SMART GLOVE FOR SIGN LANGUAGE TRANSLATION

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***Abstract*—Communication is the primary tool to exchange any information between people. But it becomes difficult for speech impaired and hearing impaired people to communicate as they use sign language for communication. Also it becomes difficult for normal people to understand sign languages. Smart Glove for Sign Language Translation is a work that aims to present an easy way of communication to speech impaired, hearing impaired people and normal people. This work consists of a glove equipped with sensors which senses different sign language gesture and Bluetooth module is used to transfer the data to commonly used Android phone. Android phone translates these gestures to respective voice, text and image of that particular gesture is also displayed on Android mobile using application.**

Besides, this application also translates voice of user (normal people) into text and text typed by the user into voice and image of that gesture is displayed. There are different types of sign languages which differ from country to country. This work deals with American standard sign language and Nepali sign language.

In real life, the sign language users mostly use both hands. Thus, this is a prototype work presenting an ease in communication for the speech impaired and hearing impaired people.

Keywords—Sign Language Translation, Sensor Based, Communication, Bluetooth module

I. INTRODUCTION

The number of speech impaired and hearing impaired people are increasing day by day. About 7 to 9 million people in the world are hearing impaired [1, pp.16]. We often come across these people communicating with the normal world. These people communicate with the help of sign language. When a speech impaired person tries to communicate with normal person and vice-versa, they feel difficult to understand. Therefore to bridge the gap between speech impaired, hearing impaired and normal masses, gesture recognition system is being used. Gesture recognition is a widely explored field. A lot of work has been done in the past few years. An electronic device has been used as a language interpreter and provides convenient way for communication between speech impaired, hearing impaired and normal people. Gesture for American Standard Sign Language is shown in figure 1. Gesture recognition is classified into two main categories i.e. vision based and sensor based. The main disadvantage of vision based techniques includes complex algorithms for data processing. Another challenge in image and video processing includes variant lighting conditions, backgrounds and field of view constraints. The sensor based technique offers greater mobility.

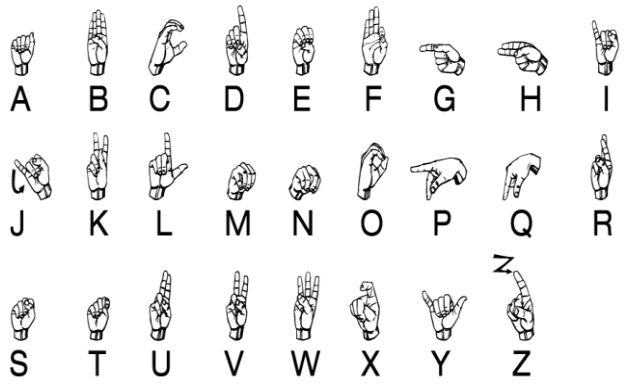


Fig. 1. American Standard Sign Language

This work uses sensor based technique instead of vision based technique. First of all, sign language is converted to analog voltage signal using flex sensor and accelerometer. Using ADC from the microcontroller board analog signal is converted to digital signal. Now, the microcontroller processes this digital signal, detects respective characters and passes through Bluetooth module to Android phone. An application on android is used to display the characters received from Bluetooth module in the form of text and text to voice translator to get voice output. Also, voice to text translator is used to display text and convert it into sign language.

II. OBJECTIVE

- To translate sign language into text and speech.
- To translate speech into text and sign language.
- To translate typed text into respective voice and sign language.
- To break gap between speech impaired, hearing impaired and normal masses.

III. LITERATURE REVIEW

Many attempts have been made throughout years to bridge the gap between the speech impaired, hearing impaired and normal people. Majority of the attempts included converting the sign language to the audible signals. This paper has presented brief summaries of different past attempts which were made for developing smart glove using various technologies.

