**LITERATURE REVIEW**

We have read 15 research papers into which we have seen different methodologies used by different people in the field of communication between the deaf and the normal people. There are two types of systems used for the communication purpose.

* Wearable Communication Device
* Online Learning System

Wearable communication systems involves the glove based system which was invented 30 year ago and research is still continuing. E-learning environment is one of the most used techniques for educational purpose of Deaf and hard hearing person .Researches on the usage of the e-learning environment for hearing impaired students started from the year 2005 and still it is going on to make it more effective. With the advantages of different systems there are also some limitations of the above category systems which are discussed below. These system have different functionalities and methods and have different principles on to which they are working. Some of the systems are given below.

**2.1 Deaf Mute Communication Interpreter- A Review**

In this research paper, Saraswathi, Anitha [1] proposed different kinds of interpreter used in communication system for deaf and dumb persons. These interpreters includes the Wearable Communication Devices and the Online Learning Systems. Wearable Communication devices includes the Glove base System in which user wear a glove and uses it as interpreter to communicate with the impaired person using different sensors like Flex Sensors, Tactile Sensors along with Accelerometer, Controller and Text To Speech Conversion Module embedded on glove. Glove base system improves the ambiguity of gesture made and thus improves the effectiveness of gesture for deaf person. On the other hand Learning base System includes SLIM Module, TESSA, Wi-See Technology, SWI\_PELE System (Secure Wireless Infrastructures and Personalized Educational Learning Environments) and the Web Sign Technology.

**2.1.1 Flex Sensors:** Five flex sensors are used which measure the angle of each finger. By bending the finger the sensor produce resistance in relation to voltage and the magnetic field.

**2.1.2 Tactile Sensors:** These sensors consist of two pins among which one is grounded and other is of +5volts. These pins was used in order to improve the accuracy of the words.

**2.1.3 Accelerometer:** It uses the low pass filter and temperature compensation to get the output voltage proportional to acceleration.

**2.1.4 Controller:** The most important part of the system includes ADC module that converter analog signal from sensors to digital signal.

**2.1.5 Text To Speech Module:** This module converts the input gesture into voice by the use of encoder and microprocessor that has various letters programmed in it.

**2.2 Full Duplex Communication System for Deaf & Dumb People**

In this research paper, Shraddha R. Ghorpad, Surendra K. Waghamare [2] proposed artificial speaking mouth for dumb people in which the recognition of Sign Language and converting it to voice signal. Automatic speech recognition system is also use to change the speech to text and sign language. The system includes two parts Image to sound conversion and Voice to image conversion. Image to sound conversion includes Extraction Method, Features Extraction and Gesture Classification for the normal person to understand the gesture. While on the other hand, Voice to image conversion includes Acoustic preprocessing, Feature Extraction using MFCC and Speech-Recognition Algorithm for impaired person to communicate with the normal person.

1. **Extraction Method:** Segmentation
2. **Features Extraction:** Feature Vector on segmented image like fingertip etc.
3. **Gestures Classification:** Classification and matching of input.

**2.2.1 Extraction Method:** This method involves the segmentation of input image into regions depending on the tracking information such as skin color, shape using tools such as Kalman filter.

**2.2.2 Feature Extraction:** Feature vectors of the segmented image is extracted in this process by the use of method “hand contour and silhouette”. Segmented image is divided into different block sizes and each block represents the brightness measurement in the image.

**2.2.3 Gesture Classification:** This method was used to classify the gesture. By the use of Euclidean distance metric, gesture was classified. Statistical tools used for the classification are “HMM tool, Finite State Machine (FSM) and Learning Vector Quantization, and Principal Component Analysis (PCA)”. Neural networks is also used for the classification of the gesture in many other devices.

**2.3 HAND GESTURE RECOGNITION AND VOICE CONVERSION SYSTEM**

In this research paper, MONISHA.J, ARUNA.G.V, PRITHIBA.S, MONISHA.R [3] proposed a Human Computer Interface system that understand sign language to ease impaired people to communicate with the normal ones. This system has a digital glove, which includes CMOS camera, Flex sensors, Leaf switches and cupper plate to generate a digital pattern, which help in showing the signs for a particular pattern. This system also has a transmitter and a receiver. Transmitter includes the Digital Glove, Microcontroller and the RF Transceiver, which generate a digital pattern and send it to receiver to generate particular text. Receiver includes UARTreceiver pin, Micro controller, a Module and LCD Display to display the text received by the transmitter. This text is than convert to speech and at last played by speakers.

