Project presentation on

“Gesture-to-Speech System for Enhanced Communication Among Deaf and Mute Individuals”

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Introduction

In today's world, communication is essential for everyone, but deaf and mute individuals often face challenges due to limited understanding of sign language by others. Traditional methods require interpreters or prior knowledge of gestures. To solve this problem, we developed a real-time, wearable system that converts hand gestures into both speech and text using simple sensors and a microcontroller. Our solution is cost-effective, portable, and removes the communication barrier between deaf-mute and hearing individuals.

Problem Statement

- Deaf and mute individuals rely on sign language, which most people cannot understand.
- This creates a communication barrier in daily life and especially in emergency situations.
- Existing solutions are:
  - Expensive or complex
  - Dependent on mobile apps or PCs
  - Lacking real-time voice output
- There is a need for a low-cost, wearable system that works independently.
- Additional Need: Emergency Support
- In emergencies, users must be able to send alerts quickly.
- Existing gesture systems lack emergency communication features.
- Our system integrates Twilio API to send emergency SMS alerts when a specific gesture is detected.

Solution

- We created a wearable device (glove)
- It detects hand gestures using sensors
- Converts gestures into text (OLED) and speech (speaker)
- It’s low-cost, real-time, and user-friendly
- Also Support Emergency Support

Literature Survey

Author	Study Year	Algorithms/Techniques Used	Limitations Identified	Improvement in Our Project
S. Patel et al.	2020	Flex sensors + Arduino + Android app	Required mobile device, lacked speech output	Standalone system with direct text and voice output
A. Kumar et al.	2021	ML-based CNN for gesture recognition	High processing power needed, not suitable for real-time on hardware	Used simple rule-based logic suitable for embedded ESP32
M. Sharma et al.	2022	Hand gesture glove with Bluetooth to PC	Required external PC, no voice output	Fully wearable and includes built-in voice output
R. Joshi et al.	2023	AI-based hand sign translation using camera	Depended on camera and background lighting	Used sensors for reliable gesture capture in all lighting conditions
N. Deshmukh et al.	2024	DNN-based smart glove system	Complex training and deployment, expensive setup	Simple, low-cost hardware with predefined gesture mapping

Algorithms/Techniques Used

- No AI or ML used
- Used a rule-based approach
- Each gesture is identified using fixed threshold values from flex sensors and accelerometer
- Mapped gestures to words and audio manually
- Emergency gesture triggers:

  Twilio API to send SMS alert

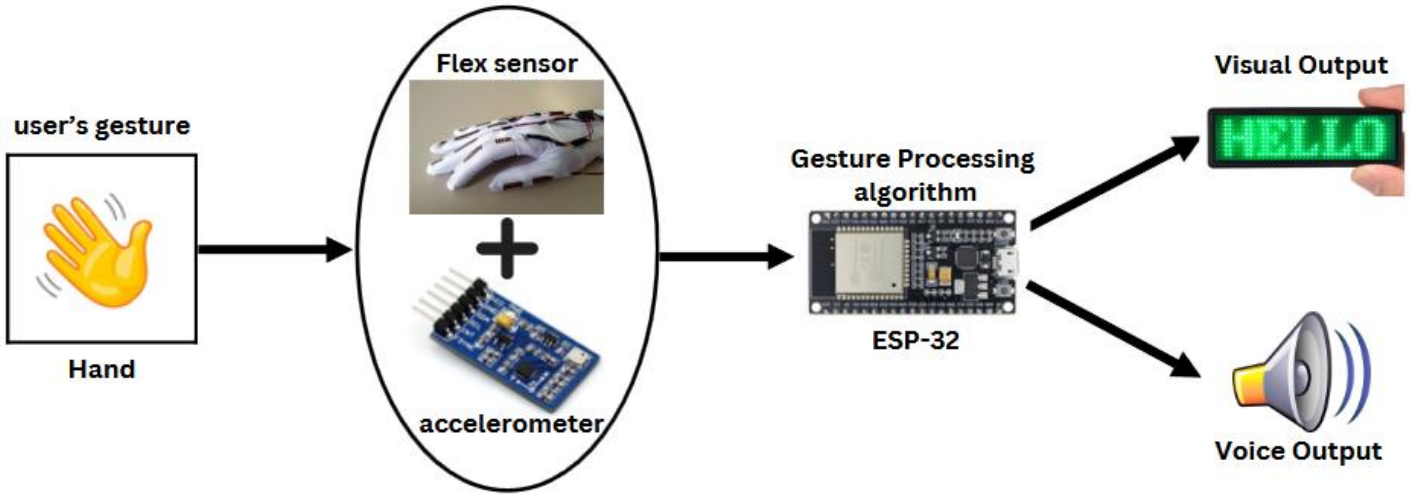
Modules Split-up

- Input Unit: Flex sensors + ADXL335 (captures finger and hand movements)
- Processing Unit: ESP32 microcontroller (detects gesture using logic)
- Output Unit: OLED display (text) + Speaker (voice)

