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Implementation of Hand Gesture System for Speech Impaired People

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Abstract
Human beings are the most beautiful creature created by the Almighty. But the harsh reality is that in India, out of the 121 Cr population, about 2.68 Cr persons are 'disabled' which is 2.21% of the total population in which 7.5% of the population is having a speech disability. And unfortunately, some people lose their ability to speak in an accident. In our daily life, we observe that the interaction of speechless/dumb patients with normal peoples finds many difficulties Since we know visual communication is more effective than verbal communication, influenced by this phenomenon we will execute a system which will be boon to our society. But there are some people with this disability use different methods to communicate with others. For them, the most commonly used method is sign language. Sign language allows people to communicate with human body language; each word has a set of human actions representing an expression. But it is very difficult for deaf-mute people to communicate or convey their message to normal people. To deal with the problem we implement a model that will help in reducing the communication gap between dumb-deaf people and society. The goal of this paper is to design a flex sensor-based audio command through a gesture recognition module that can efficiently translate the hand gesture into words. This makes the communication process much simpler and cost-effective which provides a human interpreter dispensable. The system can be customized by the individual according to his needs as the messages are derived from a database developed after predictive analysis.

Keywords: *Atmega328, Gesture Recognition, Hand gloves, Flex sensor, Raspberry pi 3 B.*

I. INTRODUCTION

Acording to the world health organization, about 1 million people are dumb and 300 million people are deaf in the world. The power of communication can either be a blessing or a curse. It helps to express thoughts and feelings.

At times GOD plays his pranks on human beings and steal from them the ability to listen and speak The so-called normal peoples calls them DEAF AND DUMB. They are normal in all aspects except that they can't communicate like others. This inability always differentiates them from others in society.They use sign language as the only medium for communication. Sign language uses both facial expressions and hand gestures to convey the essence of what an individual is trying to express. Each country generally has its own, native sign language, and some have more than one.

To achieve the human-computer interaction for the disabled people, the human hand could be an input device. Various approaches have been proposed for enabling hand gesture recognition. The common methods used for raw data collection are (i) Data glove based hand gesture recognition and (ii) Vision-based hand gesture recognition.

For digitizing finger motions into multiparametric data, data-glove based methods

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use flex sensors. The extra sensors make it reliable to collect hand configuration and movement. However, the extra devices are quite costly and bring much inconvenient experience to the users. Vision-Based methods require only a camera, which is the medium for interaction between humans and computers without the use of any extra devices.

This paper represents how to minimize the communication gap between deaf-dumb communities with normal human beings. It is based on the need of developing an embedded system device that can translate hand movements into speech in order to make the communication. A Wireless data glove is fitted with flex sensors along with the length of each finger. To communicate with normal people the mute people can wear these gloves to perform hand gesture and it will be converted into speech.

The rest of the paper comprises of section II presents the Literature Survey, System Designs covered in section III, we further described Hardware and Software Technology used in section IV, Section V covers the Implementation &Results, finally, the paper concludes in section VI with Future Works and its applications.

II. LITERATURE SURVEY

Generally, communication between impaired people and normal people is done through synthesized speech which is known as sign language. Using a flex sensor and Arduino Mega 2560 Microcontroller information is converted into voice command and then an impaired people can have communication with the normal people [1]. In case of emergency, the location of the user can be tracked through GPS and a message is sent to the guardian through GSM. The prototype system can be employed to recognize full sign language. Most people don't understand the signed language so another system is designed using a vision-based approach. In the suggested system the system complexity increases and image extraction and classifications need to be done [2].

Different research is done to analyze and evaluate how the device can reduce the difficulty in Communication among people having listening and speech disability and find out the limitations of the device in comparison to the other technologies and devices working towards a similar objective. Their communications with others only involve the use of motion by their hands and expressions and designed an artificial speaking mouth for dumb people. This will also help other people to understand impaired people [3].

A system is designed for the speechless patients which have used gloves that translate the bending movement of the fingers into a voice using flex sensors. The messages are displayed on the LCD when spoken through a speaker [4].

Another solution to the same problem is given by using Hand talk glove that converts any sign language to a globally recognizable language such as English so that any person who can read and write can understand the deaf-dumb people [5][6].

Several authors have discussed and prepared a prototype model using different costly sensors like Kinect V2 sensor, leap motion controller where the recognition accuracy is 89.5 % [8]. This area of research is becoming very active and technological advances in computing, sensor & actuator devices, materials, and processing/classification techniques will make the next generation of glove devices cheaper, more powerful and versatile[7][9].

Sign language is the way through which deaf and dumb people can communicate with

each other. It has been observed that impaired people find it very difficult to interact with society. Normal individuals can't able to understand their sign language. To bridge this gap, the proposed system acts as the mediator between impaired and normal people. So a system is designed with a sensor implanted on the fingers which capture the bending of the finger movement and then controller processes the sensor data and transmits the processed data using Bluetooth to the main server device which produces the voice command in turns others can understand and work accordingly.