Following is the algorithm of the system

**Algorithm:**

**Step 1**:- start

**Step 2**:- read digital pattern from gloves

**Step 3**:- Send characters for corresponding patterns toRF transmitter

**Step 4**:- Receive text from transmitter via UARTreceiver pin

**Step 5**:- Display text on LCD which was enclosed withgestures ‘S’ and ‘.’

**Step 6**:- Send that data to emic module via UARTtransmitter pin

**Step 7**:- Text to voice conversion

**Step 8**:- Play voice output

**2.4 Smart Communication System for Deaf-Dumb People**

In this research paper,Mina M. Abdel-Masieh, Manuel M. Nasief [4] proposed a system, which overcome the database issues of the previous systems. This system has several other language like Arabic Sign Language and Arabic Vocal Language. This system includes Xbox 360 Kinect camera and sensor, Image Processing Based Language Converter system using a computer webcam to convert RGB images to binary and 4 flex sensors having an accelerometer in each hand for hand motion detection [5] along with voice and LCD module for output. System works on the two parameters among which first the fingers position using compressive sheet and second hand orientation indicated by the accelerometer. The data from compressive sheet and accelerometer is match with the memory loaded with the sign language database.

System components includes

* **Arduino Nano.**
* **Arduino Mega**
* **Compressive Sheet**
* **Accelerometer.**
* **Rechargeable Batteries.**
* **RF Module.**
* **Speaker & LCD**.

**2.5 Sign Language Recognition System for Deaf and Dumb People**

In this research paper, Sakshi Goyal, Ishita Sharma, Shanu Sharma [6] proposed system in which, real time image is captured first and then extraction of features takes place to identify which sign has been articulated by the user using SIFT (scale invariance Fourier transform) Algorithm. As purposed by the author their system give 95% accurate result for nine alphabets taken from different sides of Indian Sign Language. The proposed algorithm consist of four steps, which are Image Acquisition, Feature Extraction, Orientation Detection and Gesture Recognition. First image is capture and features of that image is extract. Those features are than match with the image in the database using SIFT function by using comparison and finally find the highest key points matching image.

Proposed system includes

**Image Acquisition:** In this step hand gesture made in front of the camera & frame capture function is used to create a still image from real-time video capture.

**Preprocessing & Segmentation:** This still image is converted from video frame format to RGB color Model Format for further processing. After obtaining RGB image, it is converted into gray scale. From converted gray scale image interest points are detected using SURF. Interest points of captured image & reference image stored in database is detected.

**Description & Feature selection:**After feature detection, features are extracted from captured image as well as from reference image. Feature extraction is also refer as feature description. Extraction of features are done using SURF.

**Matching:**The final step is matching. Matching reference feature and reference points between reference images and input image i.e. captured image with closest match using Minimum Euclidean distance.

**2.6 Image Processing based Language Converter for Deaf and Dumb**

In this research paper,S.N.Boraste, K.J.Mahajan [7] proposed method in which RGB covert to text message. The system consist of two module. Capture color image is convert to gray scale image, which is convert to binary form using coordinates of the image. The system also have two modes, first is Training mode, which is a part of machine learning where we train our system to accomplish the task to implement and the second is Operational mode. This algorithm of the system was implement in C# and .Net using various images captured by the web camera. After the image is capture, different pixels value is calculated and binary image is form. Pixel values are match with different colors to get the text behind those colors i.e. Red color will have an alphabet ‘A’. This system also convert text into voice by using speech synthesizer so that blind people can also communicate. This system include the following steps in it.

* **RGB Color Recognition:** Webcam captures red image. This image will be converted to binary image.
* **Color calibration RGB Adjust software:** After the image is captured, pixel values are calculated
* **Conversion of Image from Color to Binary:** From the pixels binary values of the image are used for further processing.
* **Coordinate Finding:** The above pixel are termed as marker pixel and will be highlighted as white color pixels. From here area for the each color is generated.
* **RGB to Text Conversion:** In this process different color are used by deaf and dumb to talk and generate the output as text. For example the red color can be termed as ‘a’.

Following is the block diagram of the system.

