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A Study on Communication Platforms and Services Needed and Available for Mute and Deaf Community

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Abstract - *According to the World Health Organization, Mute and deaf community are among the 5% of our world population that is approximately 430 million people. This number can increase to up to 2.5 billion till 2050 i.e. one among 10 people would suffer from some kind of hearing disorder. Often these differently abled people are neglected by society. These people face various problems like lack of basic education, platforms to express themselves to people who don't understand sign language or able to earn jobs to fulfil their basic needs, etc. According WHO unaddressed issues faced by mute and deaf people were that, there are almost 32 million kids who suffer from hearing loss and these are from currently developing countries where there is limited budget to provide education, or any other facilities that could help these people to compete with world. Thus, in adults the unemployment rate is quite high. Further leading to social isolation, loneliness, depression. Thus, this survey majorly focuses on comparing various currently available communication platforms and services for these differently abled people and further what are the necessary services they need. This survey also compares the techniques to build platforms to bridge the gap between these people and people lacking the knowledge of sign language.*

***Key Words*: Sign Language, communication platforms, Deep learning algorithms, learning platforms, teaching techniques**

1. INTRODUCTION

According to study, in India there were about 12.3million people who suffered hearing inabilities [7].The impact of lack of hearing abilities generally causes issues such as social connect, communication inabilities, behavioural issues ,psychological well-being ,safety concerns, etc. [2]. Mute and deaf community mainly communicate using sign languages efficiently [1]. There is no specific globally accepted sign language. There are various sign languages available having very minimal changes in gestures among them American Sign language is considered as Standard Sign language[2]. Performing sign language gestures has been the most efficient way of communicating but for this both parties should have knowledge about sign language. To learn sign language there are very limited instructors who are trained to teach the language of hand gestures [2]. The Lack of instructors or learning resources causes obstacles in providing knowledge to the mute and deaf community [2]. Recent research focuses on e-learning platforms and efficient as well as easy to use communication platforms. There are currently various approaches available to bridge the gap between commoner and deaf. The most efficient of them are two approaches 1} Image based 2) Sensor based [1]. These approaches are for sign language recognition i.e to convert the gesture to text/speech. Various researchers suggest sensor-based approaches can also be used for teaching sign language with greater efficiency [5]. The approach of flipped classrooms has also been seen to give better understanding results when experimented with the deaf and mute community for complex teaching (like engineering subjects) [6].

This paper majorly focuses on studying various applications currently available for mute and deaf to communicate, their methodologies and results to find the most efficient way to build an easy and friendly platform for communication. Also the purpose of the survey is to find various teaching/learning methods to make an efficient platform to spread knowledge and resources to learn sign language.
The various sections of paper will be organized as Section II will be a comparison and study of various platforms currently available platforms, section III will be about the various techniques to build a communication platform, section IV will shade light on educational techniques and e-learning approaches, while finally V will be the conclusion of the survey.

2. COMPARISON OF AVAILABLE PLATFORMS

As suggested by WHO that till 2050 there will be 900 billion people around the world who will be vocally impaired. The study shows currently there is a lack of instructors and resources for deaf and mute community to compete with the other side of the world [2]. The currently available applications have very basic functionality which can be inadequate for them to gain enough learning or help. There are several applications like Talk to Deaf, Deaf Communication, Mute speaker, deaf-mute helper, etc. these are currently available application which the deaf and mute user can use for communication purpose. But all these applications provide text to speech and speech to text functionality whereas the mute and deaf community majorly relies on sign language to communicate [1]. There this method to type and then convert into speech and vice versa seems unfriendly. Various other platforms like Sign language Tutorial, Indian Sign language, Alphabets for deaf-mute, etc. provide only basic learning options for mute and deaf learners. The mute and deaf community needs e-learning

platform to learn skills and knowledge required by industry so that they can earn the living by themselves. Following is the comparison of the currently available applications and their features:

Table -1: Comparison of Available Platforms

Applications	Features	Future Scope
Monovoix (research based) [4]	-converts the real time image into audio message -designed for children in age group 1-12 years -built for ASL users and translate alphabets, numbers, colors and greetings	-application has limited functions -application can be made more user friendly -more gestures can be added and user experience can be enhanced
Let me hear again (available for users)	-application has 5 major functionalities -convert text to speech and speech to text, make notes, make and receive calls, alerts -Supports 71 languages	- User experience can be enhanced -Sign gestures translation can be added
Sign Language ASL(available for users)	-application has various categories stating lessons such as food, actions, greetings, etc. -these lessons are video tutorials to learn sign language gesture for that specific word	-limited resources to learn -very basic knowledge provided
Assistive SIGN LANGUAGE Converter for DEAF AND DUMB (Research based) [7]	-portable device that captures the image translates it into audio -light weight device trained for 26 alphabets and 4 essential gestures -CNN model prediction having accuracy of 99%	-the device is needed to be bought which would add to expense -maintenance of device also costs money -always the device has to be worn by user
AAWAAZ (research based) [2]	-web based application translates gesture to text -uses HCV for skin region detection -further uses Harris algorithm for feature extraction and deep learning algorithm for prediction	-this application can be modified and upgraded to mobile application -more features like speech to text, alert, and other helpful services can be added to app
Sign Language to Speech Conversion Using Smart Band and Wearable Computer Technology (research based)[8]	-converts gestures to audio -wearable device easy to carry -works on motions of hands -based on motions while performing gestures are analyzed for detection	-the device is needed to be bought which would add to expense -maintenance of device also costs money -always the device has to be worn by user
Real Time Translator for Sign Languages [9]	-offers features like sign to text, text to sign and add gesture -is an android application	-available for limited gestures only
Mute Speaker	-provides various buttons when on click they play audio of button clicked -one can also type and convert the text into audio	-very limited translation options -application can be modified by adding various gestures

After comparing above applications, we understand there are applications with basic functionality like text to speech, speech to text, teaching platforms like ASL, ISL etc. or applications that are in research only. There has been a lot of research on gesture to audio conversion yet these applications are not available for differently abled people to use in daily life. The various teaching platforms available only teach basic gestures such as greetings, alphabets, numbers, emergency signs, etc. These services aren't enough to help differently abled people to cope-up with common people. Various services like communication platform, e-learning platform, emergency alert signal mechanism, etc are few services which can help these people for fighting their battle if integrated in one application.

3. COMPARISON OF TECHNIQUES FOR COMMUNICATION PLATFORM

Communication is most important for sustaining in the world. Normally people express themselves with words but the scenario isn't the same for people who suffer hearing loss from birth resulting in muteness. These people need a mode of communication to express themselves, for people to understand what they want to convey and for understanding what people want to convey.

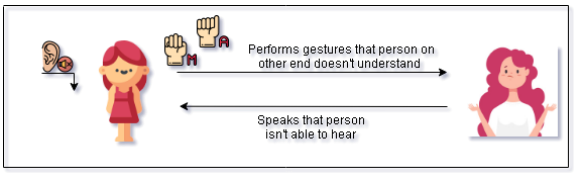

Fig -1: Communication Scenario

Sign language is one of the main communication methods to bridge the gap for speech and hearing-impaired communities. There has been a lot of research conducted to find friendly ways for these differently abled people to express themselves efficiently. Majorly these applications built for them, can be classified into two categories i.e. hardware-based application and software-based application. The communication platforms in the hardware category are devices built with gloves, sensors, microcontrollers, motion detectors, wearable

bands, etc. to recognize the gesture performed. While software-based category has applications where either android devices or laptops are used to capture images and then processed further for extracting features and given to neural network or machine learning algorithms to predict the gesture performed.

3.1 HARDWARE BASED APPROACH

Around the late 1970s the research about devices or applications for deaf and mute community's mode of communication started. Initially the device invented was gloves for hand gesture detection using light-based sensors and flexible tubes [4]. Further these glove technology evolved as the technology evolved for sensors. The gloves-based approach for sign gesture detection is quite old and has a lot of research. The glove has sensors mounted which are data collecting devices. These collect data and movement of hand and send to the device where it gets processed. Usually flex sensors or proximity sensors are attached on gloves. These collect the data about bent fingers and transmit this data to microcontrollers like Arduino, raspberry pi, etc. [10,11]. In hardware based sign gesture detection sensors, microcontrollers and display devices are few constant hardware used.