Many methods for hand gesture recognition using image processing have been proposed. “Hand Gesture Recognition System using Image Processing” uses digital image processing techniques using modified SIFT algorithm. With the help of the algorithm the sign language is decoded successfully. The advantage using this algorithm is high processing speed which can produce result in real time. Although the proposed system is fast requires expensive materials also [2].

“Sign Language Recognition Using Image Processing” uses image processing with the help of SURF (Speed up Robust Features) algorithm. Video camera is used to record hand movements, and the input video is partitioned into frames, for each frame, a set of features are extracted. The system is implemented in MATLAB [3].

“Deaf-Mute Communication Interpreter” uses sensor based technique comprising of flex sensor, tactile sensors and accelerometer to translate American Sign Language gestures to both text and auditory voice. Although, they were only able to translate thirteen sign into their respective alphabets namely letters ‘A’ ‘B’ ‘C’ ‘D’ ‘F’ ‘I’ ‘L’ ‘O’ ‘M’ ‘N’ ‘T’ ‘S’ ‘W’ and tactile sensor were used to improve the accuracy of three letters M, N and T [4].

“Sign Language to Speech Translation System Using PIC Microcontroller” consists of flex sensors that is used to detect finger gestures and gyro sensors for providing a signal corresponding to the orientation of the motion of the hand [5].

“Design of Smart Gloves” uses pair of gloves with flex sensors along each finger, thumb and arm is used to capture the movement of user. The problem with this work is it can detect only few letters [6].

“A Review Paper on Smart Glove - Converts Gestures into Speech and Text” uses five flex sensors and accelerometer attached on the back of the glove to measure the bending and motion of the hand. The problem with this work is it is only able to recognize some letters. Letters M, N, O, R, S, T, V and X cannot be displayed due similar in gesture with another letters [7].

“Digital Text and Speech Synthesizer Using Smart Glove for Deaf and Dumb” uses five flex sensor to detect finger gesture and accelerometer to sense x, y and z axes, find tilting angle of the glove. The glove is capable of translating sign language gestures into speech through android phone. This work focuses the translation of words only [8].

“Smart Glove: Gesture Vocalizer for Deaf and Dumb People” uses glove at the transmitter side which has to be worn by the user. This glove is mounted with 4 flex sensors each on the 4 fingers of the glove namely thumb, index, middle and ring. This work also focuses the translation of words only [9].

IV. Problem Statement

Sign language is the only communication tool used by speech impaired and hearing impaired people to communicate. However, normal people do not understand sign language and this will create a large communication barrier between speech impaired, hearing impaired and normal people. In addition, the sign language is also not easy to learn due to its natural differences in sentence structure and grammar. Therefore, there is a need to develop a system which can help in translating the sign language into voice and voice to sign language in order to ensure effective and easy communication between different communities.

V. Working Principle

A. *Materials*

- Flex Sensor
- Accelerometer
- Touch Sensor
- Arduino UNO
- Bluetooth Module
- Android Mobile

