Real Time Two Way Communication Approach for Hearing Impaired and Dumb Person Based on Image Processing

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Abstract

In the recent years, there has been rapid increase in the number of deaf and dumb victims due to birth defects, accidents and oral diseases. Since deaf and dumb people cannot communicate with normal person so they have to depend on some sort of visual communication. Gesture shows an expressive movement of body parts such as physical movements of head, face, arms, hand or body which convey some message. Gesture recognition is the mathematical interpretation of a human motion by a computing device. Sign language provide best communication platform for the hearing impaired and dumb person to communicate with normal person. The objective of this research is to develop a real time system for hand gesture recognition which recognize hand gestures, features of hands such as peak calculation and angle calculation and then convert gesture images into voice and vice versa. To implement this system we use a simple night vision web-cam with 20 megapixel intensity. The ideas consisted of designing and implement a system using artificial intelligence, image processing and data mining concepts to take input as hand gestures and generate recognizable outputs in the form of text and voice with 91% accuracy.

***Keywords*-Deaf and Dump, Hand Gesture Recognition, Voice Conversion, Gesture to Speech, Speech to Gesture Conversion.**

I. INTRODUCTION

In our daily routine we can communicate with each other by using speech and use gestures to navigate point and emphasize. Gestures are more preferable and natural to interact with computers for human thus it builds richer bridge between humans and machines. For many hearing impaired and dumb person, sign language serves as their primary language creating a strong sense of social and cultural identity. Proposed system is based on vision based hand recognition approach which is more natural and comfortable and does not required any database to identify particular gesture. The hand gestures must be identified under varying illumination conditions. There are many feature extraction methods and classification techniques are available and the decision on which ones to use is challenging task. The proposed method performs background segmentation of the hand from the acquired data then we assign particular gesture for different alphabets. It involves feature extraction methods to calculate peak calculation and angle calculation of hand gestures, then finally the gestures are recognized and converting these gestures into speech and vice versa. To convert acoustic speech to gesture form speech recognition system is used. For extracting the features of speech signal we used mel frequency cepstrum coefficients and dynamic time warping for the comparison Hence two way communication is possible. The proposed system is based on MATLAB i.e. Matrix Laboratory. It is a high-level language that performs computationally tasks faster than the C, C++ and FORTRAN. MATLAB contains The Image Processing Toolbox which supports a wide range of digital image processing operations such as Geometric operations, Neighborhood and block operations, Transforms, Image analysis and enhancement, Region of interest operations, Linear filtering and filter design and Binary image operations.

II. RELATED WORK

Eriglen Gani and Alda Kika [1] proposed a real time Albanian Sign Language Recognition captured from signers both hands. Kinect device is used to construct depth map. To classify signers hand a k means clustering algorithm is used to partition pixels into two groups. After extracting the hands contour pixels centroid distance is calculated and Fourier descriptors is obtained which is used for hand shape representation .Every input gestures compared with training data set by calculating Fourier coefficients and Euclidean distance then the lowest Euclidean distance is considered as a match. Proposed system gives an accuracy of 91%.

Miada A. Almasre, Hana Al-Nuaim [2] works on two sensors that is Microsoft's Kinect with a Leap Motion Controller .In this paper Real time hand gesture letters are recognized using supervised learning method and natural user interface libraries with the Kinect SDK Version 2 and LMC. Thus, letters with overlapping fingers or letters with multiple frames need more processing to be accurate. Rashmi B. Hiremath and Ramesh M. Kagalkar [3] presents work on image processing techniques such as frame extraction, erosion, dilation, edge detection, blur elimination, noise

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elimination, wavelet transform and image fusion techniques. Fourier descriptors are used for feature extraction and extracted features with hindi text are stored in the database and compared with given input testing video of the signer.

Cao Dong, Ming C.Leu, Zhaozheng Yin [4] presents the work on American Sign Language Alphabet Recognition Using Microsoft Kinect. Kinect is nothing but Microsoft motion sensor which consists of depth sensor, RGB camera and multi array microphone. For extracting different features distance adaptive scheme was used and support vector machine is used for classification purpose. This system has one disadvantage that it gives limited accuracy.