III. SYSTEM DESIGN

The approach behind this work is to interface a sensor-based gesture recognition system through which the information gestured by a deaf-mute person can effectively convey to a normal person which can reduce the issue during communication between a dumb and general public.

This project-based on the need for developing an electronic device that can translate sign language into words to make the communication. A Wireless data glove is gloves fitted with flex sensors along the length of each figure. The flex sensor is interfaced with the digital ports of the ATmega328 microcontroller. The data from the ATmega328 microcontroller will be transferred to the Raspberry Pi through Bluetooth communication. Then the data will convert to speech.

This project is also useful for the deaf and dumb, it can also be used for the (speechless) patients with half of their bodies paralyzed and who are not able to speak but can move their fingers.

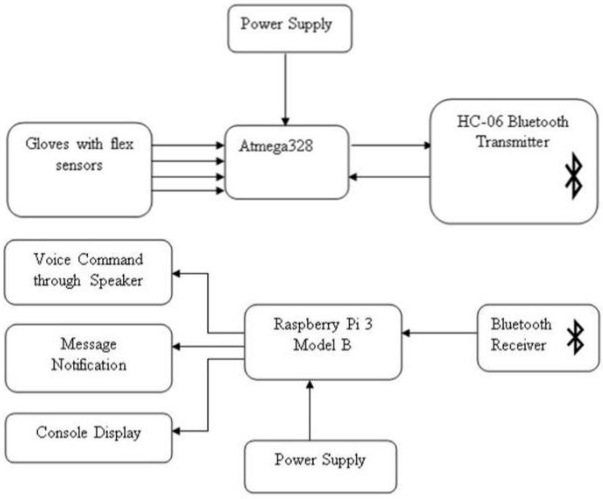

Figure 1: Block Diagram of Proposed system

The whole project is divided into 2 parts based on the working area to simplify the project. Two parts are listed as 1. Transmitter Section and 2. Receiver Section. The transmitter section takes the real-time values from the sensor and converts into the digital value with the help of an 8-bit microcontroller. Then after a Bluetooth module is connected to the controller to transmit the data from the transmitter section to the Receiver section. Now let's looks into the receiver part which consists of a processing unit that has inbuilt Bluetooth to receive the information and an Audio jack gives the voice commands.

IV. HARDWARE & SOFTWARE TECHNOLOGY

This section described the different hardware used in the work. The main controlling and processing unit used here is the Raspberry Pi Model B and ATMEGA328P, figures are shown in Fig 2 and Fig 3 respectively. The very important point here is we have not used the Arduino Uno Board. We have made our board with the help of ATMEGA328P IC which can be programmed.

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Figure 2. Raspberry Pi Model B

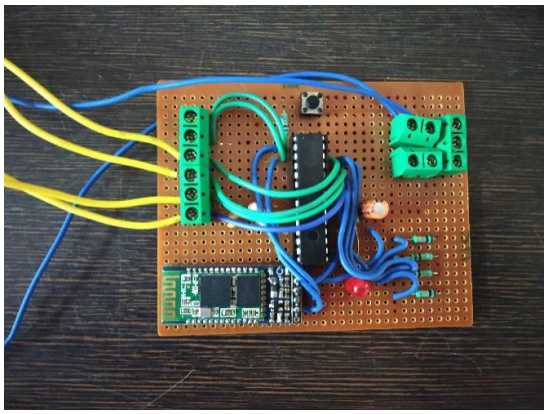

Figure 3. ATMEGA328 Model

As per the flex sensor principle when it bends its resistance changes which are converted to a binary value. By using these binary values then able to trace 2^n number of outputs where n represents the number of flex sensors used shown in Fig. 4.

Figure 4. Flex Sensor

HC-05 is a Bluetooth module that is used for wireless communication is shown in Fig. 5. This module can be used in a master or slave configuration. It has a range of up to <100m. It is IEEE 802.15.1 standardized protocol.

Figure 5. Bluetooth Module

An HP Mini Bluetooth Speaker 300 has taken, which has a 3.5 mm audio connector and compatible across all devices having Bluetooth as shown in Fig. 6. It's chargingcapacity is 6 hours.

Figure 6. Speaker

The software used to set up the system is described in Fig. 7. & Fig. 8. We have used different software IDE for different processing Hardware. We have used Arduino IDE for extracting the sensor values from the glove and python IDE for wirelessly receiving signals from the transmitter section and actuating the speaker which produces the voice command.

