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An Intelligent Glove For Hand Gesture-Based Communication

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Abstract: Human beings have a natural ability to see, listen and interact with their external environment. Unfortunately, there are some people who are deaf and mute can't use their senses to the best extent. There are around 300 million deaf and mutes in the world. They depend on other means of communication like sign language. This produces a major barrier for people in the deaf and mute communities when they attempt to interact with others, especially in their educational, societal and professional environments. Therefore, it is necessary to have a sign language detection system to bridge the communication gap between deaf people and the normal people. This electronic glove designed to help an easy communication by interpreting the sign language. The gesture recognition is done using the electronic glove which consist of accelerometer sensors and flex sensors which are positioned on fingers. The acceleration and bend values of a hand motion are observed by microcontroller and it displays the corresponding text through LCD. This system allows individuals with hearing and speech impairments to communicate effectively by converting sign language gestures, captured through an electronic glove, into text displayed on an LCD screen. It can also assist speechless patients with partial paralysis who cannot speak but retain finger mobility.

Index Terms: Hearing and speech impairments, Flex sensors, Accelerometers, Sign language, Arduino mega.

I.Introduction

Communication is an inevitable part of human life. Humans communicate with each other by conveying their ideas, thoughts, and experiences to the people around them. There are several ways to achieve this and the finest one among all is the gift of "Speech". For hearing impaired people, non verbal communication is the only method in which they can convey their thoughts. Most hearing impaired people express their thoughts using hand gestures. The only way of communication for deaf and dumb people is the "Sign Language". In Sign language communication is possible without the means of auditory sounds. There are around 300 million people in the world are deaf and mute. They were using sign languages to communicate with others. But, this is not understood by the normal person. This research will be helpful to reduce the communication gap between them.

II.Sign language

Wherever communities of deaf-mute people survive, sign languages have been developed. Sign languages differ from region to region and are not universal. Each country or area typically has its own version with distinct gestures and meanings. A general misunderstanding is that all sign languages are common in worldwide and that the sign language is international but, Sign languages are varies according to the region, place and country. Sign language is well ordered code gesture and each gesture has a connotation mapped to it. Normally, Sign languages do not have any linguistic relation to the spoken languages of the lands in which they come up. The relationship between the sign and spoken languages is intricate and sign languages differ depending on the country and more than the spoken language. There are two approaches of sign language recognition: sensor-based and vision-based. While the previous needs wearable devices to capture the signed gestures, it is generally simple and more precise. On the other hand, vision-based approaches employs cameras to capture the chain of images. Although, the second is a more natural approach, it is usually more difficult and less truthful. There are different ways to perform sign language such as dynamic or static, but dynamic gesture recognition is not easy one. This work is using the static hand gesture for recognizing the signed hand gestures. This method is painless to implement and highly truthful.

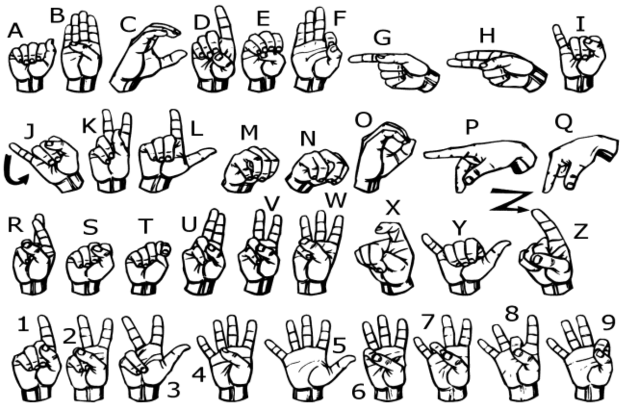

Fig.1 Sign Language

III. HARDWARE DESCRIPTION

3.1 Flex sensor

A **flex sensor** is a type of variable resistor that changes its resistance based on the amount of bending or flexing applied to it. When the sensor is straight, it exhibits a lower resistance, and as it bends, the resistance increases in proportion to the bend radius. A sharper bend results in a higher resistance value. Typically, the resistance range of a flex sensor lies between 10 kΩ and 125 kΩ, and it operates within an input voltage range of 3 V to 12 V. The output voltage is approximately 65% of the supply voltage when the sensor is straight and about 80% when it is bent. Due to its simple design and reliable response, flex sensors are widely used in applications such as gesture recognition systems, robotic control, and motion tracking devices.

Fig.2 Flex sensor

3.2 Accelerometer

The **ADXL335 accelerometer** is a small, low-power, three-axis accelerometer capable of measuring acceleration along the X, Y, and Z axes. It provides analog voltage outputs corresponding to the acceleration applied to each axis. This device can measure both static acceleration, such as gravity, and dynamic acceleration caused by movement, shock, or vibration. With a measurement range of ±3 g, it is ideal for detecting tilt, orientation, and motion in real-time. Its compact size and minimal power consumption make it suitable for various applications, including mobile devices, wearable technology, gaming controllers, and robotics.