**2.7 Hand Gesture Recognition System for Deaf and Dumb People Using PCA**

In this research paper, Manisha U. Kakde, Amit M. Rawate [8] proposed a system, which recognize nine gestures from sign language using MATLAB. Using YCbCr color transformation model, features are extract from the captured image using web cam. PCA algorithm is use to recognize sign. PCA compared feature of captured image with the training database to calculate minimum Euclidian distance. Finally, recognized output is convert into text and speech. Step in this system are Image capturing, Color separation, Morphology, Gray Scaling and Thresholding, Binarization, Feature extraction, Recognition and Sign to Text or Text to Speech. The system give high accuracy and output was in form of text and speech format, which helps in reducing the communication gap between normal and impaired people.

* **Database Creation:** In this process 100 images are used which are used as 10 images for 10 signs. High resolution camera was used in this system. These 100 images were used as the training and the testing database.
* **Preprocessing:** This process includes the functions like transformation, thresholding, morphology and the binarization. RGB captured image is segmented to YCbCr color transformation where Y is illuminance, Cb and Cr are chrominance (hue, saturation). The standard size of the image was set to 200 x 200 pixels. Noise was add during color transformation so to remove the noise median filter was used by the system. After removing noise or morphological process threshold detection of hand was carried out to separate the object and its background and image is converted to binary form. In binary form image represent the features which are used for the sign recognition. After the binary conversion of the image or the binarization, again the morphological operations are apply to filter out the noise and smooth image is obtained.
* **Feature Extraction and Recognition:** PCA was applied on the training set to extract the most significant features of the image.

Steps involve in the system

* Image Acquisition from webcam
* Color separation.
* Morphological Operation.
* Gray Scaling and threshold.
* Binarization.
* Feature Extraction.
* Recognition of gesture.
* Sign to Text and Text to Speech.

Feature extraction involves the following steps.

* “**Step 1**: Convert the all result image into the column matrix as ‘T’
* **Step 2**: Calculate the Mean Column Vector ‘m’ for ‘T’.
* **Step 3**: Computing the difference for each vector set Ai = Ti– m where (i=1, 2 …N)
* **Step 4**: Calculating a covariance matrix C=A\*A'
* **Step 5**: Calculate the eigenvalues and unit eigenvectors of the covariance Matrix ‘C’.
* **Step 6**: Sort the eigenvalues.
* **Step 7**: Solve the mapping eigenvectors and project data on Eigen space for matching.” [8]

**2.8 Real Time Sign Language Processing System**

In this research paper, Dibyabiva Seth, Anindita Ghosh, Ariruna Dasgupta, Asoke Nath [9] proposed real-time autonomous system using American Sign Language. The system includes five main objectives. First is to be able to recognize the gestures by figure spelling, second is to be able to show letters or numerical digits or some special characters as output, third is to be able to show relevant sign language from the text file, fourth is to be easy to use fifth is to make use of existing hardware. The system is divide into three modules Image Processing module, Training module, Gesture Recognition and Mapping module. Image processing module takes the image via webcam surrounded by four red LEDs and scan through all the pixels of the image. If the image lies in pre-defined pixel value range, make it white or else make it black. If the area of largest white region is less than predefined threshold, move the white region and stop else keep the white region and extract sign shown by the user. Extracted gesture is send as input to the gesture recognition module. Gesture recognition module compare the extracted gesture with all perceptron. If a match found, the relevant letter is display at the screen.

Modules of this system are

* **Image Processing Module.**
* **Training Module.**
* **Gesture Recognition Module.**

**Algorithm:**

* **Step1:** Image capture by the webcam.
* **Step2:** Scan all pixel of image. If the pixel lines in pre-defined range, make it white else make pixel black.
* **Step3:** Area in the white connected region are checked.
* **Step4:** Keep larger white region and remove the smaller one.
* **Step5:** If the white region is less than the pre-defined area-threshold, then remove the white region else keep the white region and it is the extracted gesture. Send this gesture to gesture recognition module.

**2.9 Android based Portable Hand Sign Recognition System**

In this research paper, Jagdish L. Raheja, A. Singhal, Sadab [10] proposed a system, which based on Android or for mobile phones. In this system, frames taken as input from camera and check, whether the frame recognize any gesture. Match the gesture from database using PCA (Principal Component Analysis) and then find the meaning of gesture in the form of text. Text is then convert to speech and get the command in the form of audio. Like face recognition, which is inherently a classification problem in a high dimensional feature space, we also treat the recognition of hand gestures as a problem in the field of pattern recognition, and indeed, many techniques has proposed in this area. PCA is a standard tool in modern data analysis in diverse fields from neuroscience to computer graphics - because it is a simple, nonparametric method for extracting relevant information from confusing data sets. Steps involve in this system are as follow.