B. *Methodology*

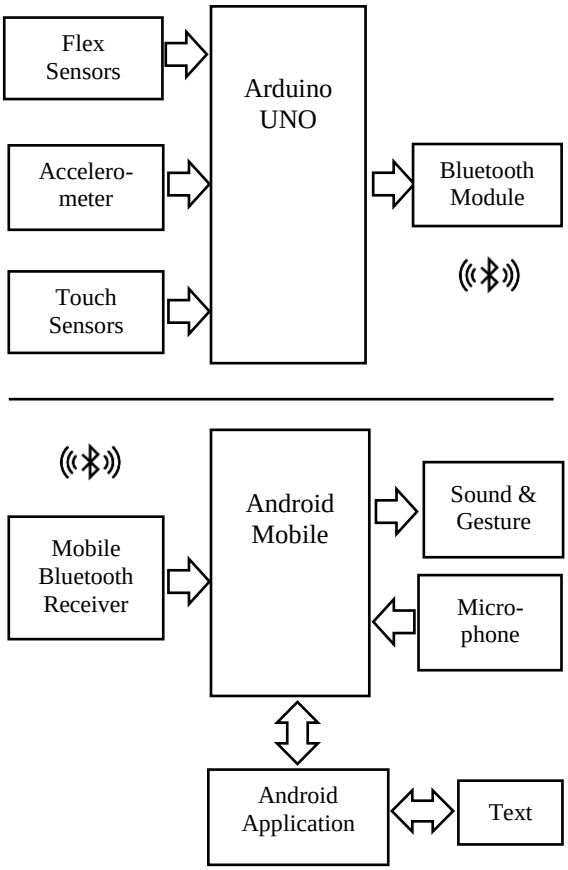


Fig. 2. Block diagram for smart glove

The flex sensor measures the bending of fingers according to gesture and outputs change in resistances corresponding to the amount of bending. Accelerometer sensor measures the linear movements of hand in X-axis and outputs different values of X-axis. Touch sensor measures contact between two fingers and provides high output when

two fingers comes in contact with each other. All the data from sensors are then processed on Arduino UNO and resultant output is compared with pre-stored values of different signs. For comparison, appropriate ranges are set and stored in the microcontroller associated with each alphabet and words which are termed as pre-stored values. A Bluetooth module is connected to Arduino UNO. The processed data are then transferred to Android Mobile through Bluetooth module. Android mobile receives data via Bluetooth in bytes format, convert them into string and finally string is converted into voice using the text to speech converter of Android mobile. This overall system is mounted over a normal glove for easy handling.

