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Hand Gesture Recognition System For Translating Indian Sign Language Into Text And Speech

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Abstract—Communication is merely a means of transferring information from one place, person or group to another. Vocal Communication is the manner in which human being interact with others. Be that because it might, not every one of us isn't able to share our thoughts in verbally due to some physical disabilities. It is very difficult for Deaf and Mute people to convey their thoughts and ideas with normal people. Most of the people does not know sign language which make it difficult for silent people to communicate with others. Some devices are available that convert sign language to text and speech in English ,but no device is available for any other language specifically Malayalam. The proposed system will recognize Indian Sign language and convert it into speech and text in 2 languages English and Malayalam and display it on Android phone.

Index Terms—Arduino UNO, Android Studio, ASL, ISL, TTS, Computer Vision

I. INTRODUCTION

India is the second most populated country in the world. According to the researches done by various college around 6.4 percent of the population have some level of hearing disabilities. Communication is the means to convey our thoughts, idea and messages with each other through verbal and non verbal means. Some people are not so lucky to convey their message verbally due to some disabilities. The deaf and mute people need sign language for communication. But majority of population doesn't understand the sign language. People around us are willing to learn other languages for communication, but no one is trying to learn Sign language. That make it difficult for deaf and mute people to pass on their message with normal people. In India there are only a few number of sign language interpreter available today. Some researches shows there are only 250 sign language interpreter available for translating sign language to other language [1].

In recent years, there have been many development in the field of Sign language recognition systems. there are some device that are available which convert sign language to English language. But accuracy is a major problem for such devices. Also only a few of such devices is based on Indian Sign Language. Most of sign language interpreting devices are based on American Sign Language. To address this issues ,paper presents a system called Flex Sensor based Indian Sign Language Recognition System which translate Indian Sign Language into text and speech in Malayalam language and English language and display it on mobile phone [2]. There

are have been many development in the field of gesture based systems [3]. Main aim of this paper is to implement a recognition system with improved accuracy [1].

There are two main category of gesture recognition system. Vision based System [4] and Sensor based System. Vision based system consist of a camera which is used to capture the image or video of sign gestures and this captured image or video is sent to image processing unit. Through image processing technique, captured content is processed and features are extracted and trained using static images. By using various image recognition algorithms the corresponding sign gestures are recognized [5].

One of the disadvantages of Vision based system is usage of advanced algorithms for process [4]. Varied lighting conditions, background and field of scan constraints are the other challenges. Sensor based method is more accurate and sensitive as compared to image processing method. In Sensor based system, sensor are placed on the hand gloves. 1970s the 1st hand gloves centered methods introduced and after that numerous designs came [6].

In this paper, sensor based system is used. That system will recognize Indian Sign language and convert it into speech and text in English and Malayalam language and display it on Android phone [2]. Flex sensor is the integral part of this system design. Flex sensor is fixed on the hand gloves. The operation of flex sensor is as per the quantity of bend occurring within the fingers the resistance worth of the flex sensor conjointly changes [5]. Voltage values corresponds to each gesture are stored in the microcontroller and to check the validity of the real-time hand gestures, compare the gesture voltage value with the value one that stored in the microcontroller. If the gesture is valid it will display on the android phone else it will be recorded again. Microcontroller we are using is Arduino UNO. For wireless communication between microcontroller and android phone we use HC 05 bluetooth module [7].

Now-a-days almost 90 percent of people use smart phone for communication. So in this experiment we use smart phone to display recognized signs. Experiment was conducted and 90 percent accuracy achieved when matched with the real time input.

II. RELATED WORK

1970s the 1st hand gloves centered methods introduced and after that numerous designs came. The Hand glove model firstly introduced by Daniel Sandin and Thomas de Fanti in 1977. They called the glove "Sayre Glove". It consist of flexible tube in each fingers having a light source and a photocell [6].

In 1987, as a commercial device digital glove started to emerge. Instantaneously these devices gained popularity around the world. "Data glove" was introduced by Zimmerman in 1983. It include thin bendable plastic pipes, detectors as well as certain sunlit sources for detecting and examining combined angles [8].

"The Power Gloves" was introduced in 1989. It was used as the video game support and it was most popular among video game developers. It consist of bendable plastic twists which had resistive ink compute finger movements and determine total flexion of the hand. In 1995, Nissho Electronics came up with "The Super Gloves". It had sections sewed on gloves which can be used for resistive ink.

