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Two-way Smart Communication System for Deaf & Dumb and Normal People

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***Abstract*—With regards to deaf & dumb individuals, communication with others is way longer struggle for them. They are unable to speak with traditional individuals properly. They face difficulties in finding jobs and living traditional life like others. In this paper, we are introducing a two way smart communication system for Deaf & Dumb and also for Normal people, The system consists of two main parts: The first part is for Deaf & Dumb people to convey their messages to normal people by using our hardware system which is portable to wear and the second one is for a normal person who can also respond them easily without learning a sign language by using our Android Application. This ensures a two-way smart communication system and will make life less demanding for them.**

***Index Terms*—Pakistani Sign Language (PSL); Leap Motion Controller (LMC); Android Application; Raspberry pi; Google API; Bluetooth; Cloud.**

I. Introduction

The number of Deaf & Dumb people is over five-hitter of the population. Linguistic communication is principally used by Deaf & Dumb to speak with one another. The most downside today moon-faced by Deaf & Dumb folks is to speak with those that don't understand linguistic communication, whereas writing is associate degree possibility, it's thought of as a slow and inefficient manner of communication. Thus a viable possibility would be to rent an expert linguistic communication translator.

In this paper, we are introducing two-way smart communication system for Deaf & Dumb and Normal people, the project is building a system that assists Deaf & Dumb people to convey their messages to Normal people. Also, Normal people can respond to their messages to Deaf & Dumb people. We have a two way smart communication system, In this system a way of communication is for Deaf & Dumb person sit down with a standard person, we tend to square measure victimization Leap Motion device for hand movement recognition are done so by victimization motion track information of Leap Motion device, system is trained with PSL Sign Language. The system can acquire information through the Leap Motion device that information is wont to acknowledge the PSL Sign Language then convert into associate degree audio kind within the speaker. Also, In a different way of communication is for a standard person to speak to a Deaf & Dumb person while not knowing and learning PSL Sign Language, we tend to build Android Application within which the communication module of projected system can acquire information (voice) from a standard person through microphone, and then the perceived information will be converted into text and send through Android Application to Raspberry pi 3b+ TFT screen within the kind of text, and also extra options like emergency are obtainable within the Android Application.

II. Literature Review

A. Sign Language Recognition

Sign Language Interpretation created by ALEX COLGAN in 2014 was about a communication method for deaf persons. Utilizing sign language as data to Information and Communication Technology devices, it is feasible for hearing impaired to get something which is difficult to carry out by a typical console or touchpad. G. Marin et al. [1] have explained their approach for recognition of hand indications utilizing two new hand motion control based gadgets Leap Motion Controller and Microsoft Kinect. In their research, they split hand gesture identification into 5 vectors which are subdivided into two sets, 3 for Leap and the remaining 2 for Kinect and then input these calculated sets into SVM (Support Vector Machine) classifier to identify the acted gestures. They have checked the contrast between both the devices which shows the accuracy in recognizing the gestures by each device. According to the combination of the feature sets of both devices, high precision recognition is attained. Chai et al. [2] in their research gave a sign language recognition system which is based on Microsoft Kinect. As the current data gloves technique for identification provides an enhanced outcome for huge sign jargon but it is expensive to promote. They conferred a classification of 3D coordinates to be equated for identification of hand positions, consisting of two modes. In the first mode, has a capability

of identifying the signs as phrases and in the other mode, a realization converts those signs to written form so that a typical person can effortlessly perceive. Raees et al. [3] gave a graphical Pakistan Sign Language (PSL) identification system which receives values from the two hands, thumb value is obtained by implementing a Template matching technique although the identification of the rest of the fingers have been carried out by deep pixels-based analysis. For sign language recognition, an algorithm is used through which seven phases are identified in a model. This system attained an efficiency of 84.2% with 180 numerics values and 240 letters of PSL. Ching-Hua Chuan et al. [4] used a palm-sized, handy and a low-cost 3D motion sensor for recognition of American Sign Language. They used Support Vector Machine and K-nearest neighbor to analyze the 26 English alphabets in American Sign Language utilizing the imitative aspects of the collected data. The testing results in the high mean classification rate of 79.83% and 72.78% was attained by a SVM and k-nearest neighbor accordingly. Rajesh B. Mapari and Govind Kharat [5] innovated a system, which recognizes Indian Sign Language (which uses the two hands with LMC). This sensor beats the major problems in surroundings like lightening condition, blockage, and background. It scans the hand gestures and gives values in 3D format. The datasets from all the fingertips along accompanying the palm of the two hands are utilized in identifying finger shape based on Cosine similarity and Euclidean distance with the average recognition accuracy of ISL is 90.32% for Cosine similarity and 88.39% for Euclidean Distance method. At the time of doing hand gestures, the Leap Motion Camera is kept a bit tilted so that depth data is correctly obtained. Although Leap Motion sensor can track the two hands perfectly it can't track gestures which associate any other body part.

