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DIGITAL TEXT AND SPEECH SYNTHESIZER USING SMART GLOVE FOR DEAF AND DUMB

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***Abstract*-Perhaps the single quality most central to humanness is the ability to exchange thoughts, ideas, and feelings with others. The importance of the capacity to connect with other people cannot be overstated. Helen Keller was once asked, if she could have eitherher vision or her hearing, but not both, which would she choose? Without hesitation, she replied, "My hearing." When asked why, she responded, "Blindness separates a person from things, but deafness separates him from people".**

Persons with severe and profound disabilities may be especially vulnerable to this problem of separation from the mainstream of society. Federal legislation has defined persons with severe disabilities as those "who because of the intensity of their physical, mental, or emotional problems, need highly specialized education, social, psychological, and medical services in order to maximize their full potential for useful and meaningful participation insociety and for self-fulfillment. Many individuals who have severe disabilities experience substantial difficulties in communicating effectively with those around them

With the advent of wearable technology, it is now possible to implement numerous and extremely creative ideas to serve humanity in unprecedented ways. Thus, came the idea of such a system which can act as a medium for deaf and dumb people to communicate and convey their feelings in a more appropriate and efficient manner. Due to communication gap deaf and dumb community is restricted in a small social circle and is not able to mix up and interact with normal masses. This proposed system is a path towards the breaking of this communication gap.

***Index Terms*- Augmentative Communication, Accelerometer,Deaf, Flex Sensors, Sign Language, Smart Glove.**

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I.INTRODUCTION

Smart glove is a system which comes under the category of Augmented and alternative communication. Augmentative and alternative communication (AAC) is a prominent component in the development of support services for individuals with disabilities, especially those with severe disabilities. Technologies such as augmentative and alternative communication (AAC) systems can help to minimize this separation from other people. An AAC system is an "integrated group of components, including the symbols, aids, strategies, and techniques used by individuals to enhance communication". These technologies range from relatively low-tech systems (i.e., simple adaptations with no batteries or electronics, such as communication boards). AAC systems may be roughly classified into one of two categories: unaided communication systems and aided communication systems. Unaided AAC systems do not require any sort of external communication device for production of expressive communications. Sign language, facial expressions, gestures, and non-symbolic vocalizations are all unaided modes of communication. Aided systems require an external communication device for production. Examples of aided systems include the use of picture communication boards and voice-output devices. Perhaps the most dramatic change in AAC has been the explosion in the availability and capabilities of technology. The advent of the microcomputer led to the development of user-friendly communication devices with sophisticated voice output. These advances have led to communication options and possibilities for persons with severe disabilities that were unavailable even a decade ago.

Electronic communication devices can be broken down into two categories: dedicated and undedicated systems. A dedicated device is strictly a communication device—the only thing it does is speak. Undedicated devices, which are computer based, not only speak, but also feature all the functions of a regular PC or laptop—word processing, e-mail, web surfing, etc. Smart Glove comes under the category of dedicated device.

Smart glove is based on the wearable technology. It is basically a device which has some specific wearable sensors with phenomenal temperature stability. All the sensors are fitted on a glove which measures the different analog parameters associated with the movement of fingers and orientation of the hand during any particular gesture. These sensors readthose particular analog values and coding is done in the microcontroller according to these values. Also the glove has a bluetooth fitted in the hardware which sends these values to a smart phone which has an android app in it which gives the equivalent text and speech corresponding to that particular gesture of the sign language.

II. LITERATURE REVIEW

TusharChouhanet al.implemented wired interactive glove, interfaced with a computer running MATLAB or Octave, with a high degree of accuracy for gesture recognition. The glove maps the orientation of the hand and fingers with the help of bend sensors, Hall Effect sensors and an accelerometer. The data is then transmitted to a computer using automatic repeat request (ARQ) as an error controlling scheme. The system is modelled for the differently abled section of the society to help convert sign language to a more human understandable form such as textual messages. The hardware section of their proposed design has its constituent electronic components as bend sensor, hall-effect sensor, accelerometer and Machine Learning Algorithms Used for Gesture Recognition.

The bend sensor outputs are fed to the analog multiplexer (HEF4051B by NXP Semiconductors). The output of this multiplexer is given to a current to voltage converter circuit. Since the voltage output of the Hall sensor is low, an amplifier is needed. Sensor outputs obtained are given to the inbuilt ADC (analog to digital converter) of MSP430G2553(by Texas Instruments)for sampling the values given by the sensors, which is also used for interfacing the glove with a computer running the machine learning algorithms.