Software Tools/Techniques

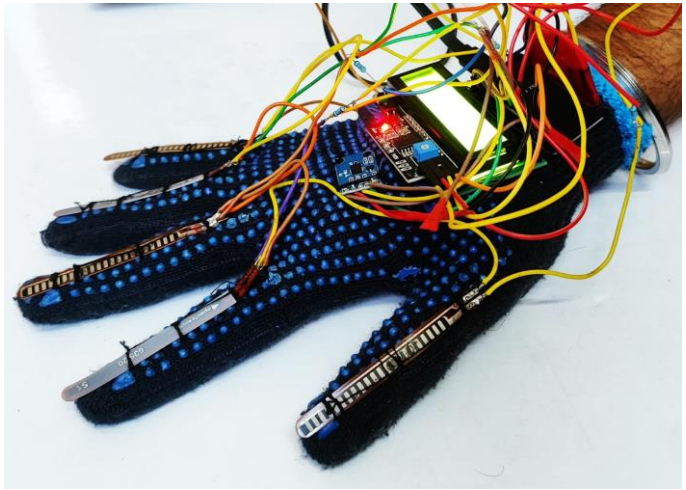
- Arduino IDE: For coding and uploading program to ESP32
- Embedded C/C++: Programming language used
- Serial Monitor: For testing and calibration
- Hardware Libraries: For OLED, sensor communication

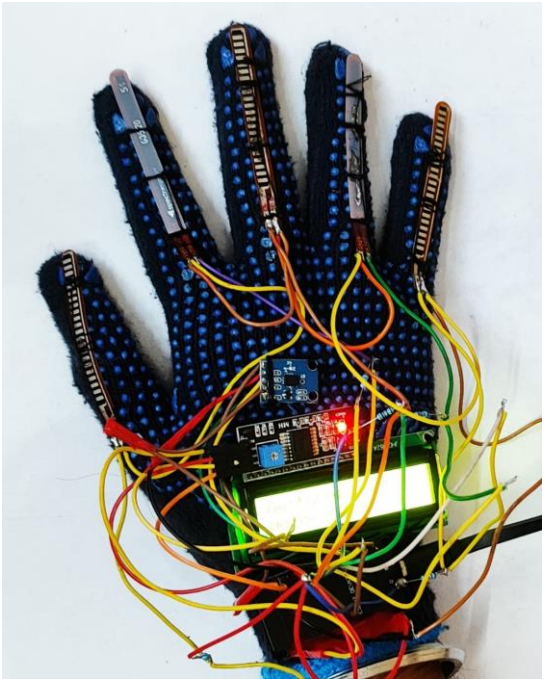
System Architecture



Result

Gesture Recognition
Voice Output
Additional Visual Output





Conclusion

The **Gesture Vocalizer** efficiently converts hand gestures into speech, providing a simple and affordable communication tool for deaf and mute individuals. It ensures accurate gesture recognition, real-time voice output, and optional visual feedback. This system promotes inclusivity and independent communication, with potential for further enhancements

Future Scope

- Add machine learning to support more gestures
- Use text-to-speech for dynamic voice generation
- Connect with mobile devices using Bluetooth
- Personalize gestures for individual users
- Support for multiple languages

References

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8. *Sharma, Priya & Mehta, Rahul. (2021). "Gesture to Speech: A Real-Time Conversion System for Speech Impaired." 10.1016/j.procs.2021.10.114.*

Achievements

- Team to secure **2nd rank and a 25k prize at Anveshana** 2025
- Participated In National Level Competition at Anveshna (Bangalore) 2025
- **IIT Bombay** Eureka Semifinalist & invited for E-summit 2025
- SRUJAN -2K25 National Level 2nd Rank and 5k Prize Money


Thank You