B. Voice recognition

Voice or speech recognition is a capability of a system to determine phrases from communicated expression and change them into an understandable language. Capability to identify human speech has fascinated the society especially due to the ability to be integrated into different applications. In our project, we are using Google API for Voice Recognition. Scott M. et al. [6] gave an instance of an audio directed application in which the end-user can speak any command like "Send Message to Jim", the application will identify the audio and sends a message to Jim's number. Wong S. et al. [7] suggested an application for teaching earless kids who have issues in acquiring knowledge, understanding and responding, to overcome this issue by providing a reciprocative virtual environment. The concept was to inspire them to exercise, maintain and improve without any aid from anybody else. If the audio correlates a word exactly in the database, the pictorial output is seen.

C. Speech-to-text Conversion

A Speech-to-text conversion is an advantageous means of involving people with hearing the loss in vocal settings, e.g. interactive sessions, interviews or conferences. In our Android Application speech to text, the conversion is done using Google API and transmitted via Bluetooth integrated with Raspberry pie. B. Raghavendhar Reddy and E. Mahender [8] proposed an online speech-to-text application which receives audio via a microphone and alters the audio to identify the spoken words in the English language. The identified text can be gathered in a file. This system directly extracts and transform speech to text that improves approach-ability by supporting input alternatives for a deaf or disabled who can message on a number. Speech identification is accomplished utilizing the Internet, linking the application with the server. Lochan Basyal and Sandeep Kausha [9] developed a system which works on voice recognition by converting the input voice signal into text and after that, it is transmitted to embedded a system which has an Arduino atmega328 micro-controller via Bluetooth as a means of serial communication between an Android application and an embedded system. The received text on an Arduino can check with a predefined audio command which was already programmed on embedded C and if it matches, then the specific task is performed by enabling the respective pin of an Arduino.

D. Gesture to Voice Conversion

Muhammad Wasim et al. [10] presented a two-way communication system using Pakistan Sign Language (PSL). This two-way system is performed by a transformation from text into gestures and gesture to voice. However, the transformation from gestures is accessible not only in text but also with audio giving ease to a hearing person who can input a word or phrase in the application, after analyzing the linguistics, the text splits into tokens and sub-tokens and gesture is seen against it as an output. On the other hand, when gestures were performed and fed into the application, via the implementation of image processing algorithms, the hand gestures were identified and transformed into an equivalent written or audio form. M.V.N.R.P. Kumar et al. [11] created a system consisting of a gadget that converts a sign into audio and text to enable the contact among the silent societies and the hearing people. The tongue-tied people can use these gloves to depict gestures that will be transformed into audio so that hearing people can effortlessly comprehend its interpretation. Data glove can detect almost all the hand movements and AVR microcontroller based system converts described movements into audio and text form on LCD for the hearing impaired.

III. Methodology

A. Hand Gesture Recognition

Gestures provide a more advanced level of absorption handling the LMC tracking by observing the motion of fingers in real-time. We use Hidden Markov Model for hand gesture recognition. HMM is usually use for serial data designing. According to Rabiner (1989) three tuples expressed by pi, A, B, where pi, A = [aij], i, j = 1,2,...N and B are a basic probability distribution, state transition matrix from state i to j, and the experience probability. Hidden Markov Model behaves

as a probabilistic scheme primarily utilized for design method with time-sequential signals. Clear bayesian connotation and unified way of time-varying signals make it a preferred gesture modeling testimony. Hidden Markov Model based on the estimation of system space into a minimum figures of digital space. HMM is useful for designing time-sequential data. Still, its method is bounded to basic state-space with the distinct hidden variable at a single period. Expect, we have two hidden variables that are sovereign where the proceeding conveys and are highly identical to each other. If we show a hidden single variable by typical HMM, we can take out aspects from the multi-sensor information that benefit in obtaining the beat output as demonstrated in Figure 1.

