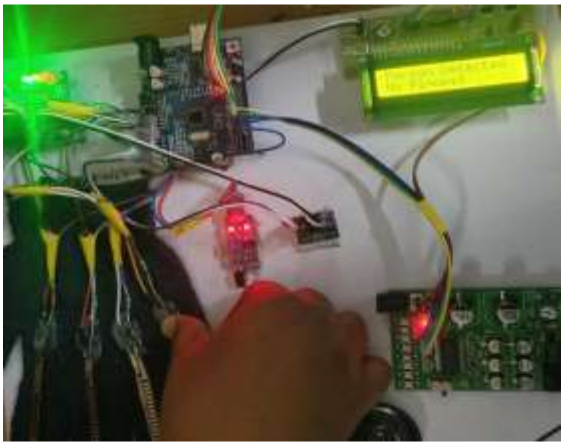


Fig: Person Detected

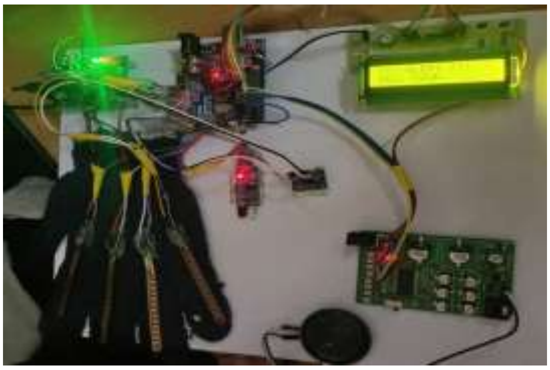
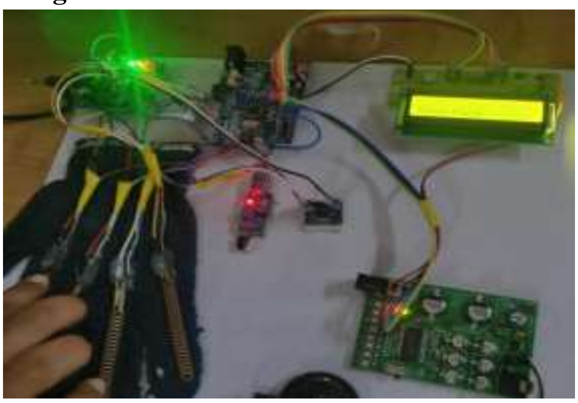


Fig: Fell Down Alert



International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 04 | April - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

Fig: Need Food

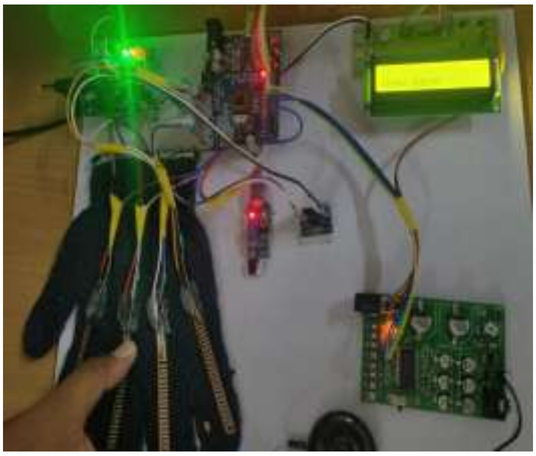


Fig: Need Water

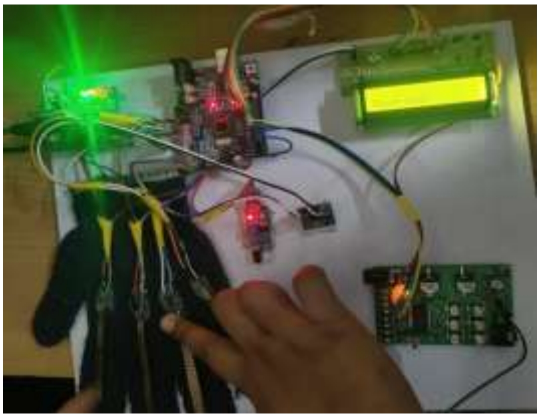


Fig: Need Walk

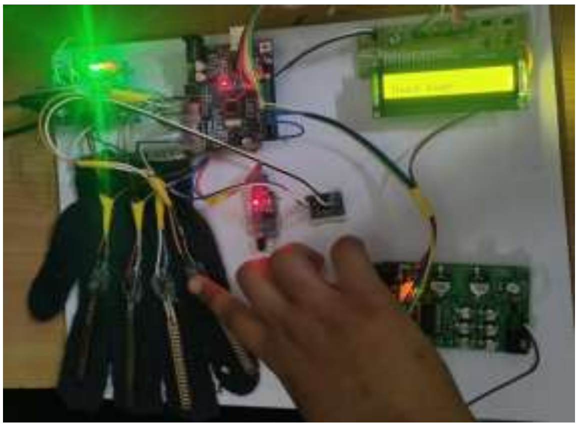


Fig: Need Water

VI. CONCLUSION

The project successfully demonstrates a wearable, sensor-based communication system that converts hand gestures into real-time speech, improving interaction for mute individuals. By using sensors with an Arduino Uno and APR33A3 voice module, the system achieves accurate, fast, and reliable performance without complex setups. It is cost-effective, portable, and suitable for everyday use, while also offering scope for future enhancements like advanced gesture recognition and compact design improvements.

VII. REFERENCES

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