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A Smart Glove for the Dumb and Deaf

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Abstract – *The dumb and deaf community find it very difficult to communicate with the normal people. They communicate using a hand gesture language, called sign language, which is not commonly known by people. Usually, they need to be accompanied by a human translator, who is aware of sign language and the common tongue. This problem can be overcome by using a smart glove which will translate hand gestures into speech by using various sensors. Flex sensor, accelerometer, gyroscope are used. Flex sensor detects the finger movement and accelerometer and gyroscope detect the hand movement. The output is heard through speaker.*

Key Words: smart glove, sign language, dumb and deaf, hearing loss, communication, mute, disability, gesture, flex, accelerometer, gyroscope, and speaker

1.INTRODUCTION

Over 5% of the world's population – or 466 million people – has disabling hearing loss (432 million adults and 34 million children). It is estimated that by 2050 over 900 million people – or one in every ten people – will have disabling hearing loss.

Disabling hearing loss refers to hearing loss greater than 40 decibels (dB) in the better hearing ear in adults and a hearing loss greater than 30 dB in the better hearing ear in children. The majority of people with disabling hearing loss live in low- and middle-income countries.

Approximately one third of people over 65 years of age are affected by disabling hearing loss. The prevalence in this age group is greatest in South Asia, Asia Pacific and sub-Saharan Africa.

A person who is not able to hear as well as someone with normal hearing – hearing thresholds of 25 dB or better in both ears – is said to have hearing loss. Hearing loss may be mild, moderate, severe, or profound. It can affect one ear or both ears, and leads to difficulty in hearing conversational speech or loud sounds.

'Hard of hearing' refers to people with hearing loss ranging from mild to severe. People who are hard of hearing usually communicate through spoken language and can benefit from hearing aids, cochlear implants, and other assistive devices as well as captioning. People with more significant hearing losses may benefit from cochlear implants.

'Deaf' people mostly have profound hearing loss, which implies very little or no hearing. They often use sign language for communication. [1]

A sign language is language that employs signs made with the hands and other movements, including facial expressions and postures of the body, used primarily by people who are deaf. There are many different sign languages as, for example, Indian and American sign languages. [2]

The sign language is not understood by normal people. Hence it becomes difficult for these people to communicate with normal people.

Wherever communities of deaf people exist, sign languages develop. Signing is not only used by the deaf, it is also used by people who can hear, but cannot physically speak. While they use space for grammar in a way that spoken languages do not, sign languages show the same linguistic properties and use the same language faculty as do spoken languages. Hundreds of sign languages are in use around the world and are at the cores of local deaf cultures. Some sign languages have obtained some form of legal recognition, while others have no status at all.

2.LITERATURE SURVEY

Through the years, Deaf people have faced numerous challenges. Other past challenges included little access to education and almost no opportunity for gainful employment. Although things have improved over time, deaf people still face obstacles.

Sign language, like the deaf people who use it, has had to fight for survival. Around the world, Sign language — as well as those who communicate this way — has been viewed as lesser than that of the hearing world. Many hearing people have dedicated themselves to changing the deaf and their language.

For centuries, deaf people had to undergo the treatment of being viewed as incomplete because of their absence of hearing. Some religious groups wanted to *save* deaf people, while other groups wanted to *teach* them. Because of a lack of speech, deaf people were viewed as deaf and dumb. This label, which Aristotle invented, has been attached to the Deaf people since ancient Greece.

Some people mock signing in front of deaf people or tell them how sorry they are that they can't hear the birds singing or the phone ringing. Others are so rude as to talk

about deaf people right in front of them as though they aren't even there.

Many deaf people and deaf advocates have risen to challenge this oppression, and they seem to have been successful because deaf people are still signing to one another every day.

Current situation:

Although Deaf people aren't viewed as being possessed by the devil anymore, they still continue to face the challenges presented to them by a hearing world. Deaf people have fought for equal opportunities in education and employment and for cultural recognition, just to name a few. Take a look at how the Deaf community has overcome modern obstacles.

The dispute over whether sign language is an actual language has been ongoing. Those who think that it should be considered a language often cite the following reasons:

- It syntactically contains properties like other languages, such as nouns, verbs, and adjectives.

- It maintains grammar rules that must be followed.

On the other hand, many people don't buy the argument that sign language is a real language. Their argument goes like this:

- All countries, including the United States, use their own indigenous sign language. Therefore, if you were from Spain and travelled to Peru, your Spanish Sign Language wouldn't be compatible with Peruvian Sign Language, even though the hearing communities from both countries could speak Spanish and understand each other.