Paulo Trigueiros, Ferando Ribeiro, Luis Paulo Reis [5] proposed a vision based system for recognition of Portuguese Sign Language. In this paper real time implementation can be done and support vector machine method is used for comparison. In this system vowels recognized with accuracy 99.4% and consonants recognized with 99.6% accuracy. Vajjarapu Lavanya, M.S. Akulapravin and Madhan Mohan [6] proposed a hand gesture recognition system using wireless data gloves fitted with flex sensors. Hearing impaired people can wear these hand gloves and perform hand gestures then the system can convert these gestures into speech so normal person understand their expression hence the communication can be possible between deaf and normal person.

K. Sangeetha and L. Barathi Krishna [7] present android based gesture recognition for deaf and dumb person. The proposed system can captured image using mobile camera and converts into speech. To extract the features of gestures many image processing techniques and skin detection algorithm is used. M. M. Gharasuie and H. Seyedarabi [8] proposed a system to recognize English number from 0to9 using dynamic hand gestures. The system mainly focuses on image preprocessing and classification. . Discrete Hidden Markov Model is used for the classification which is trained by Baum-Welch algorithm with Average recognition rate from 93.84% to 97.34%. Aditi Kalsh and N.S. Garewal [9] proposed a system in which gray scaling, peak detection and canny edge detection method is used for feature extraction and if else rules can be used for the classification purpose. So the gestures are recognized within minimum time.

Puneet Kaur, Bhupender Singh and Neha Kapur [10] had discussed how to use Hidden Markov Model in the process of recognition of speech. To develop an ASR (Automatic Speech Recognition) system the essential three steps necessary are pre-processing, feature Extraction and recognition and finally hidden markov model is used to get the desired result. Research persons are continuously trying to develop a perfect ASR system as there are already huge advancements in the field of digital signal processing but at the same time performance of the computer are not so high in this field in terms of speed of response and matching accuracy. The three different technique used by research fellows are acoustic phonetic approach, pattern recognition approach and knowledge based approach

III. PROPOSED SYSTEM

A. Gesture to Speech Conversion System

Figure drawn below shows the flow diagram for hand gestures to speech conversion System

