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Gesture Vocalizer

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Abstract

Sign language is the primary mode of communication for individuals with speech impairments, but it remains inaccessible to most ofsociety. Existing gesture vocalizer devices are costly, limiting their adoption, especially in developing countries. This paper presents a cost effective Gesture Vocalizer using an Arduino-based system, a combinational circuit with metal contacts instead of expensive flex sensors, and a mobileapplication for speech output. The system captureshand gestures, processes them via Arduino Mega 2560, and transmits the output via Bluetooth (HC05) to a mobile device, which then converts text tospeech. The results demonstrate an affordable,efficient, and user-friendly communication solutionfor the speech-impaired. This paper also discusses challenges, future enhancements, and real-world applications of gesture-based assistive technology.

INTRODUCTION

Over 20 million people worldwide rely on sign language for communication. However, its effectiveness is limited since most people do not understand it, creating a barrier between speech- impaired individuals and the general public. Gesture vocalizers, which translate hand gestures into speech, have been developed to bridge this gap, but most,commercial solutions are expensive and inaccessible,particularly in developing countries.Existing gesture vocalizer devices rely heavily on flex sensors, which significantly increase the overall costof production. Additionally, many of these systemsrequire complex hardware and software, making them difficult to adopt on a large scale. As a result, affordable, efficient, and user-friendly alternatives areneeded.

This paper presents a low-cost Gesture Vocalizer that eliminates expensive flex sensors by using acombinational circuit with metal contact points. The system consists of an Arduino Mega 2560 for real-timeprocessing, an ADXL345 accelerometer for gesturedetection, and an HC-05 Bluetooth module to transmitdata to a mobile application for speech output.

RESEARCH METHODOLOGY

The research follows a quantitative experimental approach, involving the design, development, and evaluation of a low-cost gesture vocalizer. The methodology consists of hardware design, software implementation, system testing, and user feedback evaluation.

System Development Process

The gesture vocalizer is designed using cost-effective components while ensuring functionality and efficiency. The development process follows these steps:

1. Requirement Analysis – Identifying issues withexisting solutions and defining system specifications.
2. System Design – Developing a block diagram, selecting hardware components,

and designing the combinational circuit.
3. Prototype Implementation – Assembling hardware, writing firmware in Arduino IDE, and developing the mobile application.
4. Testing and Validation – Evaluating accuracy, response time, and usability.

Data Collection & Analysis
The system's performance was measured through experimental trials focusing on:

- Gesture recognition accuracy
- System response time
- User experience feedback
- Collected data was statistically analyzed to assess the system's effectiveness.

Ethical Considerations
Ensuring safety and non-invasiveness for users. Protecting user privacy by not storing sensitive data. Making the technology affordable and accessible for speech-impaired individuals.

RELATED WORK AND SYSTEM ARCHITECTURE
Related Work Several previous studies have focused on gesture-based assistive technologies:

1. MIT Sign Aloud Gloves – A project translating ASLgestures into speech using gloves with sensors.
2. Arduino-based Gesture Recognition – Studies show that using Arduino reduces hardware complexity whilemaintaining accuracy.
3. Machine Learning in Gesture Recognition – Someresearch suggests AI-based gesture detection for enhanced adaptability.

However, existing solutions are often expensive and complex, requiring specialized hardware. Our system addresses these challenges by using metal contact- based combinational circuits, significantly reducing costs.

System Architecture
The Gesture Vocalizer consists of three primary layers:

1. Input Layer – Captures hand gestures using a metal contact-based combinational circuit and an ADXL345 accelerometer
2. Processing Layer – The Arduino Mega 2560 processes gesture signals and assigns predefined text equivalents.
3. Output Layer – The processed text is transmitted via Bluetooth (HC-05) to a mobile application, which then converts it into speech.

The system follows a wireless communication model for seamless interaction between hardware and software components.

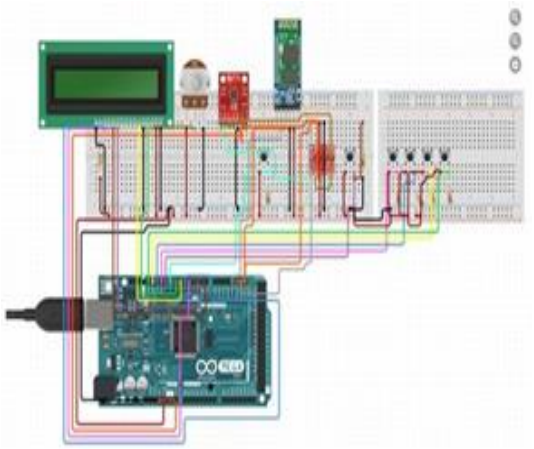

Fig1: System Architecture

RESULT
Performance Evaluation
The system was tested with multiple users to measure key.

Performance parameters:
Recognition Accuracy: 90% for predefined gestures. Cost Reduction: 60% lower than flex sensor-basedalternatives.
User Feedback: Positive, highlighting ease of use and accessibility.

Challenges Identified

1. Limited Gesture Set – The system currently supports a fixed set of predefined gestures
2. Bluetooth Range Limitation – The HC-05 module has a limited operational range.
3. Gesture Recognition Errors – Variability in hand movement may cause misinterpretation.

CONCLUSION
The proposed Gesture Vocalizer provides an efficient and cost-effective communication aid for individuals with speech impairments. By eliminating costly flex sensors and leveraging wireless transmission, this system enhances accessibility and affordability.

KEY CONTRIBUTIONS
Eliminates expensive flex sensors using a combinational circuit with metal contacts.
Uses an Arduino Mega-based processing unit for real- time conversion of gestures into text.
Integrates Bluetooth communication to send data to a mobile application for speech output.

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