VI. Flow Chart Of Smart Glove

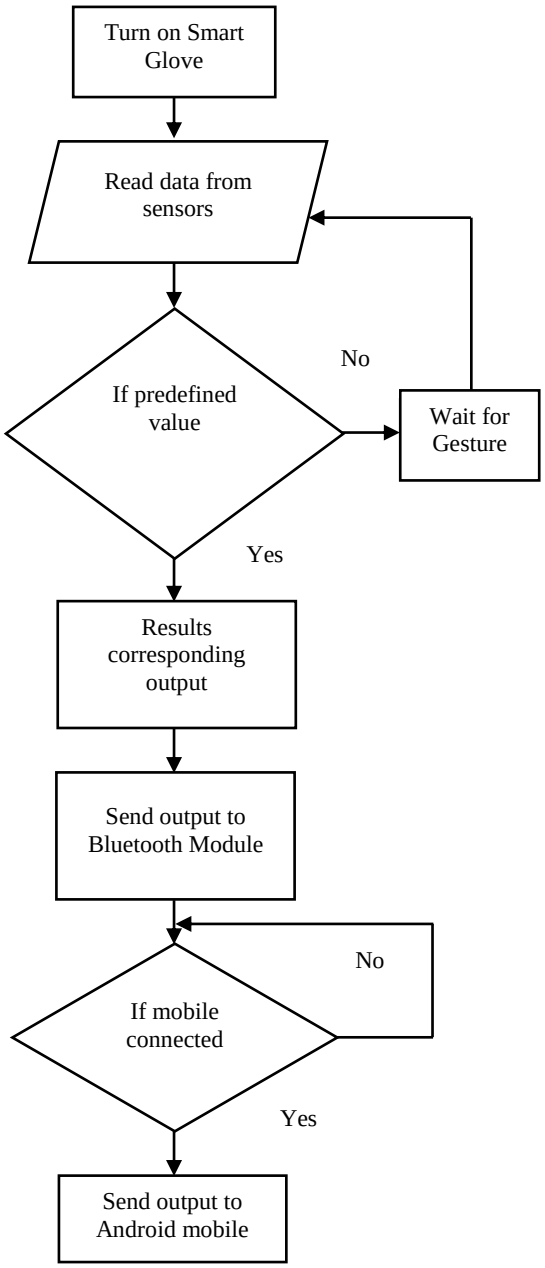


Fig. 3. Flowchart of Transmitting Section

VII. Flow Chart Of Android Application

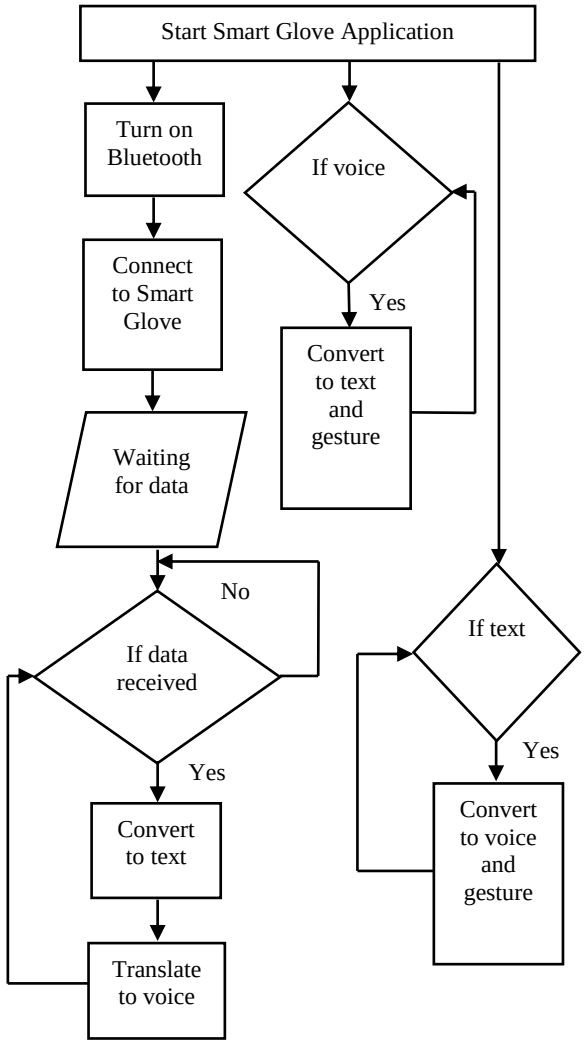


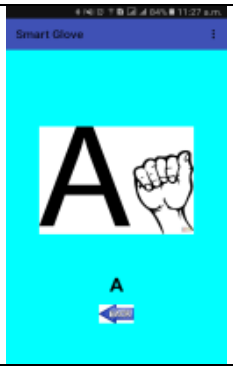
Fig. 4. Flowchart of Receiving Section

VIII. Result And Discussion

The outcomes of this work as estimated were successfully displayed into text and voice. So, it can help speech impaired and hearing impaired people to communicate with normal people easily. There is also another feature in this system which makes normal people to communicate with speech impaired and hearing impaired people with android application which converts people's voice into text and sign language. All works mentioned above deals only with one way communication from impaired people to normal people but this work allows two way communication between these groups. Also, this work converts all of the letters and some words unlike others. The only work that converts all letters and some word is "Digital Text and Speech Synthesizer Using Smart Glove for Deaf and Dumb" but this work deals with converting gestures into text and speech only. So, this project is quite feasible to develop two way communication between speech impaired, hearing impaired and normal people.

For the convenience four alphabets 'A' 'C' 'U' and 'V' with sign language, output and graph have been shown below.

TABLE I. OUTPUT OF HAND GESTURE ‘A’

Sign	Output
	

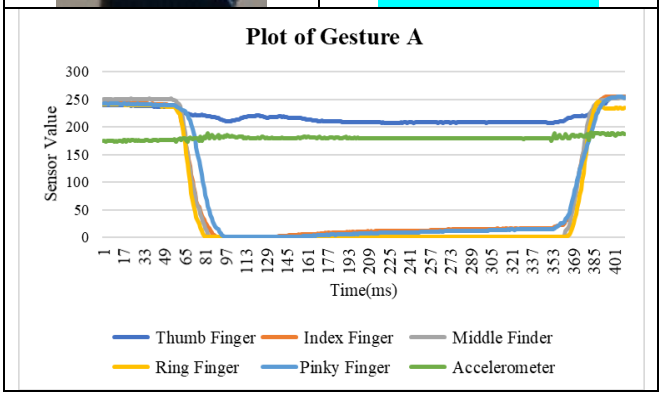


TABLE II. OUTPUT OF HAND GESTURE ‘C’