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Figure 7. Arduino IDE with code

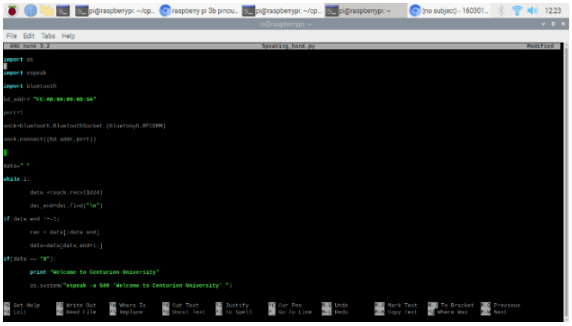

Figure 8. Raspberry pi with Code

The complete hardware setup is shown in Fig. 9. After getting the data from ATmega328 we programmed Raspberry Pi for speech conversion. For this, we wrote a python program for getting the output through audio jack on Raspberry Pi through eSpeak. To make the output audible we have to install an additional package on Raspberry Pi which is eSpeak. After installing we activated the audio jack of Raspberry Pi through CLI, find below the commands to complete the configuration in Raspberry Pi.

Commands for installing Bluetooth:

i. sudo apt-get install bluetooth
ii. sudo apt-get install bluez
iii. sudo apt-get install python-bluez

Commands for installing espeak:

i. sudo apt-get install espeak
ii. sudo apt-install espeak python3-espeak speech-dispatcher-espeak

After all the configuration, if we run that C program and Python program on Arduino and Raspberry Pi respectively we have got the audio output from Raspberry Pi according to the bending of finger.

Figure 9. Complete Hardware setup

V. IMPLEMENTATION & RESULTS

We have designed & implemented the work with the use of several components. In the beginning, we have tested the working of the whole model by interfacing all the components on the breadboard shown in Fig 9.

First, we have designed the data glove for data sensing. For designing of data glove we have fitted all the 4 flex sensors on the glove, and then the data pin of flex sensor was connected to analog pins of ATmega328 which is not only sensing analog data but also it will convert the analog data to digital data. For transmitting the digital data to Raspberry Pi we have used wireless communication through Bluetooth technology.

As per the feature of Raspberry Pi 3B, it has its own inbuilt Bluetooth so we don't need to interface additional Bluetooth with Raspberry Pi. For ATmega328 we have used an additional HC-06 Bluetooth module. And for the transmitting of data, we have used cross-communication between ATmega328 and Bluetooth module. Cross communication means

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Rx and Tx pin of ATmega328 to Tx and Rx pin of HC-06.

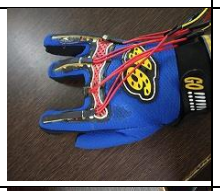
Now with the help of C programming on Arduino IDE, the data will successfully be transferred to Raspberry Pi through Bluetooth Module. Now by connecting the speaker to the Raspberry Pi's 3.5mm Audio jack, we get the audio output when we run python code in Raspberry Pi.

A Smart Speaking Glove for Speech impaired People has been designed and implemented with 16 gestures. Each gesture specifies basic needs such as "GOOD MORNING", "NEED WATER", "NEED FOOD", and "TURN ON TV" etc. are shown in Table 1.

Figure 10. Transmitter Section

Figure 11. Receiver Section

Table-I: Result of Gestures with corresponding Voice Messages

Hexadecimal Value	Image Of Hand Gesture	Binary Valu	Voice Message
		e	
0		0000	NO MESSAGE
1		0001	GIVE ME A GLASS OF WATER
2		0010	ONE TEA PLEASE
3		0011	GIVE ME SOME FOOD
4		0100	TELL ME THE WAY TO POLICE STATION
5		0101	TELL ME THE WAY TO HOSPITAL
6		0110	GIVE ME MEDICINE
7		1110	I AM NOT FELLING WELL
8		1000	I NEED REST

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9		1001	LEAVE ME ALONE
A		1010	SNACKS PLEASE
B		1011	I AM IN DANGER
C		1100	TURN ON TV
D		1101	GIVE ME MY PHONE
E		1110	I WILL BE BACK
F		1111	JAY HIND

VI. CONCLUSION

A smart, low cost, portable, cost-effective, lightweight, easy to use system is designed to help a person who cannot speak as compared to the other proposed system. We have successfully achieved 16 different gestures along with voice message which can help a speech-impaired person to express their needs. Hence this model is an attempt to make it easy to understand the actions of the dumb people by getting the output in the form of voice which bridges the gap between the speed impaired people and the other people. And also the voice output can be manipulated in any language according to the user's need. The completion of this prototype suggests that more gestures can be employed to recognize full sign language as we have implemented four gestures

We hope to extend the work to use other gestures. Also, the glove can be fitted with other sensors such as gyros and accelerometers to detect more complex gestures. It can send an SMS / Email through a smartphone app to the person who is far from his area of communication. It can be used as a variety of applications like the same command can be used to automate electronic gadgets, taking lectures, playing computer games and can simulate virtual reality. The same can be used in public places for interacting with normal people like railway stations, airports, medical stores. The voice commands can be stored in the database concerning date and time for the future prediction analysis.

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