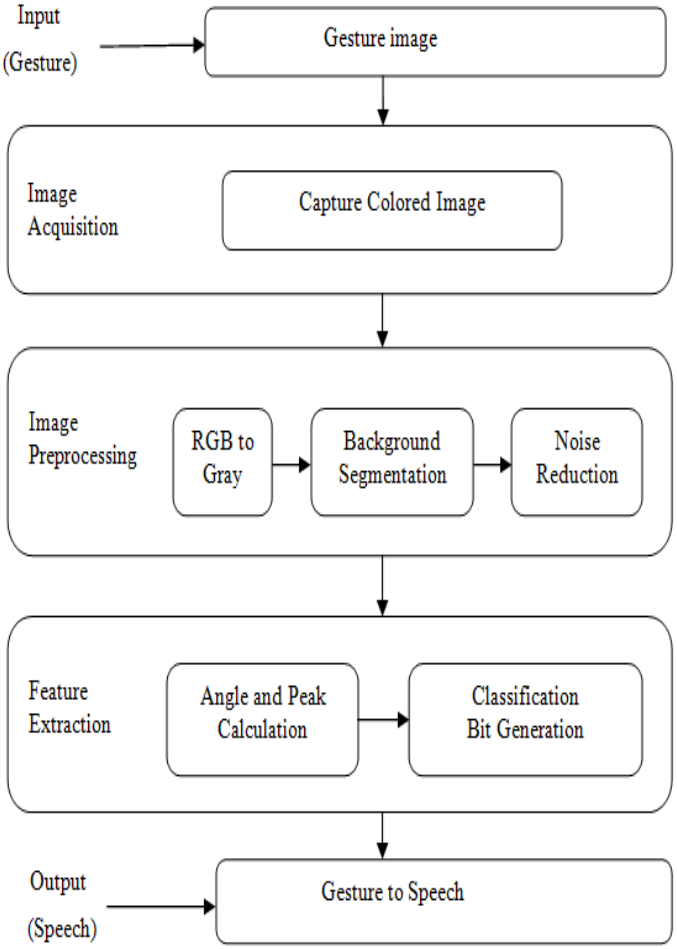


Fig.1 Flow diagram of hand gestures to Speech conversion System

1) *Image Acquisition*: There are many input devices for image acquisition are available some of them are hand images, data gloves and markers. In this system a real time image is acquired by using 20 mega pixel web cam using MATLAB inbuilt command.
2) *Image Preprocessing*: Image preprocessing is very important step for getting good results. The real time RGB color images are captured using a 20 MP webcam and converted into gray Images. Background segmentation is used to separate the hand object in the image from its background. Noise elimination steps are applied to remove connected components.

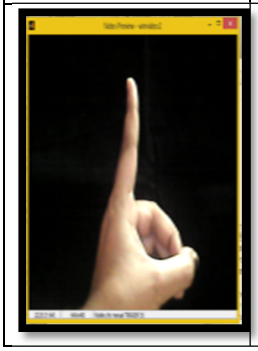
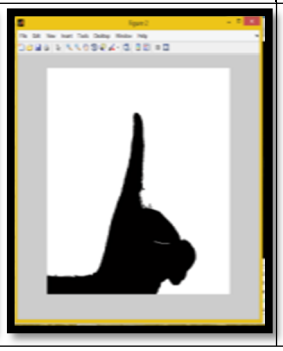
3) *Feature Extraction:* There are many techniques are available for feature extraction like edge detection, hidden markov model, contour tracking algorithm and Gabor filter. The proposed system uses the angle and peak calculation to extract the features of hand gestures. Peak calculation calculates the number of raised and folded fingers and to differentiate gestures we used zero, positive and negative angles. For classification 12 bit binary sequence is generated for each hand gesture which classifies the different hand gestures, Then finally we recognize the hand gestures and then convert it into speech by using MATLAB inbuilt command.

TABLE I
Feature string and angle of Gestures

sr no.	Different Gestures	Feature String	Generated angle
1	A	000100000000	Zero
2	B	000100000011	Positive
3	C	000100000111	negative
4	D	001011000000	Zero
5	E	001011000011	Positive
6	F	001011000111	Negative
7	G	001111100000	Zero
8	H	001111100011	Positive
9	I	001111100111	Negative

4) *Gesture to Speech conversion:* After recognizing the gestures the hand gesture images are converted into speech for providing better communication for hearing impaired and dumb person.

TABLE II
Gesture to Speech Conversion System

Input Gesture	Output Gesture	Gesture to Speech
		 A

B. Speech to Gesture Conversion System

Speech recognition or Automatic Speech Recognition (ASR) is an essential and integral part of the human computer interaction Voice Recognition based on the speaker can be classified into two types namely: Speaker-dependent and Speaker-independent. Figure 2 shows the speech to gesture conversion system.

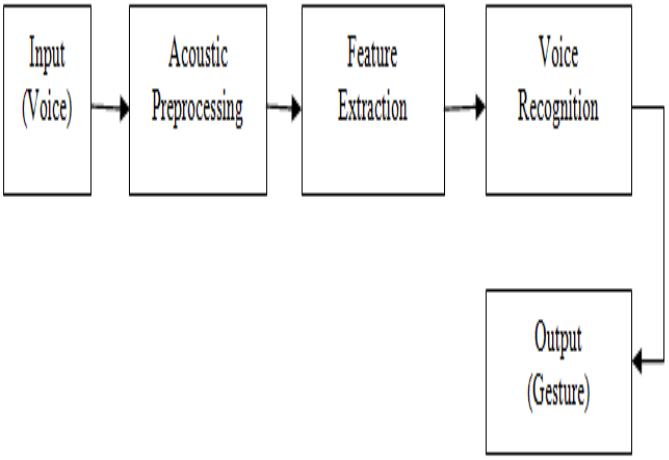


Fig.2 Block Diagram of Speech to Gesture Conversion System

For speech to gesture conversion system we use mel frequency cepstral coefficients for both training and testing phase. Dynamic time warping is used to compare the feature vectors of signals. Since each person's voice is unique, the program cannot contain a template for each potential user, so the program must first be "trained" with a new user's voice ,then give voice as input to testing section this voice is compared with the data base of training section and voice is recognized and converted into gesture. Thus, deaf and dumb person can understand the language of normal person.