- At best, some countries, such as the United States, have had a profound impact educationally on other countries. Many foreign deaf people come to the United States for schooling, and they take home many sign language signs.

- In a real sense, deaf people are a silent minority. The majority is made up of those who can hear. For deaf people, living in a world where one's language is known by few and understood by even fewer influences how deaf people view themselves. (To categorize how deaf people view themselves is too big a label to put on people who are individuals with various educational, economic, social, and deafness levels. Some people are more adaptable than others — in both the hearing and deaf worlds.)

It also influences their feelings about how to exist as a people. This experience is often compared to living in a foreign country.

Question to be considered: How would one feel if he/she were living in a foreign land where the language, customs, and culture weren't native to him/her? One would want to say what's appropriate, not something that would be viewed as ignorant. The dumb and deaf feel frustrated when they want to state their opinion but cannot make themselves understood.

When speakers of a minority group come together, apart from the majority, they feel a certain sense of freedom to be able to speak — or sign — as fast as they want, and to converse, using idioms in their native language.[3]

3.METHODOLOGY

The system makes use of 3 types of sensors: flex sensor, gyroscope, and accelerometer.

The microprocessor used is Raspberry Pi. The microprocessor requires digital inputs as it cannot process analog signals. Flex sensor being an analog sensor, cannot be directly connected to the processor.
Thus a signal conditioning circuit is designed using operational amplifiers and comparators to convert the analog values of flex sensor to digital values.
Gyroscope and accelerometer are combined in one MEMS sensor named as MPU6050. This sensor is given as another input to the processor. The sensor is connected to the microprocessor using I2C protocol.
The microprocessor further processes the inputs, analyses it and gives text output, on the raspberry pi terminal, detecting the meaning of the sign shown by the dumb and deaf.

Furthermore, text to speech conversion is done with the help of ESpeak and the voice version of the sign is heard through the speaker connected to the glove.
Thus, the dumb and deaf would be able to convey their message smoothly and efficiently to any person.

3.1.MICROPROCESSOR

Raspberry Pi is a microprocessor used to carry out various processing activities [4]. It accepts inputs from both the sensors (flex sensor and MEMS sensor). The values of each sensor are found out individually in different positions of the glove according to the sign language. From these readings, both the sensor values are coordinated and coding is done to display the correct message of the sign gestured by the person.

Raspbian is an Operating System of Raspberry Pi which is used to carry out various operations with the processor. The coding is done in Python language on the terminal available in the Raspbian.

3.2. SENSORS

3.2.1.FLEX SENSOR:

The Flex Sensor patented technology is based on resistive carbon elements. As a variable printed resistor, the Flex Sensor achieves great form-factor on a thin flexible substrate. When the substrate is bent, the sensor produces a resistance output correlated to the bend radius—the smaller the radius, the higher the resistance value. It has a flat resistance of 25KΩ. The bend resistance range is from 45KΩ TO 125KΩ.it can support up to 0.5W of continuous power.

The life cycle of a flex sensor is greater than 1 million years. So chances of mechanical breakdown are less. It can operate in varied temperature conditions ranging from -35°C to +80°C. [5]

The basic working of flex sensor is as follows:
The flex sensor is linked to using a flexible conductive ink printed on flexible base forming a resistor. It works when bent with the ink on the outside of the curve. When bent, the conductive layer is stretched and thus extends, resulting in reduced cross section (imagine stretching a rubber band). This reduced cross section and increased length results in an increased resistance, which can be measured.

The sign language involves bending of the fingers to various degrees. The flex sensor gives different analog values on the basis of position of fingers. The flex sensor is usually used in a voltage divider configuration.

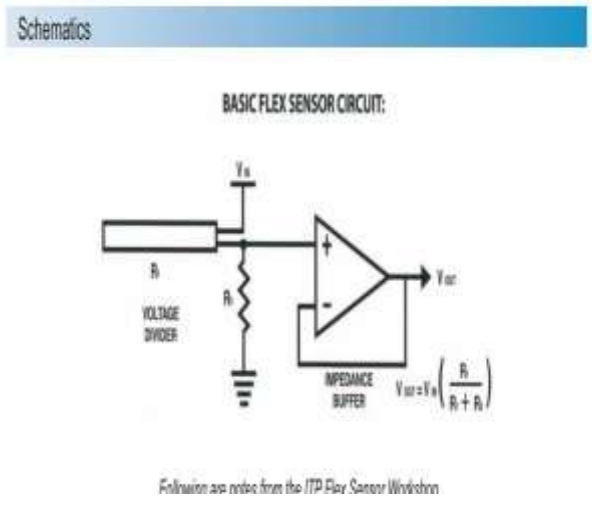

Fig- 1: Flex sensor basic circuit

3.2.2.ACCELEROMETER AND GYROSCOPE (MPU6050):