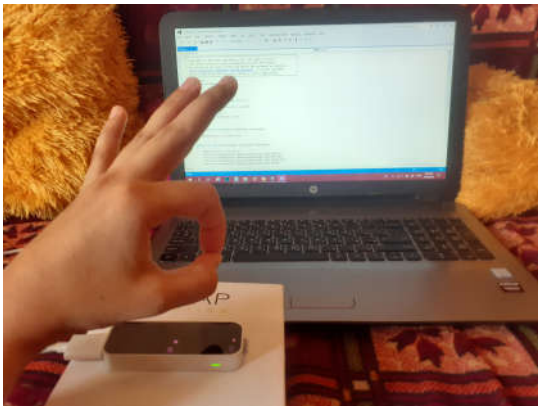

Fig. 1. Hand Gestures Recognition using LMC

B. Feature Extraction

With the assistance of leap motion device identify and track hands, fingers, and bones such as objects covered discrete position and movement. Leap Motion API has other methods for fingers, bones, hand, and gestures. like: The hand model gives the message about the type of both hands is left or right, the center point of the Palm in mm, velocity is computed in mm/sec and other attributes of a recognize hand, the arm is connected with hand so the list of fingers are connected with the hand.
Fingers relevant attributes consist of finger direction calculated in vector position, finger length calculates in mm, width, dip position, pip position, tip position, tip velocity, and MCP position. Certain gestures motion arrangements are identified by the leap motion device. LMC identifies the movement of a finger tracing a circle as a Circle gesture, downward tapping movement by a finger, and a linear movement of a finger as a Slap gesture. Leap Motion and Kinect both relate the data in the 3D vector position. It gives the 3D location of the finger ID of the fingertips that show up in the overlook of the sensor. Leap Motion and Kinect devices calculate frame rates i.e. 120 and 30 fps. Using this we calculate the frame rates for Pakistani sign language by using LMC and map it to a real word.

C. Gesture to Voice Conversion

In this Step after calculating the frame rates of Pakistani sign language and mapped on real word, it sends to the raspberry pi. The raspberry pi is an operating system it converted into voice output with the help of the speaker. The small size of the speaker is attached with the Raspberry pi. The raspberry pi 3b+ is a microprocessor it reads input from Leap Motion Device then converted hand gestures into speech and shows output in the form of an audio with the help of the speaker. The small size of the speaker is attached with the Raspberry pi 3b+ as displayed in Figure 2

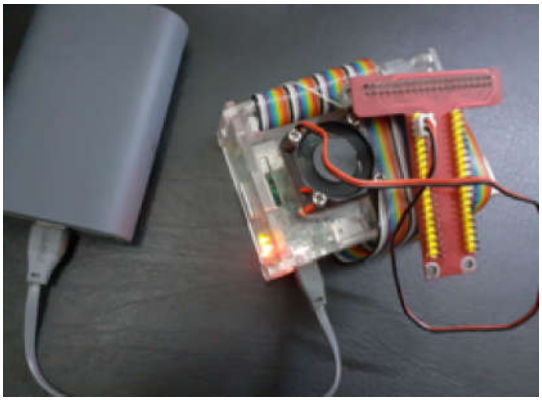

Fig. 2. Raspberry Pi converting gestures to speech

D. Speech to Text Conversion

Speech to Text conversion by using Google API in which read input from a speech by a person and then converts into the text to display.
Our Android Application is for traditional folks to convey their message to Deaf & Dumb folks unaware of sign language. In Android App, traditional folks speak in microphone then the speech is converted into text by the exploitation of Google API Speech-to-Text conversion as shown in the Figure 3, the converted text will be stored on cloud and retrieved from it to be transmitted through bluetooth of the phone and the TFT screen attached on Raspberry pi will recieve and display it.