IV. RESULT

A. Results For Gestures To Speech Conversion System

For hand gesture detection we take 9 different gestures A,B,C,D,E,F,G,H and I .Each gesture repeated ten times ,so the total number of tested images was 90 among which hand gesture recognition images from correct recognition was 81 and hand gesture recognition images from wrong recognition was 9 with an average detection rate of hand gestures of 90.00%.

TABLE III
Percentage Accuracy of different Gestures

Different Gestures	No. of test Conduct	No .of correct test	error	Percentage of accuracy
A	10	9	1	90%
B	10	10	0	100%
C	10	10	0	100%
D	10	9	1	90%
E	10	8	2	80%
F	10	10	0	100%
G	10	9	1	90%
H	10	7	3	70%
I	10	9	1	90%

Figure 3 shows the Graph for Average recognition rate of different hand gestures which is shown in below.

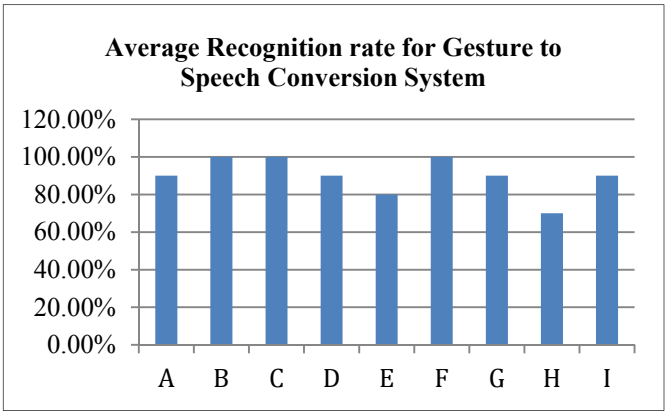


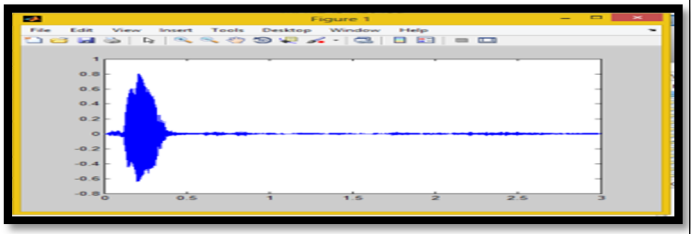
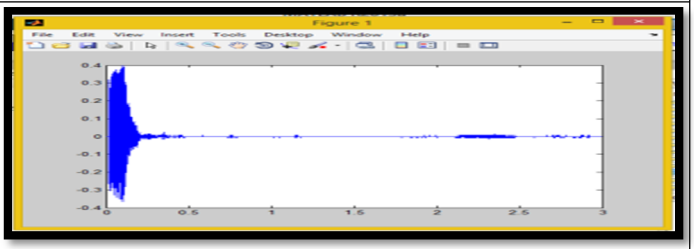
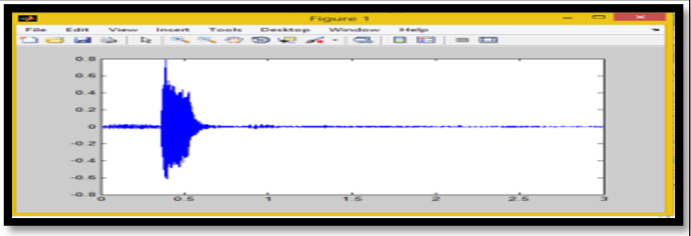
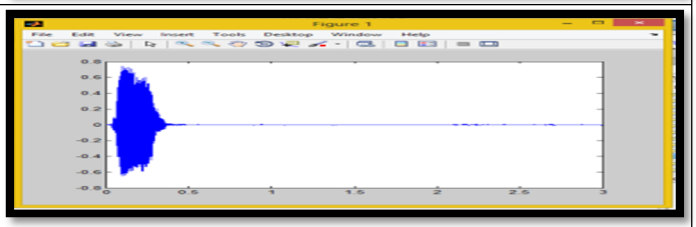
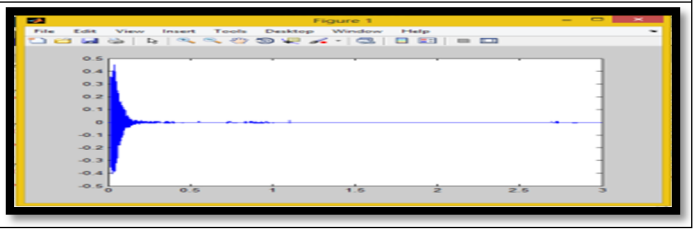
Fig.3 Average recognition rate for Gesture to Speech Conversion System