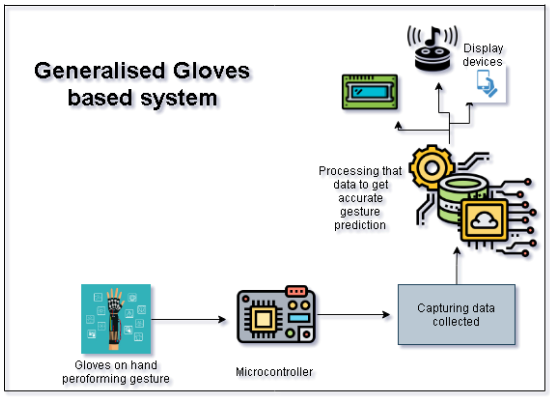

Fig -2: Generalised Gloves based System

One of which is an implementation of flex sensor gloves that had 3 flexi force sensors mounted on gloves, which converted the load into voltage and further passed as voltage to the LCD board [10]. The LCD board displayed the text based on voltage signal. Various similar gloves-based systems are developed and evolved with time and need of community. Similarly, an application for real time conversion of sign language gesture to text/audio was developed [12], here authors have attached flex sensors to gloves and the angle varies when the hand bents while performing gestures. As the angle changes the value of the resistor changes as well and these values are analyzed using the Artificial Neural Network (ANN) algorithm for obtaining the correct prediction [12]. The system further sends the output to cloud and using SIM900A GSM sends to mobile devices. The system is a blend of gloves-based system and mobile application. As various studies show gloves-based systems have drawbacks like high cost, maintenance, having to wear the gloves connected with various wires, etc. Thus, gloves-based systems were overtaken by devices that are easy to handle and carry. One of which is hardware-based systems using Microsoft Kinect [13]. Microsoft kinect is first of its kind which is also a budget friendly device. It is combination of RGB camera and depth sensor. It is majorly used for depth camera[13].Using the microsoft kinect technology majorly focuses on capturing the depth of image[13]. The device captures the image from the RGB sensor to capture its depth, further the preprocessing steps are performed and pixel values are compared with computed sign language values to predict the output [13]. The approach gives better output than image based systems [13]. Further another similar wearable device application was developed by researcher in 2019 assistive Sign language converter [7], this is a device of total 163g of which 3gm is camera device and 5*5*3.5cm speaker and 113gm connector. The device captures image through the camera for which the openCV library is installed on the system [7]. Image is further passed to raspberry pi microcontroller where the image captured is processed and sent to the CNN prediction model for gesture detection and prediction which has given the accuracy of 99% [7]. The processing carried out for preprocessing or analyzing the data is carried out using MATLAB [7,9,13].

Thus, studying different applications and approaches hardware-based systems seems bit costly, bulky, and has responsibility to handle. Deaf and mute people need a platform easy to handle and use.

3.2 SOFTWARE BASED APPROACH

Recent generations are more grown towards internet and web/mobile applications. One of the Sign language recognition approaches is imaged based sign language recognition. Software based applications are either mobile applications or web applications. These applications are easy to use, affordable and accurate. So, there are various applications designed for mute and deaf which are easily accessible. In most software-based applications image is captured through mobile/web camera further pre-processed to get region of interest and further features are extracted which are given to machine learning or neural network models for prediction. An mobile application for real time translating sign language [9], was modeled on single hand and double hand sign gestures for alphabets and numbers. Application had features like sign language to text/audio, text to audio and add gesture. Application was trained on SVM linear and RBF kernel, KNN and Random forest algorithm among which SVM classifiers gave highest accuracy [9]. Further various mobile applications used this approach of capturing RGB image further finding area of interest through preprocessing RGB image by applying various filters or methods. The preprocessed approach is sent to feature extraction and further the image is compared with stored data for identifying gesture [2,4]. Libraries like OpenCV are used for image capturing, languages like Python,

matlab is used to code the model, data storage like SQLite is used for storing training images and their identifications [4].

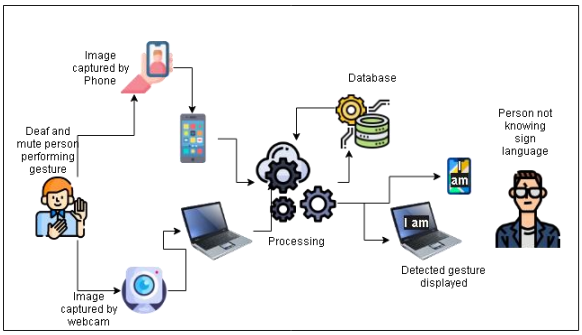

Fig -3: Generalized Software-based system

The software based or vision based sign recognition system has four major steps namely:

1. Image Capturing
2. Pre-processing
3. Gesture Detection
4. Conversion to text/audio.

3.2.1 IMAGE CAPTURING

Image acquisition is the first step in vision-based gesture detection. Usually an image is captured using a webcam or camera of a mobile device. The Image is a RGB image which further needs to be preprocessed for extracting Area of interest.

