Sign language Translator with Speech Output

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Abstract – The Automatic Power factor Correction (APFC) using Arduino project aims to enhance electrical system efficiency by maintaining a near-unity power factor. Power Factor is crucial for optimizing energy usage and reducing wastage in electrical networks. The system employs an Arduino microcontroller to continuously monitor the power factor and based on real-time measurements, automatically controls power factor correction capacitors. Through precise control .the Arduino adjusts the capacitors to ensure the power factor remains close to unity , thereby minimizing reactive power and enhancing overall system performance. This project contributes to energy conservation and cost reduction in industrial and commercial settings by intelligently managing reactive power, aligning it with the real power demand. The integration of Arduino technology provides a cost-effective and efficient solution for power factor correction, promoting sustainability and resource efficiency in electrical systems.

Key Words: *Automatic Power Factor Correction (APFC), Arduino, Power factor improvement, Reactive power compensation, Capacitor bank control, Energy efficiency, Real-time monitoring, Industrial power management.*

1.   INTRODUCTION :

Communication is one of the most important parts of human life. However, people who are deaf and mute face difficulties in communicating with others. Sign language is their primary mode of communication, but not everyone understands sign language. To solve this problem we designed a **Sign Language Translator Glove.**

This project is built using an Arduino Uno as the main controller. The system uses four flex sensors attached to detect finger bending. When a person makes a hand gesture, the flex sensors change their resistance.

These changes are read by the Arduino through its analog pins.

To improve accuracy, an accuracy, such as the MPU6050 is used. It detects hand tilt and movement direction. This helps the system recognize more complex gestures.

Once the gesture is detected, the Arduino processes the sensor values and compares them with predefined patterns stored in the program. When a match is found:

- The corresponding message is displayed on a 16*2 LCD screen.
- A pre-recorded voice message is played using the DF player mini.
- The message can also be sent wirelessly to a mobile phone using the HC-05.

For example:

- If the user shows a specific gesture, the LCD may display "HELLO", and the speaker will say "Hello".
- Another gesture may display "I NEED HELP", and the system will announce it through audio.

The entire circuit is powered by a battery, making it portable and easy to wear. ALL components are connected using a PCB and mounted carefully to ensure stability and comfort.

The main objective of this project is to create a low-cost, portable, and efficient device that helps deaf and mute people communicate easily with others.

2.   LITERATURE SURVEY

I.Smart Glove Based Sign Language Translator

Communication barriers between hearing-impaired individuals and the general public create challenges in daily interactions. This paper presents a Smart Glove Based Sign Language Translator designed to convert hand gestures into readable text and audible speech. The

system utilizes flex sensors to detect finger bending and an MPU6050 accelerometer to capture hand movements. An Arduino microcontroller processes the sensor data and maps specific gesture patterns to predefined alphabets or words.

The translated output is displayed on an LCD screen and can also be converted into speech using a DF Mini Player module. The system reduces dependency on human interpreters and provides real-time communication support. Experimental results show that the device achieves high accuracy in recognizing predefined gestures. The proposed system is cost-effective, portable and suitable for educational and assistive applications. The study concludes that sensor-based gesture recognition significantly enhances communication accessibility for hearing-impaired individuals.

II.Role-Based IoT Architecture for Sign Language Recognition System

This paper proposes a structured and role-based IoT architecture for a Sign Language Recognition System. The system integrates sensor-based glove technology with wireless communication modules to ensure efficient gesture translation and data handling. The architecture is divided into two primary modules: Gesture Acquisition Module and Output communication Module.

The Gesture Acquisition Module of flex sensors and motion sensors connected to an Arduino microcontroller. The Output Communication Module includes Bluetooth connectivity for transmitting translated data to smartphones or computers. Secure data transmission and structured gesture mapping improve system reliability. Performance evaluation demonstrates improved response time and stable communication between hardware components. The research emphasizes the importance of modular design and secure wireless architecture in assistive communication technologies.

III.Automated Gesture Recognition and Speech Conversion System

Traditional sign language communication requires interpreters for interaction with non-sign users. This paper introduces an Automated Gesture Recognition and speech Conversion System that translates predefined hand gestures into both text and voice outputs. The system employs flex sensors for detecting finger curvature and an accelerometer for motive tracking. Sensor data is processed using threshold-based algorithms within an embedded microcontroller. Recognized gestures are mapped to corresponding words stored in the system database. The output is displayed on an LCD screen and converted into audio signals through a Voice playback module. Automation significantly reduces communication delays and enhances real-time interaction. Experimental testing confirms reliable performance with minimal latency. The findings demonstrate that automation plays a crucial role in assistive communication systems.