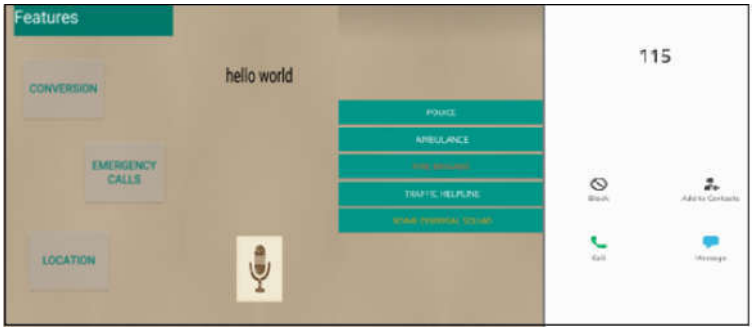

Fig. 3. Android Application Features

IV. Experiments & Results

The hardware system being tested over Deaf & Dumb people. We have a two-way smart communication system, so during this testing, Deaf & Dumb person sits down with a standard person, we use Leap Motion device for hand movement recognition are done so by victimization motion track information of Leap Motion device, a system is trained with PSL Sign Language. The system can acquire information through the Leap Motion device, that information is wont to acknowledge the PSL Sign Language then convert into audio kind within the speaker as represented in Figure 4.

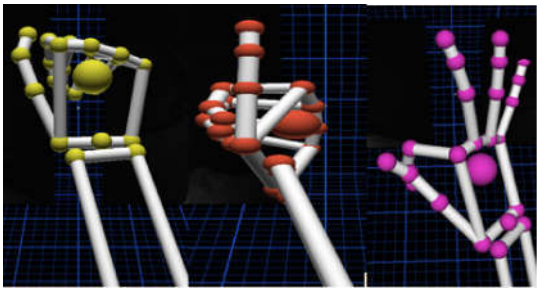

Fig. 4. a) Alphabet A b) Good c) Better

The data for the above words have been collected. The global and separated precision, recall and accuracy of the system has been calculated. The overall result of efficiency standard for 3 PSL words are represented in Table 1 and Figure 5.

Performance Measures %	A	Good	Better
Accuracy	94.90%	92%	98%
Precision	81.80%	80%	95%
Recall	90%	85%	95%
F-Score	85.71%	85.66%	95%
Overall Accuracy of the system= 92.5%			

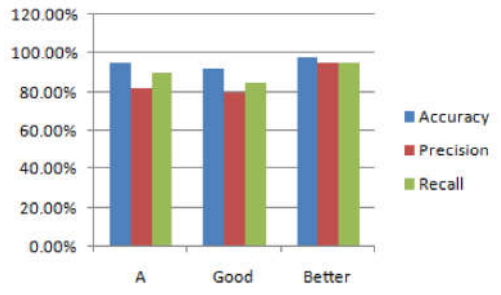

Fig. 5. Shows the results for accuracy, precession, and recall of this sytem

Also Another way of communication is for a standard person to speak to a Deaf & Dumb person while not knowing and learning PSL Sign Language, we tend to build Android Application within which the communication module of projected system can acquire information (voice) from a standard person through microphone, and then information convert into text and send through Android Application to Raspberry pi 3b+ attach with TFT Led screen within the kind of text, and also extra options like emergency are obtainable within the Android Application as shown in the Figure 3. The importance of the research is associated with its objective to aid the class of non-vocal folks to approach the hearing world and enhance their involvement for the betterment of their nations. The system has been designed, programmed, implemented and tested with very satisfying testing.

V. Conclusion

In our research, we have elucidated how a Leap Motion Device can be used to develop an innovative two-way communication system through which all the hinderances of hearing disabled people with their surroundings can vanish. The concept applauds a new way of communication by linking hand gesture recognition and gesture to voice conversion. To back this concept we have created an android application with the help of Google API for speech to text conversion and also has much-needed features like emergency calling and location tracking for caretaking purposes. Dr.Ayesha Nadeem (Dentist, DUHS) discussed with us the circumstances of communication the doctors face while medicating the deaf people. This project can be utilized in Dentistry and other aspects also. From all these features we are able to remove the conversational barrier among the deaf & dumb and the hearing society.

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