3.2.2 PRE-PROCESSING

The captured image needs to be preprocessed and for which libraries like OpenCV are used[4]. The preprocessing includes converting RGB image to grayscale, blur the background or skin segmentation, morphological operations etc. [2,4,14]. The grayscale image can be further smoothened by gaussian blur function after which a threshold value for blurred image can be calculated by OTSU binarization [4]. While for skin segmentation Hue-Saturation-Value histogram can be obtained for getting skin detected from image [2]. Skin colour also can be detected by using YCbCR model. Once we get the blurred/ Image with ROI then set the threshold values [4,14]. Further the apply morphological operations for removing noise from image and detect the edges

3.2.3 GESTURE DETECTION

After the image is preprocessed the features are extracted from the image. These extracted images help in detecting the gesture. Feature extraction can be done by various methods such as Fourier Descriptor, Scale Invariant Feature Transform (SIFT) or Principal Component Analysis (PCA). Histogram of Oriented Gradients (HOG) is another successful method of feature extraction [2,4,16]. The features extracted from each image of the dataset are stored in matrix in a mat file. These values are compared with the image captured and processed. The distance between matched features has to be calculated and the image with least value is the most matching image. According to which output is displayed in either text or audio.
Even image captured can be labeled and using machine learning or neural network algorithms we can predict the gestures.

3.2.4 CONVERSION TO AUDIO

The text we got after applying the mathematical calculation can be converted into audio using google API that helps users to convert the text to speech. The google API is freely available.

Image to audio can be performed by performing the above steps and can get good results. we have taken Sign Language MNIST hand gesture dataset with 27,455 training images and 7172 test images and performed above steps with 4 algorithms and following are results:

Table -2: Comparison of Algorithms

Algorithm	Accuracy
CNN	94.36%
SVM	80.18%
Random Forest	80%
KNN	60%

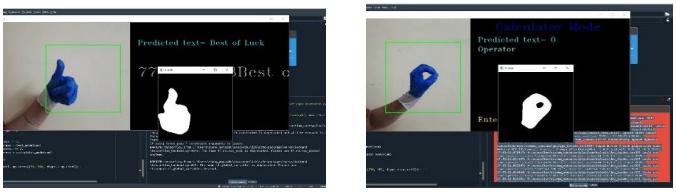

Fig -4: Software-Based Sign Recognition

4. EDUCATION PLATFORM

Development of any individual begins with learning and acquiring knowledge. There are around 32 million kids around the world suffering from hearing disabilities. The learning process shouldn't stop for them. There are 3 ways to learn for these differently abled people. Sign language, without sign language and visually [19]. Various web applications are developed and study about efficient ways to teach these differently abled people has been a research topic. A research in 2017[19], is a web application where online mute and deaf kids are provided courses they can learn at their pace and also have features to interact and learn more. Web e-learning platforms with user-friendly, easy to access and navigate is important for grabbing users' attention. Various studies show that better Visuals help in

user understanding concepts easily, interactive sessions or activities, graphics visuals,3-D pictures etc are beneficial in the teaching-learning process [5,6,18].

One of the researches suggested that the concept of flip classrooms helped students to understand engineering level knowledge quite efficiently [6]. The quiz was taken before teaching and another quiz after teaching to understand the effect of the teaching method. Users had significant differences in scores of before and after quiz. Video based learning helps users to learn as they understand at their speed.

5. CONCLUSIONS

Communication is vital for everyone to survive in today's world. To bridge the gap between these differently abled people and normal people various applications are available, having their own advantages and disadvantages. Yet the platform that provides one in all solution for all of their problems is to be built. The major problem for mute and deaf people is to learn in language/way they understand and second is to express themselves in way others understand what they say. A platform having a communication platform that is easy to carry or use and e-learning facilities that can provide them basic to high level courses which they can learn at their speed can solve their problems

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