The data acquisition process starts with the processor sending control signals to multiplexer for receiving values from the different sensors sequentially and temporarily storing it in an array. These stored values are transmitted to the computer using universal asynchronous reception and transmission (UART) connection for further processing and decoding of the received signals. While transmitting the values in UART automatic repeat request (ARQ) scheme has been incorporated for avoiding the information loss because of transmission errors. [2]

JanFizza Bukhari et al. proposed a system consisting of 21 sensors, out of which 9 were flex sensors, 11 were contact sensors and one for measuring acceleration. At least 9 analog voltage channels for flex sensors and at least 10 digital channels for contact sensors were required. To enhance the performance and accuracy of the system, signal conditioning for accelerometer readings was needed. Baud rate was set at 9600 and sampling rate at 500 samples per second. The device used was: NI PCI-6250. SCB-68A I/O block was used for interfacing signals to plug in DAQ devices with 68 pin connectors. The NI PXI 8330 module was used to connect an external controller (our desktop computer) to a PXI chassis. It was paired with a PCI 8330 in desktop computer with a MXI cable running between the two. It contained a MXI-3 Multi-System Extension Interface for PCI.

A total of 26 gestures were trained, with 20 recordings of each consisting of 250 samples each. Principle Component Analysis was used for classification and feature extraction to reduce dimensionality while preserving as much class discriminatory information as possible. [3]

VajjarapuLavanya et al. presented a system which can be made using small metal strips that are fixed on the five fingers of the glove. A copper plate is fixed on the palm as ground.

According to their design implementation it is better to use a ground plate instead of individual metal strips because the contact area for ground will be more facilitating easy identification of finger position. The copper strips indicate a voltage level of logic 1 in rest position. But when they come in contact with the ground plate, the voltage associated with them is drained and they indicate a voltage level of logic 0. Thus necessary gestures are formed. The microcontroller used in this was PIC16F877 and a voice synthesizer named EMIC-2 which is a multi-language voice synthesizer that converts a stream of digital text into speech. It is a simple command-based interface that makes it easy to integrate with any embedded system. [4]

AmbikaGujrati et al. proposed a system which consisted of flex sensors, tactile sensors and accelerometer. Their hardware requires 5V DC and hence a voltage regulator of 7800 series (7805) is used. LED‟s are used which informs about the supply being activated. A 330Ω resistor is used to drop the voltage and make it 2-2.5V as required by the LED. The deflection of the flex with a minimum angle of 40°, a resistance is obtained which is increased by bending and voltage is obtained. Four flex sensors along with their connection ports are placed. The voltage is in milivolts so op-amp (LM358) was used to amplify it. The op-amp used is a non-inverting type with high voltage gain. Rf resistor is variable resistor with (0-10)kΩ and Ri is 2.2kΩ. A 33k resistor is used at the output of op-amp which stops the voltage from being grounded. PIC16F877 a peripheral interface controller is used with flash memory 8kb and an inbuilt ADC converter with 10 bit resolution. The microcontroller converts the analog output into digital and provides a high and low voltage. A crystal oscillator with 12MHz is used which provides the microcontroller with frequency clock pulse. Two 33pF capacitors are used along with the oscillator. The high or low voltage is then passed to an NPN transistor which gives the output which is further sent to relays. Relays used have internal magnetic field. They act as an ON-OFF switch. One relay acts as play button and the other as forward , for the 3rd flex sensor to act the forward relay will be forwarded 2 times and then played and similarly others will operate. The message is now forwarded to voice recorder ISD1720 which has mike and speaker connected to it. Electrolytic and ceramic capacitors are used which removes the ripples and cancels noise. An RF circuit is used which provides automatic gain control which gives constant output. The voice can be recorded through mike and according to the flex deflected the output is received from loudspeaker. Their circuit diagram shows the capability to measure or translate 7 potentials sign language "Word A, B, C, D, F, K and number 8".[5]

M. Mohandes et al. proposed an image based system for recognizing Arabic sign language. First, the system detects the signer's face by using the Gaussian skin model. Centroid of the detected face region is taken as the origin for each frame and then the hands movement is tracked by applying region growing technique. Hidden Markov Model (HMM) is used to perform the classification of the signs during the recognition stage, through some computation based on the features extracted from the input images. [6]

K. Park, et al. implemented a real-time embedded FPGA-based gesture recognition system using 5DT data glove. This approach is used in order to reduce the problems of space limitations, movement limitations and lighting limitations. The architecture of the system consists of three main modules that are input module, recognition module and display module. The system recognizes the hand gesture by performing data calculations with a checksum function on the input data and compares the result to the header byte before proceeds to the matching process. The matching process compares the input hand gesture with the pre-defined hand gesture. Then, the result is displayed on the LCD screen. [7]