IV. Design and Development of a wearable

User comfort and interface design are critical in wearable assistive devices. This paper focuses on the design and implementation of a wearable Sign Language Translation Interface integrated into a glove structure. The system uses lightweight flex sensors stitched along finger segments and a compact microcontroller mounted on the glove. The interface includes an LCD display and optional mobile connectivity for enhanced usability. Special attention is given to ergonomic placement of sensors, power optimization, and responsive output display. The device ensures quick gesture recognition and minimal processing delay. User testing indicates improved usability and comfort during prolonged use. The research concludes that ergonomic and responsive design significantly enhances the effectiveness of wearable communication systems.

IV.Digital Assistive Technology for Hearing-Impaired Communication

Assistive technology plays a vital role in empowering individuals with hearing and speech impairments. This paper examines the development of a digital Sign Language Translator aimed at modernizing communication methods. The system integrates sensor-based gesture detection, microcontroller processing, and audio-visual output modules into a unified embedded platform. By digitizing gesture interpretation, the system eliminates the need for manual interpretation and enhances independence. A centralized gesture database ensures consistent and accurate translation. The platform improves interaction efficiency in educational institutions, workplaces, and public services. The study

demonstrates that digital transformation in assistive communication significantly enhances accessibility, transparency, and inclusivity in society.

3. PROPOSED SYSTEM

The project uses an Arduino Uno as the main controller. Four flex sensors are connected to analog pins using 10kΩ resistors in a voltage divider circuit. The MPU6050 accelerometer is connected to SDA and SCL using I2C communication. The 16x2 LCD is connected to digital pins , while the HC-05 is connected to TX and RX pins for serial communication. The DF Player Mini is connected to digital pins with a speaker attached. All components share a common GND and are powered using a 7–9V battery connected to the Arduino.
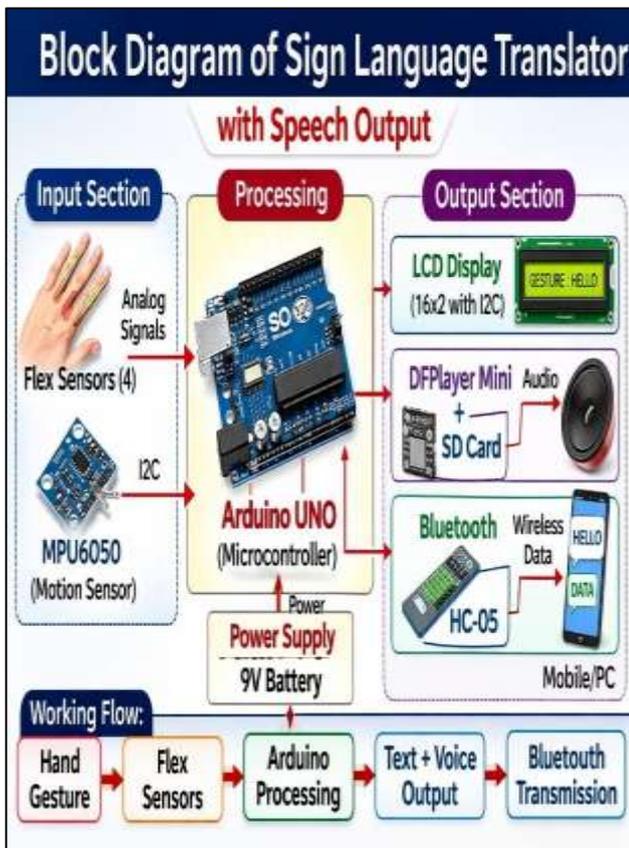
3.1. Block Diagram

Fig3.1: Block Diagram of Sign Language Translator

1.Input Section
Flex Sensors
- Attached to glove fingers.
- Detect finger bending.
- Send analog signals to Arduino.

Accelerometer
- Example: MPU6050
- Detects hand tilt and motion.
- Sends digital data via I2C communication.

2. Processing Section
Arduino Uno
- Acts as the main controller.
- Reads sensor data.
- Compares values with predefined gesture patterns. • Generates output signals accordingly.

3.Output Section
LCD Display
- Displays translated text message.

Bluetooth Module
- HC-05
- Sends text message wirelessly to mobile device.

Voice Module
- Plays pre-recorded voice message through speaker.