Sign	Output
	

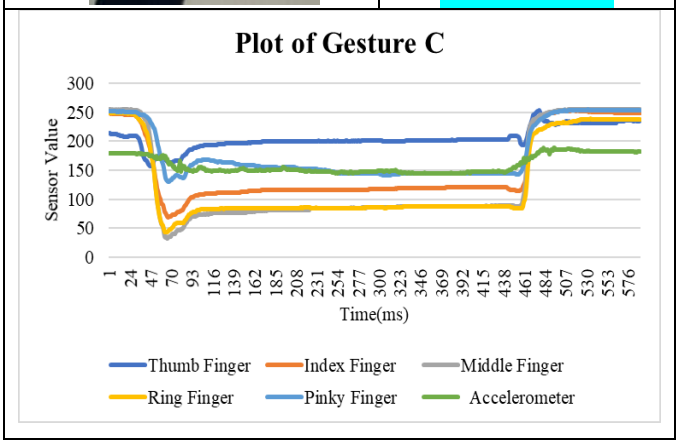
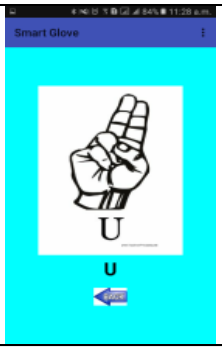


TABLE III. OUTPUT OF HAND GESTURE ‘U’

Sign	Output
	

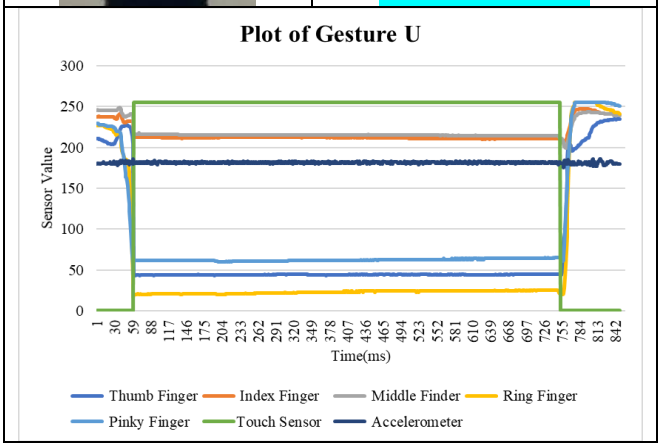
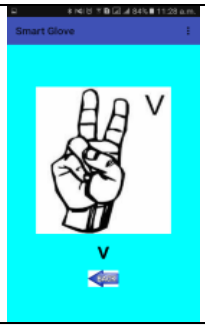


TABLE IV. OUTPUT OF HAND GESTURE ‘V’

Sign	Output
	

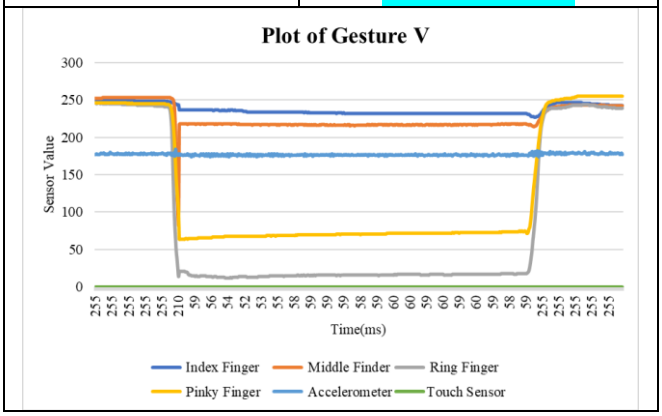


Figure 5 depicts the feature of system which helps normal people to communicate with speech impaired and hearing impaired people by converting voice to sign language.