MPU 6050 is a 6 DOF (Degrees of Freedom) or a six axis IMU sensor, which means that it gives six values as output. Three values from the accelerometer and three from the gyroscope. The MPU 6050 is a sensor based on MEMS (Micro Electro Mechanical Systems) technology. Both the accelerometer and the Gyroscope is embedded inside a single chip. This chip uses I2C (Inter Integrated Circuit) protocol for communication.
The working of accelerometer:

An accelerometer works on the principle of piezo electric effect.

Here, imagine a cuboidal box, having a small ball inside it. The walls of this box are made with piezo electric crystals. Whenever the box is tilted, the ball is forced to move in the direction of the inclination, due to gravity. The wall with which the ball collides, creates tiny piezo electric currents. There are totally, three pairs of opposite walls in a cuboid. Each pair corresponds to an axis in 3D space: X, Y and Z axes. Depending on the current produced from the piezo electric walls, we can determine the direction of inclination and its magnitude.

Working of gyroscope:

Gyroscopes work on the principle of Coriolis acceleration. Imagine that there is a fork like structure, which is in constant back and forth motion. It is held in place using piezo electric crystals. Whenever this arrangement is tilted, the crystals experience a force in the direction of inclination. This is caused as a result of the inertia of the moving fork. The crystals thus produce a current in consensus with the piezo electric effect, and this current is amplified. The values are then refined by the host microcontroller. [6]

The sensor gives different values in different position of the hands used in sign language. Calibrating all the values in various cases of sign language, coding is done.

3.3.ESPEAK

ESpeak is an open source software speech synthesizer. It uses a format synthesis method. Speech in many languages can be synthesised. The accent, male/female voice, pitch can be changed. It is used for text to speech conversion. It can be easily installed on Raspberry Pi. Pi processes and synthesises sound and gives voice out either through audio jack connected speaker or USB connected speaker. Raspberry pi also has a Bluetooth module, hence Bluetooth speakers can also be used. [7]

3.4.SYSTEM DESIGN

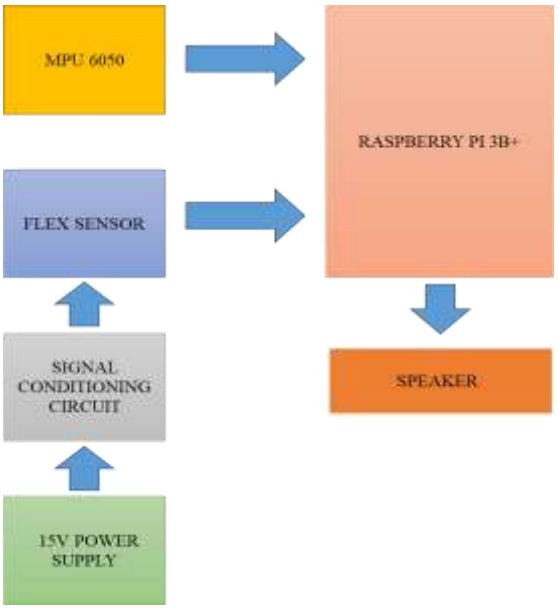

Fig- 2: System block diagram

4.RESULTS

For different flex sensors, the Sensitivity varies. Hence the values vary from 25KΩ to 125KΩ. By using signal conditioning circuitry, two values of flex sensor can be converted to digital values. The obtained values are 1.7V for logic 0 and 4.7V for logic 1. The values of gyroscope vary according to the three axis. On calibrating values of flex sensor signal conditioning and MPU6050, we get many cases according to the sign language used. The speech is heard through the speaker of the words gestured using sign language. Amplifier circuitry for volume control of the speaker may be required due to low volume.

5.CONCLUSION

An efficient communication tool for the dumb and deaf has been implemented and tested. This glove is useful for the mute community to express their views and not felt unheard. This converts gesture movements into speech which is heard by the normal community and make sense of what the mute is trying to convey. It is also a cost effective and efficient way. Values change according to different types of sign language used but the main concept remains same. Hence it is not restricted to a particular sign language.

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BIOGRAPHIES

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