"Hand Gesture Recognition based communication system for silent speakers" is a work intended to solve the problem of communication limitations faced by deaf and mute people which is by translating sign language into text and speech. This system is based on American Sign Language [7].

"Low cost tangible gloves for translating sign gestures to speech and text in Hindi language" is an another system proposed by Suraksha Devi and Suman Deb in 2017 for reducing the communication barrier between hearing impaired individuals and the normal individuals. This system translate sign language in to speech and text in Hindi language using American Sign Language. Glove consist of Flex sensor and ADXL345 for measuring hand movement [1].

"Sign Language to speech conversion" aimed by introducing recognition technique designed to implement a system that interpret hand gestures to speech. Text to speech conversion in this project based on HMM. It is based on American Sign Language and glove consist of Flex sensor, Tactile sensor and Accelerometer for finger movement measurement [5].

"Gesture based vocalizer for deaf and mute people" proposed by Noushaba Feroz, Safiya Nazir and Sumaya Fayaz aimed to establish two way communication between mute people and normal people. They made an electronic speaking glove which translate tilt angles of hand into speech by that mute person can communicate with normal people. It also contain LCD display, speech of normal person is recognized word by word and display it on LCD display. Thus communication can be done in two way. It is based on American Sign Language [9].

"Design and development of hand gesture recognition system for speech impaired people" proposed by Neela Harish and Dr. S. Poonguzhali for translating sign language to English language [7]. It is based on Indian sign language. Both Flex sensor and Accelerometer are used in the glove and for speech output a voice module is used [10].

III. PROPOSED SYSTEM

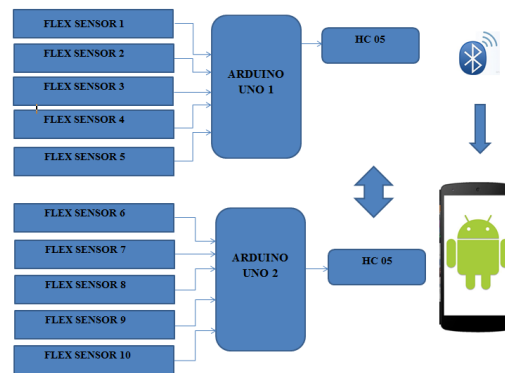


Fig. 1. Block diagram of Proposed System

The figure Fig.1. shows the block diagram of Proposed System. The proposed system is based on Indian Sign language. So it require both Hand to show gestures. System consist of 5 Flex sensor and 1 microcontroller for each hands. Microcontroller here using is Arduino UNO. Communication between 2 microcontroller done wirelessly using Bluetooth HC 05. Communication between arduino and microcontroller can be done using another HC 05.

A. Flex Sensor

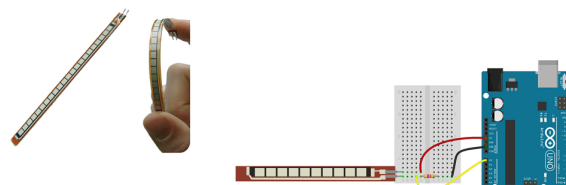


Fig. 2. Flex sensor

Flex sensor is also known as bend sensor. It is a sensor that used for measuring amount of reflection. Flex sensor is a variable sensor so it results better form factor. Sensor produce resistance output corresponds to bend radius. Higher the bend radius, smaller the resistance value [8].

B. Arduino UNO and Flex Sensor

When flexed, flex sensor changes its value. By using one of the arduino analog pin we can measure the resistance change. For that we need a fixed resistor so that we can use this resistor for assessment. Thus form a Voltage divider and this voltage divider divides supply voltage (5V) between fixed resistor and flex sensor. Analog read on Arduino UNO is mainly a Voltmeter. It would read 1023 at 5V and 0 at 0V. By using this we can calculate how much voltage is on the flex sensor. The amount of supply voltage (5V) each part, that is flex sensor and fixed resistor is proportional to its resistance. If flex sensor and fixed resistor having same value then supply voltage will split evenly to each part (2.5V) which is analog read of 512. If the sensor value is 1K and fixed resistor is

22K, then fixed resistor will soak up 20 times of that 5V as compared to flex sensor. So the flex sensor only get .217V (analog reading of 43V). If flex sensor have 40K resistance, so the flex sensor will get nearly 2 times as much of that 5V compared to 22K resistance (it is 3V) that is analog reading of 614.