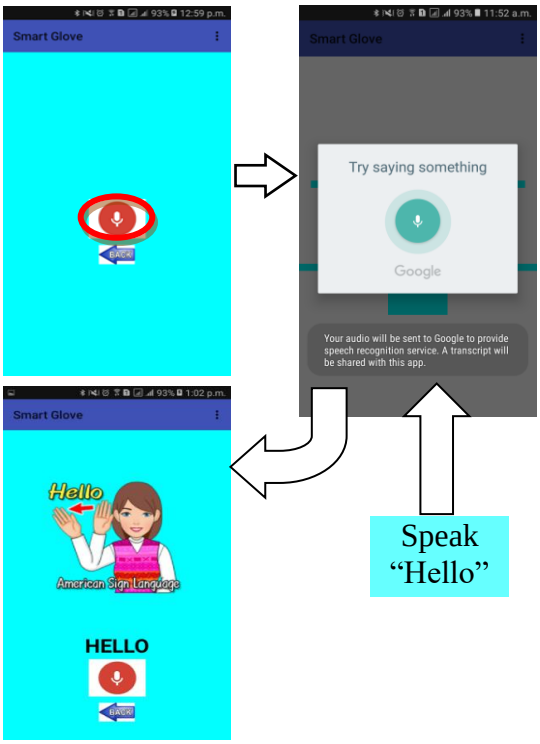


Fig. 5. Voice to Text and Sign language

Figure 6 and 7 depicts another feature of system that can help impaired people due to any oral diseases, accidental causes etc. It helps them to learn gesture through android application easily.