4. RESULTS AND APPLICATIONS

4.1. RESULT:

The Sign Language Translator project was successfully designed, assembled, and tested using four flex sensors, an accelerometer, LCD display, Bluetooth module, voice module, and battery system. The system worked properly and achieved the main objective of converting hand gestures into readable text and audible speech.

During testing, the flex sensors accurately detected finger bending, and the accelerometer (MPU6050) correctly measured hand tilt and movement. These input signals were sent to the Arduino Uno, which processed the data and compared it with predefined gesture patterns stored in the program.

After recognizing the gesture:
• The corresponding message was displayed on the LCD screen clearly.
• The voice output was generated using the DF Player Mini and speaker.
• The translated text was successfully transmitted to a mobile phone using the HC-05.

The system responded quickly with minimal delay and provided accurate results for predefined gestures. The glove-based design made the device wearable and portable. Power was efficiently supplied using a battery, making the system independent of continuous external power.

Final Outcome:
• Gestures were correctly converted into text.
• Text messages were converted into clear voice output.
• Wireless communication with a smartphone was achieved.
• The system proved to be reliable, low-cost, and user-friendly.

4.2.   ADVANTAGES:

1.   Improves Communication:
The Sign Language Translator helps deaf and mute individuals communicate easily with normal speakers by converting gestures into text and voice.
2.   Real-Time Translation:
It provides instant conversion of hand gestures into readable and audible output without much delay.
3.   Portable and Wearable:
Since it is glove-based and battery-operated, the system can be used anywhere.
4.   User-Friendly System:
The device is simple to use and does not require complex training.
5.   Low Cost:
Using components like Arduino Uno makes the project affordable compared to advanced communication devices.
6.   Multiple Output Modes:
It provides:
• Text output on LCD
 • Voice output using DF Player Mini
• Wireless transmission using HC-05
7.   Accurate Gesture Detection:
Using flex sensors and an accelerometer improves gesture recognition accuracy.
8.   Supports Social Inclusion:
It helps reduce communication barriers and promotes independence for specially-abled individuals.

4.3.   APPLICATION:

1.   Communication for Deaf and Mute Individuals
The Sign Language Translator helps deaf and mute people communicate easily with others by converting hand gestures into text and speech.

2.   Hospitals and Healthcare Centers
It can be used in hospitals where patients with hearing or speaking disabilities need to explain their problems to doctors.
3.   Educational Institutions
Schools and colleges can use it to support specially-abled students for better learning and interaction.
4.   Public Service Areas
It can be used in banks, railway stations, airports, and government offices to reduce communication barriers.
5.   Home and Daily Use
The device can be used at home for smooth communication between family members and specially-abled persons.
6.   Customer Service and Business
It helps improve customer interaction where employees or customers have speech or hearing disabilities.

5.   CONCLUSION:

The Sign Language Translator project was successfully designed and implemented to bridge the communication gap between deaf-mute individuals and normal speakers. The system effectively converts hand gestures into readable text and audible speech using flex sensors, an accelerometer, and the Arduino Uno. The translated message is displayed on the LCD screen and converted into voice output using the DF Player Mini. It can also transmit messages wirelessly through the HC-05. The project proved to be cost-effective, portable, and user-friendly. Overall, the Sign Language Translator is an innovative and practical solution that promotes social inclusion and improves communication for specially-abled individuals. With further improvements and expansion of gesture recognition, the system can become more efficient and widely usable in real-world applications.

6. FUTURE SCOPE:

1.   Support for More Gestures
The current system can detect limited hand signs. In the future, more alphabets, words, and complete sentences can be added to improve communication.
2.   Machine Learning Integration
Instead of fixed threshold values, machine learning algorithms (like gesture classification models) can be used to improve accuracy and recognize complex hand movements.
3.   Mobile Application Integration

The system can be connected to a mobile app using Bluetooth or Wi-Fi so that translated text can be displayed on a smartphone.

4. Voice Output System

A Text-to-Speech module can be added so that detected gestures are converted into audible speech, helping communication with visually impaired or non-sign users.

5. Compact & Wearable Design

The system can be developed into a lightweight, wireless smart glove for comfortable daily use.

6. Two-Way Communication System

Future development can include speech-to-sign conversion, allowing normal speech to be converted into sign language for deaf users.

7. AI-Based Real-Time Translation

Advanced cameras and AI models can replace flex sensors to recognize gestures visually without gloves.

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8. ACKNOWLEDGEMENT

BIOGRAPHIES

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