W. K. Chung et al. presented a real-time hand gesture recognition system based on Haar wavelet transform. They proposed a code word scheme based on features of hand gestures for matching process. Besides, the system reduces the database size by standardizing the orientation of hands using the principal axis. In the project, recognition algorithm based on Haar wavelet representation has been developed. Hand images with resolution of 160×120 pixels are captured by using ICE digital webcam. Skin color approach is used to extract the hands from the image. [8]

M. P. Paulraj et al. presented a simple sign language recognition system that is capable of recognizing nine phonemes in English using a machine vision system. The system had been developed based on skin color segmentation and Artificial Neural Network (ANN). There are three processing stages in the system; preprocessing, feature extraction and gesture classification. Skin color detection and region segmentation are carried out during the preprocessing stage. Skin color of the hand is detected based on the RGB values in the image frame. The feature extraction stage extracts moment invariant features, obtained by calculating the blob in the set of image frames, from the right and left hand gesture images. The gesture classification stage then uses these features as its input to ANN to recognize the sign. It is reported that the average recognition rate for this system is 92.85%. [9]

Wang et al. presented a sign language recognition system that uses tensor subspace analysis to model a multi-view hand gesture. The hand recognition process is achieved through color segmentation. Input image that is in RGB color space is converted to YCbCrcolor space to ease the process of detecting the skin that employs the Back Propagation (BP) networks model. The sign language recognition is modeled and recognized using tensor. Then, the matching process is carried out to identify the input hand gesture. [10]

The sign signal translation system created by **KuoChue Neo, et al.** is recognized as a set of hand gestures, which is the sign signal, present in an image that captured using a camera. The sign signals are recognized based on the finger counts detected in the image. They develop a sign signal translation system that is able to detect and translate the hand gesture (sign signal) from individual captured images. The detected sign signal is then translated into its corresponding numerical representation. They used Altera's DE2 board that features Cyclone II FPGA chip with Nios II soft core processor inside, to construct the system. FPGA is used to construct the system as FPGA is considered to have the capability to perform the image processing faster. Their approach is based on the image processing techniques to capture the different signs in different image. [11]

Harmeet Kaur, et al. in their paper, presented a brief description about the past attempts that were made to convert sign language to understandable form. In their paper, they have thoroughly scrutinized the previous attempts over this technology and also suggested various possible ways to implement the design of a simple smart glove. [12]

Abhishek Tandon, et al. in their paper presented a brief introduction of their proposed design of

'Smart Glove' along with the previous attempts done in the area of augmentative and alternative communication (AAC). The proposed design of their glove converts the Indian Sign Language (ISL) into text and speech. Their proposed design consists of five flex sensors, one for each finger of the hand. These flex sensors are connected to five analog inputs of the microcontroller. They used microcontroller to process input voltage of the flex sensors and send the desired text output to the android device (smart phone) using Bluetooth module. Their android device has a software application which can convert the text into audible (speech) signals. [13]

III. PROBLEM STATEMENT

Sign language is the only communication tool used by deaf people to communicate to each other. However, normal people do not understand sign language and this will create a large communication barrier between deaf people 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 text and voice in order to ensure the effective communication can be easily take place in this community.

IV. DESIGN IMPLEMENTATION

Fig. 1 depicts the proposed circuit diagram for the smart glove. It consists of five flex sensors placed on the five fingers which serve the purpose of measuring the bend of fingers during any particular gesture. Flex sensor is a resistive sensor which changes its resistance as per the change in bend or curvature of it into analog voltage. These sensors are able to detect the only the activity of the fingers hence some of the letters are not displayed as the gestures of these letters is similar to other letters. Hence, to increase the accuracy accelerometer has been incorporated in the hardware section which measures the orientation of the hand. Accelerometer can find out the angle of the glovetilted with respect to the earth. It will be attached in the middle of the glove to measure the angle of tilted of the glove. The accelerometer uses a single structure for sensing the x, y and z axis. The output voltage of accelerometer changes depending on the tilting with respect to the earth. The controller used in our design is Arduino NANO. As all the outputs from both types of sensors are analog in nature, the output from five flex sensors and three outputs from the accelerometer are given as input to the analog inputs or analog port of the Arduino NANO. Arduino NANO has an inbuilt ADC in it which converts these analog inputs into digital output. After receiving these digital outputs coding is done accordingly. All the values of the flex sensors and of the accelerometer are mapped according to each gesture and then code is written for all the gestures.