**Algorithm:**

**Step1:-**Static frame as input from webcam if the process recognize the hand gesture, proceed else take another frame.

**Step2:-**By Principal Component Analysis (PCA) match the gesture from the database.

**Step3:-**Take/find meaning of the gesture in the form of text.

**Step4:-**Convert text to speech and get command in the form of audio.

**Step5:-**From audio device, capture the frames.

**Step6:-**Send frames to the server.

**Step7:-**At server use Matlab to read the frames.

**Step8:-**If the frame is recognize as hand gesture, proceed for further step else again capture frames from audio device.

**Step9:-**Again by PCA match the gesture from the database.

**Step10:-**Find command corresponding to matched frame in form of text or audio.

Processes in this systems are as follow.

* **Image Acquisition.**
* **Edge Detection.**
* **Hand Token**
* **Recognition by the training data.**

**2.10 AAWAAZ: A Communication System for Deaf and Dumb**

In this research paper, Anchal Sood, Anju Mishra [11] proposed to develop a system, which serve the purpose of communication flexibility and absence of proper teaching centers of sign language. This application server as sign language, medical application, automated home. This system includes the features like Input image as RGB, Skin Segmentation, Morphological Operations, Region of Interest, Feature extraction of image and matching, Recognition, Display in Text. Like all other system this system also take image as input, extract its features, match it with the feature of images in the database and recognize the relevant text corresponding to that taken image and showing it as output. Skin segmentation is did by Hue-Saturation-Value (HSV) histogram. It consist of all illumination changes while Feature are extracted by the Harris Algorithm which detect the necessary interest points in the form of a Nx2 matrix, where N is the number of feature points.

Process involve in the system are

* **Image Acquisition**
* **Skin Segmentation.**
* **Features Extraction and matching with the database.**
* **Display text or audio.**

Flow of the system is as follow

* Take image as RGB image.
* Skin Segmentation of the image.
* Apply the morphological operation in order to remove the noise from the image at the process of skin segmentation.
* Detect the region of interest.
* Feature extraction of the image and matching with the database. If the features matches the gesture in the database recognize the gesture and show the result saved show the corresponding text or the audio to that gesture, else show the message no image found.

**References**

[1] Saraswathi, Anitha. "Deaf Mute Communication Interpreter-A Review." *International Journal of Applied Engineering Research* 11 (2016): 290-296.

[2] Ghorpade, Shraddha R., and Surendra K. Waghamare. "Full Duplex Communication System for Deaf & Dumb People." *International Journal of Emerging Technology and Advanced Engineering (IJETAE)* 5.5 (2015).

[3] Padmanabhan, V., and M. Sornalatha. "Hand gesture recognition and voice conversion system for dumb people." *International Journal of Scientific & Engineering Research* 5.5 (2014): 427.

[4] Abdel-Masieh, Mina M., Manuel M. Nasief, and Maher M. Abdel-Aziz. "Smart Communication System for Deaf-Dumb People."

[5] K.V. Fale, Akshay Phalke, Pratik Chaudhari, Pradeep Jadhav “Smart Glove: Gesture Vocalizer for Deaf and Dumb People”, Vol. 4, Issue April 2016

[6] Goyal, Sakshi, Ishita Sharma, and Shanu Sharma. "Sign language recognition system for deaf and dumb people." *International Journal of Engineering* 2.4 (2013): 2013.

[7] Boraste, S. N., and K. J. Mahajan. "Image Processing based Language Converter for Deaf and Dumb." *International Journal of Electronics, Communication and Soft Computing Science & Engineering (IJECSCSE)* (2015): 191.

[8] Kakde, Manisha U., and M. Rawate Amit. "Hand Gesture Recognition System for Deaf and Dumb People Using PCA." *International Journal of Engineering Science* 1892 (2016).

[9] Seth, Dibyabiva, et al. "Real Time Sign Language Processing System." *International Conference on Smart Trends for Information Technology and Computer Communications*. Springer, Singapore, 2016.

[10] Raheja, Jagdish L., A. Singhal, and Ankit Chaudhary. "Android based portable hand sign recognition system." *arXiv preprint arXiv:1503.03614* (2015).

[11] Sood, Anchal, and Anju Mishra. "AAWAAZ: A communication system for deaf and dumb." *Reliability, Infocom Technologies and Optimization (Trends and Future Directions)(ICRITO), 2016 5th International Conference on*. IEEE, 2016.