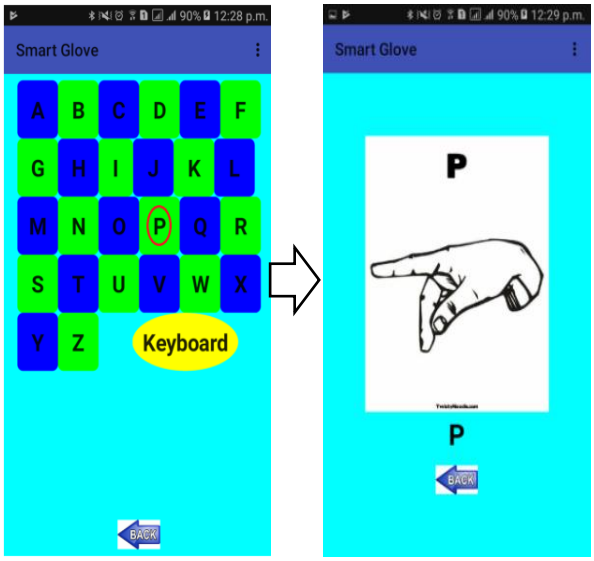


Fig. 6. Text to Sign language

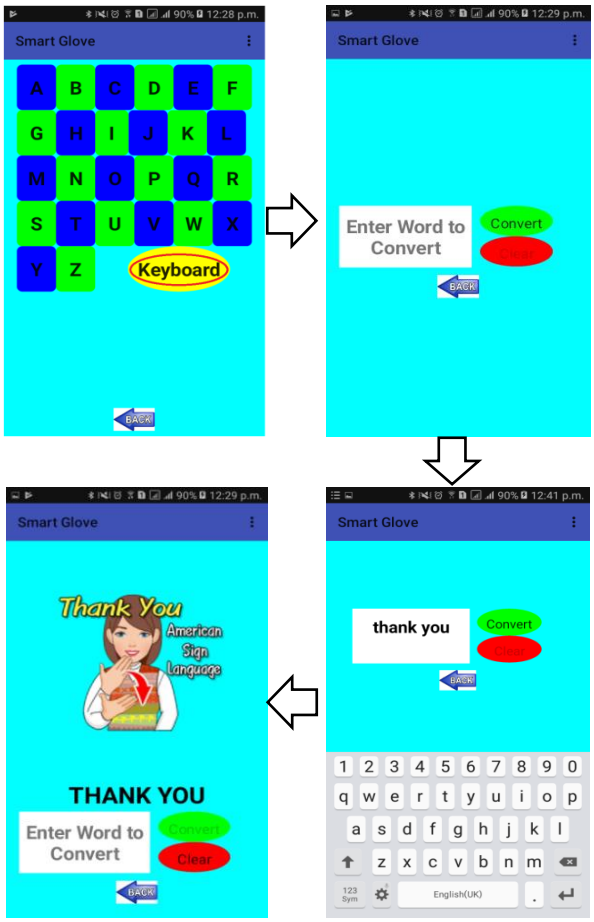


Fig. 7. Word to Sign language

A. *Two Languages*

This work consists of the option for two languages to convert gesture to text and speech and text to sign and speech. All of the English and some Nepali letters have been included in this work.

Android application consists of mode selection option for two languages. When English language is selected, the American Standard gesture made by impaired people is converted into respective analog signals, processed and compared with pre-stored values and respective letters or word is determined. Determined letter or word is transmitted to android through Bluetooth Module for conversion into respective text and voice.

When Nepali language is selected, Nepali gesture made by impaired people is processed and detected as above. The only difference between these two languages is that they have different letters and different gesture for these letters. But some of the letters in both languages are exactly similar. For example, 'B' in English is similar to 'ब' in Nepali, 'Y' in English is similar to 'उ' in Nepali and so on.

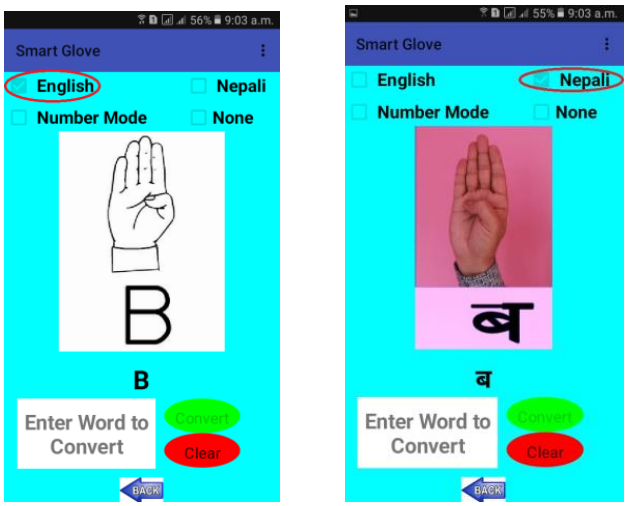


Fig. 8. Two languages for same gesture

B. *Merging Letters into Words*

This work consists of the option for merging the letters received from glove into word and then words into sentence.