A bluetooth is also present in thehardware section. The Bluetooth module transmits the received data through a wireless channel which is then received by a Bluetooth receiver in the smartphone. We have developed a text to speech app using MIT App Inventor software which receives all the data and converts it into text or equivalent speech as per user's need. Fig. 2 shows the developed GUI software.

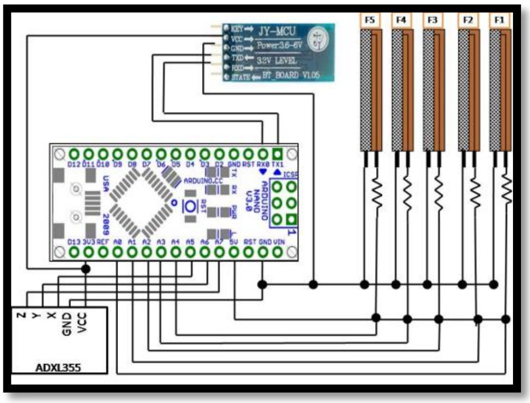


Fig. 1: Circuit diagram of the proposed design

V.RESULT AND DISCUSSION

The results of our implemented design are shown in the following table 1. In the table we have shown the outputs obtained by different orientations of the subject's hand wearing smart glove. The corresponding words are displayed on the android application as shown in column 2 of table 1. The android application also does the work of converting the received textual data into voice signals making them audible and understandable for normal masses.

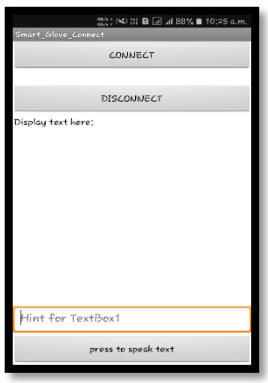
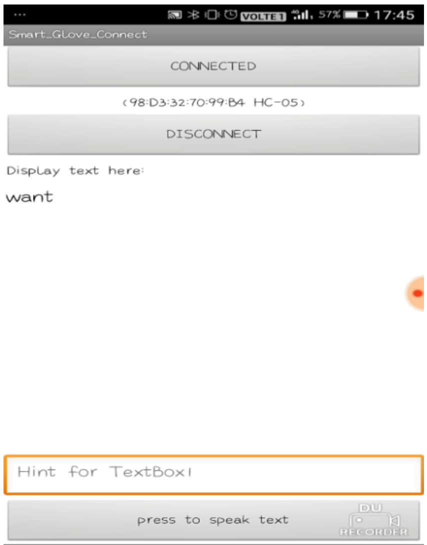
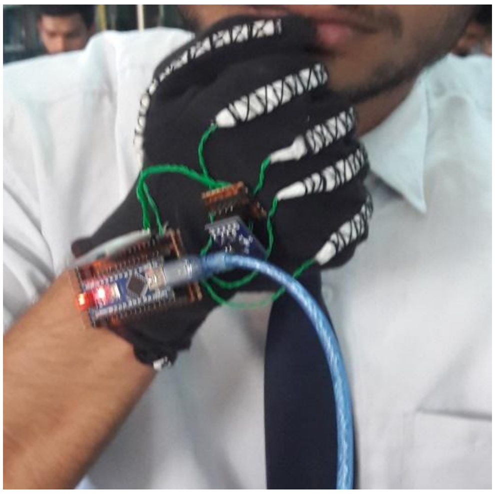
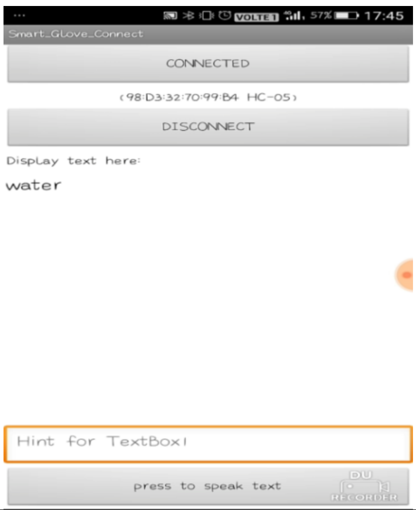


Fig. 2: GUI developed

Table 1: Results Obtained

S No.	Hand Gestures	GUI Application
1.		
2.		
3.		