B. Results For Speech to gesture Conversion System

For the purpose of training, we take many voice samples from the different person, and stored it on database. Take any persons voice as input voice to the testing section then the model can compared input speech sample with stored data base and highest match result is obtained. Dynamic time warping calculates the distance and minimum matching distance rate can show the actual matching rate. Table IV shows that how many times users generated speech sample is matching with the training data base and we get correct match samples.

TABLE IV

Analysis of Speech to Gesture Conversion System for 'A'

sr no.	Speech samples	Matching with training data base	Generated Speech sample
1	A	Match	
2	A	Match	
3	A	Match	
4	A	Match	
5	A	Not Match	

For speech to gesture recognition we take 9 different sound samples A,B,C,D,E,F,G,H and I .Each sound sample repeated ten times,so the total number of tested sound samples are 90 among which sound samples from correct recognition was 83and sound samples from wrong recognition was 7 with an average detection rate of sound to gesture conversion of 92.22% shown in figure 4.So the ovearall dual communication proposed system can gives accuracy with 91.11% shown in figure 5.

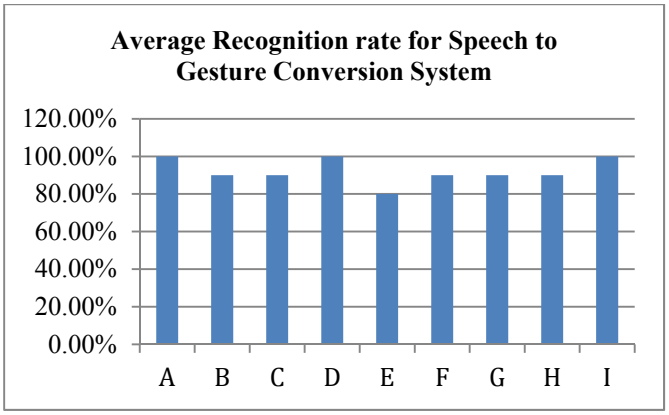


Fig.4 Average Recognition rate for Speech to Gesture Conversion System

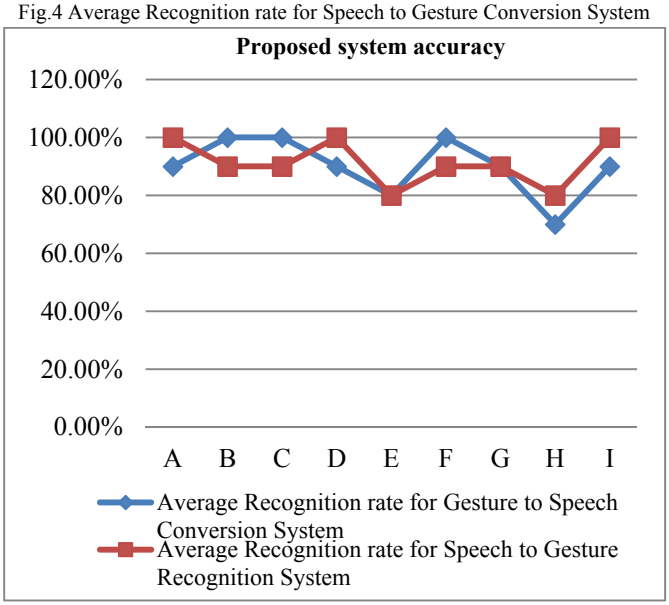


Fig .5 Recognition Result of dual communication System

V. CONCLUSIONS

The proposed system is easy to implement as there is no complex feature calculation. This system provides us with high gesture recognition rate with accuracy 90% within minimum time. The system aims to lower the communication gap between deaf people and normal world, since it facilitates dual communications. The projected methodology interprets hand gestures into speech and vice versa. The system overcomes disadvantages of previous existing system and improves their manner. With this project the deaf-mute people can use the hand gestures to perform sign language and it will be converted into speech with accuracy 93%; and the speech of normal person is converted into hand gesture, so the communication between them can take place easily. There is need of research in the area feature extraction and illumination so the system becomes more reliable. The proposed system convert gesture images into speech so the normal person knows that what the deaf and dumb person said and second part consists of speech to gesture conversion hence deaf and dumb person knows what the normal person said hence this system enables deaf and dumb people to further connect with their society and aids them in overcoming communication obstacles created by the society's incapability of understanding and expressing sign language.