C. Bluetooth Module

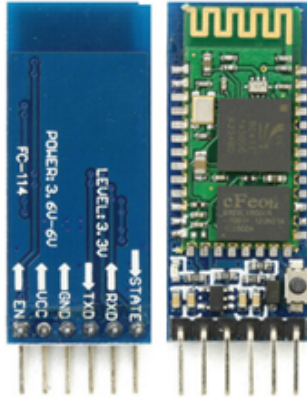


Fig. 3. Bluetooth Module

HC 05 Bluetooth module is also known as Master/Slave module and by default it is Slave. The role of Bluetooth module configured only by AT Commands. Master can initiate connection with other Bluetooth module while slave can receive data. It cannot initiate the connection with other module.

D. Design

SLAVE ARDUINO

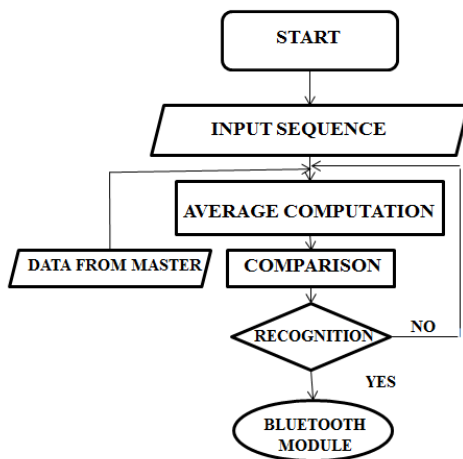


Fig. 4. Flow chart of slave Arduino

Figure 4 and 5 shows the flow chart of the Slave and Master Arduino. After starting the program, gesture input will

be given. From the voltage reading of the analog pin of Arduino average computation performed. Compare the value with prestored and if the value matches with prestored value Sign gesture will be recognized. If the values didn't match it goes back to input sequence where gesture will be recorded again.

MASTER ARDUINO

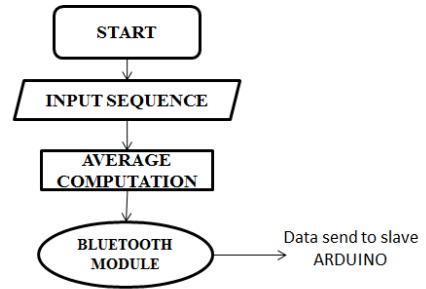


Fig. 5. Flow chart of master Arduino

E. Hardware Implementation

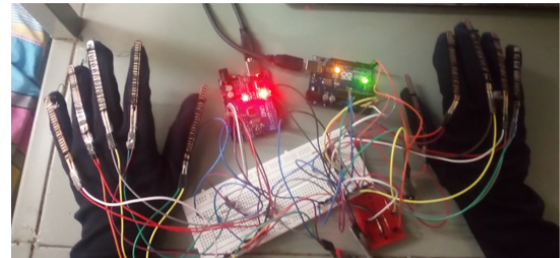


Fig. 6. Hand Gloves Setup

Figure Fig. 7. shows Hand Gloves setup. It requires 10 Flex sensors, 2 microcontroller and Bluetooth module which is HC 05. Each flex sensor is placed on the back of the fingers. Cost effective gloves are used here. Microcontroller here used is Arduino UNO in which 5 ADC channel is used. For communication between 2 microcontroller wirelessly we use Bluetooth module HC 05 is used. For communication between Arduino and Android phone we use another Bluetooth module. For communication between 2 Arduino UNO, one of the HC 05 must configure as Master and other must configure as Slave. Master can initiate connection with any device but Slave can only receive data. It cannot initiate the connection with other device. Baud rate for each Bluetooth module is set as 38400. When a gesture is given, flex sensor bend according to the gesture and will compute this bending value. It is then compared with the value that stored in microcontroller earlier and if it matches gesture will recognize. Transmission of recognized sign gesture to android phone is done by developing application using Android Studio.