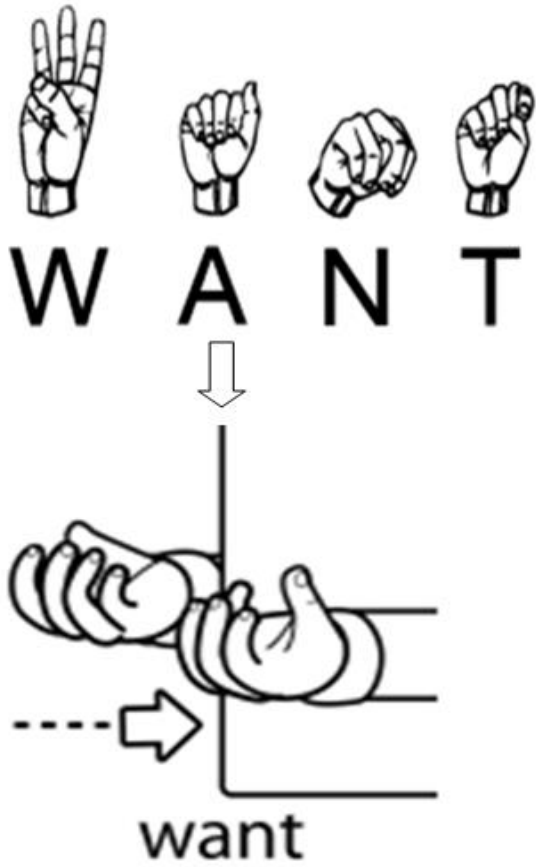


Fig. 9. Letters merged into word

C. *System's Accuracy*

To make system accurate touch sensor has been used specially to distinguish two similar gestures. For example, while setting range for letter 'U' and 'V' it was found that flex sensor and accelerometer have similar output. Therefore to distinguish them and many other gesture touch sensor has been used.

To check accuracy each gesture of both English and Nepali were randomly made 30 times. Where overall gesture for letters and words showed accuracy of 87.69 percentage.

Accuracy was not obtained 100 percent because of different reasons. While changing the gesture for one letter to another letter unwanted output was obtained due to continuous processing of intermediate signals from sensors. Another cause of inaccuracy was due to error in setting range of pre-stored values. But this can be reduced taking multiple observation and adjustment of range of pre-stored values.

IX. Conclusion

The project proposes a system for speech impaired and hearing impaired people using glove technology and enables normal people to communicate with them too. The use of five flex sensor, touch sensors and an accelerometer on a glove demonstrate that it is helpful to break the gap between speech impaired, hearing impaired and normal people. This device will be an apt tool not only for the people who got such disability naturally rather it also helps disability due to oral diseases and accidental cause which make them to learn gesture through application easily. The project can be enhanced further by including more words and different standard sign language.

X. COMPARISON TABLE

TABLE V. Comparison of this work among the previous works based on the paper published.

	Output	Capability	Language
Smart Glove for Sign Language Translation	Text, Gesture and Speech	All alphabets and some words	English And Nepali(few alphabets)
A Review Paper on Smart Glove	Text and Speech	Some alphabets and some words	English
Deaf-Mute Communication Interpreter	Speech	Some alphabets	English
Design of Smart Glove	Text and Speech	Some alphabets	English
Digital Text and Speech Synthesizer Using Smart Glove for Deaf and Mute	Text and Speech	Some words	English
Hand Gesture Recognition System for Dumb People	Gesture and Text	-	English
Sign Language Recognition Using Image Processing	Gesture and Text	All alphabets	English
Sign Language to Speech Translator System Using PIC Microcontroller	Speech	Some alphabets	English
Smart Glove Gesture Vocalizer for Deaf and Dumb People	Text and Speech	Some words	English

	Sensors Used	Conversion	Portability
Smart Glove for Sign Language Translation	Flex Sensor, Accelerometer, Touch Sensor	Two way	Portable
A Review Paper on Smart Glove	Flex Sensor, Accelerometer	One way	Portable
Deaf-Mute Communication Interpreter	Flex Sensor, Accelerometer, Tactile Sensor	One way	Portable
Design of Smart Glove	Flex Sensor	One way	Portable
Digital Text and Speech Synthesizer Using Smart Glove for Deaf and Mute	Flex Sensor, Accelerometer	One way	Portable
Hand Gesture Recognition System for Dumb People	Web-camera	One way	Non-Portable
Sign Language Recognition Using Image Processing	Camera	One way	Non-Portable
Sign Language to Speech Translator System Using PIC Microcontroller	Flex Sensor	One way	Portable
Smart Glove Gesture Vocalizer for Deaf and Dumb People	Flex Sensor, Accelerometer	One way	Portable

XI. REFERENCES

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