Fig.3 Accelerometer

3.3 Multiplexer

The **HEF4067 multiplexer** is a 16-channel analog multiplexer that enables the selection of one input signal from 16 available channels and connects it to a common output pin. This selection is managed by a four-bit binary control input. The multiplexer supports both analog and digital signals and offers low ON resistance to ensure minimal signal loss. Its versatility and wide operating voltage range make it an essential component in data acquisition systems, microcontroller-based projects, and signal switching applications where multiple sensors or inputs need to be managed efficiently.

3,4 Lcd Display

A **liquid crystal display (LCD)** is a flat-panel display widely used for presenting textual and numerical information in electronic systems. LCD technology operates by controlling the alignment of liquid crystal molecules using an electric field, which regulates light passage through polarized layers. This mechanism requires very little power, making LCDs highly energy-efficient. Commonly, a 16x2 character LCD is used in microcontroller projects, which can display 16 characters per line on two lines. These displays are favored for their clarity, low power consumption, and ease of integration into embedded systems. LCDs are extensively used in digital watches, calculators, measuring instruments, and consumer electronics to provide user-friendly information display.

IV. Block Diagram

The block diagram of the Sign Language Recognition system is shown on **figure 4**.

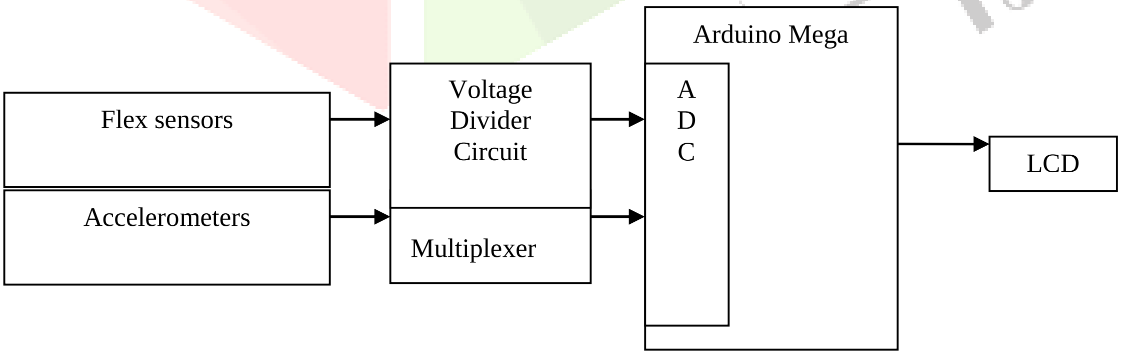

Fig.4 Sign Language Recognition System

V. Methodology

Accelerometers and flex sensors are placed at each finger. Accelerometers are used to sense the movement of the fingers in 3 directions(x,y,z). Flex sensors are used to sense the bend of the fingers. Sensor readings are multiplexed using HEF4067 which is a 16 to 1 multiplexer. The multiplexed readings are given to the Arduino mega. The raw values from the sensors are calibrated. Sensor values for different signs are obtained and analyzed by the microcontroller. Sensor values corresponding to the sign language are mapped to the alphabets and numbers. The appropriate letter will be displayed at LCD which is interfaced with the microcontroller.

VI. Hardware setup

The **Sign Language Recognition system**, as illustrated in Figure 3, is designed to interpret hand gestures and convert them into readable text. In this setup, **five flex sensors** and **five accelerometers** are employed to capture finger movements and orientation data. The flex sensors, mounted on the backside of the fingers, detect the degree of bending, while the accelerometers, positioned on the upper portion of the fingers, monitor the tilt and motion. The signals from the accelerometers are routed through an **HEF4067 multiplexer**, which efficiently selects and forwards the data to the microcontroller. The microcontroller processes these inputs, interprets the corresponding sign language gesture, and generates an output. This recognized data is then transmitted to an **LCD module**, where the interpreted text is displayed for the user. This architecture enables a smooth translation of physical gestures into a digital form, making communication easier for individuals with hearing and speech impairments.

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Fig.5 Hardware Setup

VII. Conclusion and futurework

Sign language is one of the useful tools to ease the communication between the hearing impaired and mute communities and normal society. Though sign language can be implemented to communicate, the target person must have an idea of the sign language which is not possible always. Hence this project lowers such barriers.

In future work, proposed system can be developed to differentiate the similarity between signs. In addition to that it can be focus on converting the series of gestures into text i.e. word and sentences and then converting it also into the speech which can be heard from mobile phone.

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