Fig. 7. Hand Gesture Recognition System

F. Transmission of recognized gesture to Android phone

Transmission of recognized sign gesture to android phone is done by developing application using Android Studio. For that uses two application interfaces. They are TTS application program interface and Bluetooth application program interface [3].

IV. RESULT AND ANALYSIS

Figure 6.1 shows the recognition of alphabet O in both Serial monitor of Arduino IDE and Android phone when it is gestured by user. Similarly the remaining alphabets can be gestured by the user. First calculate the voltage reading corresponds to each Flex sensor and then modify it in the code. It is based on Indian Sign Language.

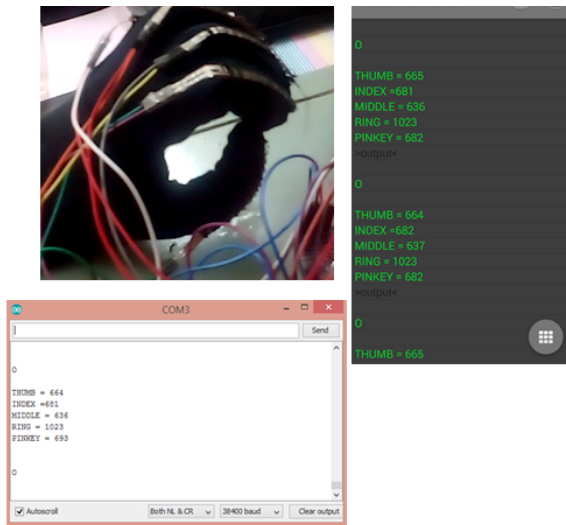


Fig. 8. Gesture O recognized

The table 1 shows the Voltage reading corresponds to each letter or word with variation of ± 0.04 . Here this gesture are made by single hand. Table 2 shows the voltage reading of hand gesture made by two hands.

Table 3 shows the accuracy percentage of sensor reading corresponding to each letter. Firstly corresponding to each

TABLE I
VOLTAGE READING CORRESPONDS TO LETTER OR WORD

Letter or Word	Thumb Value	Index Value	Middle Value	Ring Value	Pinky Value
C	3	3.17	3.05	>4	3.35
I	3.24	3.32	3.10	3.79	<3
O	3.14	3.18	3	>4	3.38
V	3.24	<3	<3	3.8	3.39
L	<3	<3	3.11	>4	3.4
ALL THE BEST	<3	3.31	3.10	3.82	3.39

TABLE II
VOLTAGE READING OF HAND GESTURE MADE BY TWO HANDS

Letters	A	B
Left Thumb Value	3.01	3.14
Left Index Value	3.29	3.18
Left Middle Value	3.11	3
Left Ring Value	>4	>4
Left Pinky Value	3.35	3.38
Right Thumb Value	<3	3.02
Right Index Value	3.2	3.01
Right Middle Value	3.2	3
Right Ring Value	3.5	3.5
Right Pinky Value	3.38	3.30

TABLE III
PERFORMANCE EVALUATION OF HAND GESTURE RECOGNITION SYSTEM

	1	2	3	4	5	6	7	8	9	10	Accuracy (%)
A	✓	✓	✓	✓	X	✓	X	X	✓	✓	70
B	✓	✓	X	✓	✓	✓	X	✓	✓	✓	80
C	✓	✓	✓	✓	✓	✓	X	✓	✓	✓	90
I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
L	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
O	✓	X	X	✓	✓	✓	✓	✓	✓	✓	80
V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100
ALL THE BEST	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	100

letter and word, flex sensor reading were calculated and noted down. It is then modified in the code. For accuracy checking this experiment is repeated for different set of people. Overall approximately 90 percent accuracy achieved.

V. CONCLUSION AND FUTURE WORKS

The key objective of this paper is to provide solution for the communication barrier between Speech impaired people and normal people so that to provide voice to the voiceless and also help deaf people and it is achieved by using proposed system. The gloves are cost effective and able to translate sign gesture into text in English and Malayalam language. The proposed system is portable and consume very low power and also provide improved accuracy. It convert Sign language with the help of Flex sensor, microcontroller and display it on Android phone using Bluetooth module HC 05.

This project can be further developed to converts more words phrases. The dynamic movements can be detected and sensed more accurately. This work can be extended to converts sign language to text and speech in other Indian Language like Hindi, Tamil using Android Studio.

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