<table>
<tr>
<td>4.</td>
<td></td>
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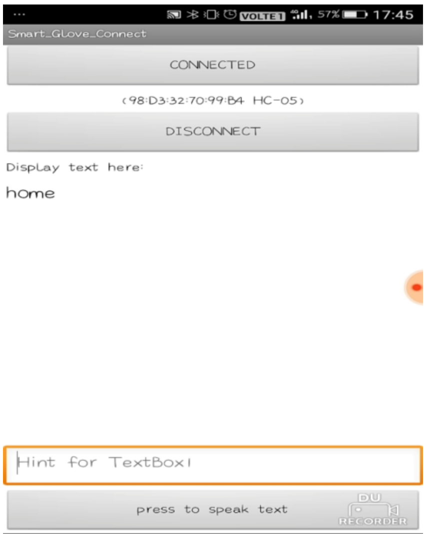
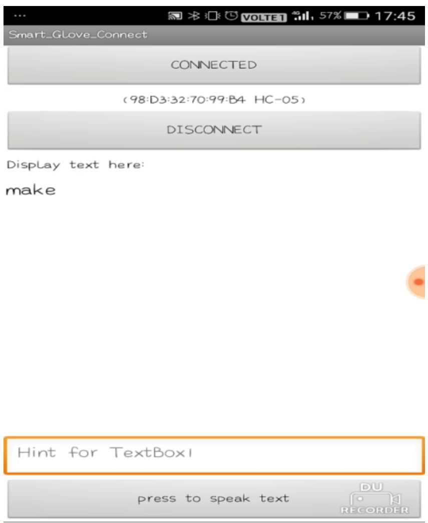
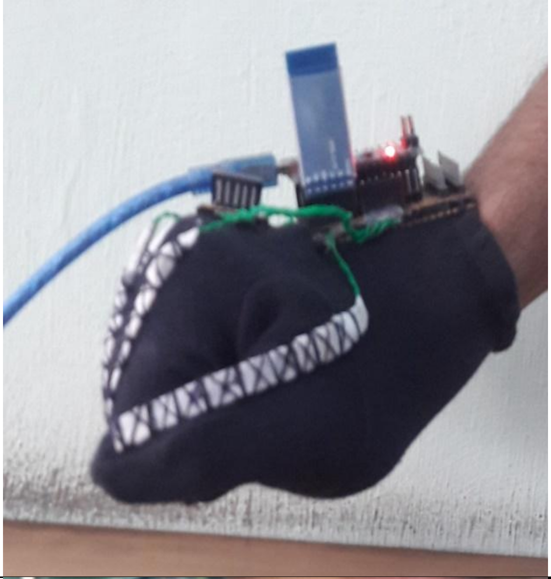
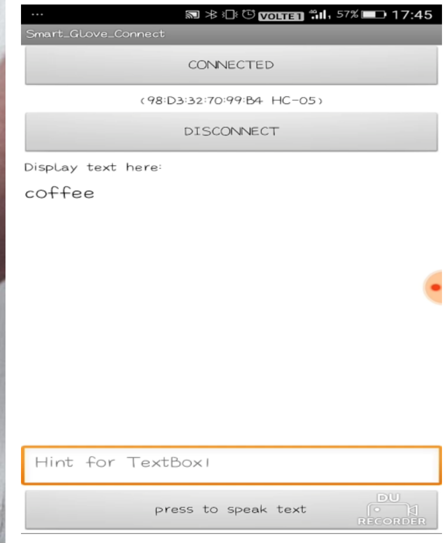
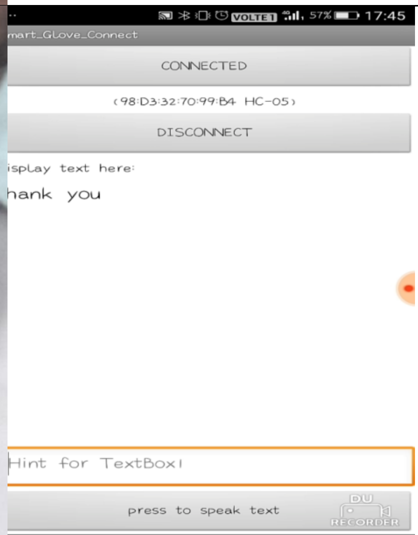
</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>
</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>
</td>
</tr>
</table>

<table>
<tr><td>7</td><td>
</td></tr>
<tr><td>8.</td><td>
</td></tr>
</table>

VI. CONCLUSION

Sign language is one of the useful tools to ease the communication between the deaf 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 our project lowers such barriers .The glove is capable of translating their sign language gestures into speech through android phone. Smart glove focuses the translation of gestures of the alphabets. Comparing with other approaches, smart glove uses Principle Component Analysis to classify the real time input data for feature extraction.

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