REFERENCES

[1] Eriglen Gani , Alda Kika, *"Albanian Sign Language (AlbSL) Number Recognition from Both Hand's Gestures Acquired by Kinect Sensors"* International Journal of Advanced Computer Science and Applications, Vol. 7, No. 7, 2016.

[2] Miada A. Almasre, Hana Al-Nuaim, "A Real-Time Letter Recognition Model for Arabic Sign Language Using Kinect and Leap Motion Controller v2" *International Journal of Advanced Engineering, Management and Science (IJAEMS),* Vol-2, Issue-5,ISSN: 2454-1311,May 2016.

[3] Rashmi. B. Hiremath, Ramesh. M. Kagalkar, "*Methodology for Sign Language Video Interpretation in Hindi Text Language"* International Journal of Innovative Research in Computer and Communication Engineering, Vol. 4, Issue 5, May 2016.

[4] Cao Dong, Ming C.Leu, Zhaozheng Yin, *" American sign language Alphabet Recognition Using Microsoft Kinect"*, Computer Vision and pattern Recognition workshop, IEEE conference, pp ,2015.

[5] Paulo Trigueiros, Ferando Ribeiro, Luis Paulo Reis, *" Vision Based Portuguese Sign Language Recognition System"*, New Perspectives in Information System and Technologies, Volume 1,Advances in Intelligent System and Computing, Springer International Publishing Switzerland,pp-605-608,2014.

[6] Vajjarapu Lavanya, M.S. Akulapravin, Madhan Mohan, *"Hand Gesture Recognition and Voice Conversion System Using Sign Language Transcription System"*, IJECT Vol. 5, Issue 4, Oct - Dec 2014.

[7] K. Sangeetha, L. Barathi Krishna, "Gesture Detection For Deaf and Dumb People ", *International Journal of Development Research Vol. 4, Issue, 3, pp. 749-752,* March, 2014.

[8] M.M.Gharasuie, H.Seyedarabi, *"Real-time Dynamic Hand Gesture Recognition using Hidden Markov Models"*, 8th Iranian Conference on Machine Vision and Image Processing (MVIP), 978-1-4673-6184-2/13/$31.00,2013.

[9] Aditi Kalsh, N.S. Garewal , *"Sign Language Recognition for Deaf & Dumb",* International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 9, September 2013.

[10] Bhupinder Singh, Neha Kapur, Puneet Kaur "Sppech Recognition with Hidden Markov Model: A Review" *International Journal of Advanced Research in Computer and Software Engineering, Vol. 2, Issue 3,* March 2012.