Gesture Based Communication System for Vocally Impaired

Noman Ahmed Siddiqui[1], Ali Akbar Siddique[2], Fahad Farooq[3], M. Tahir Qadri[4]

***Abstract*— Inability to speak or to talk is called muteness or mutism; often caused by speech disorder, loss of hearing or in some cases, surgery. The families of these people suffering from such disease often learn sign languages like American Sign Language (ASL) to communicate, but if a mute person meets someone who doesn't know ASL then there will be a communication barrier between them. So, to overcome this communication barrier we require a system through which a mute person can communicate with everyone, hence breaking down a speech barrier. In this regard, we proposed a system based on image processing to identify the sign and perform some common speech patterns using the speaker.**

***Index Terms*— Image processing, Gesture recognition, Centroids, Raspberry Pi, Morphological operators.**

I. INTRODUCTION

Gestures are basically nonverbal means of communication performed by the hands, face or maybe other parts of the body and deliver some useful information. Physical gestures are important to learn from the mute person, but one should keep in mind that they are often culture specific and may convey different message in different social or cultural settings. These gestures are different from usual sign languages and interaction with mute or deaf people is of utter importance these days, because many mute people are joining the work force and it is important for them to interact with their colleagues. We know that gestures are now so deeply rooted in our communication that many people often perform gestures while they are on the phone. There are many signs which express very difficult meaning and to understand them may be a challenging task for the people who have no understanding of that language.

Most recent researches include the system based on the Field Programing Gate Array (FPGA) acquiring the image from a visual device and recognize a gesture, then perform the desired task [1-5]. Many hand gestures based games are also introduced over the years [6]. Some researchers utilize an Artificial Neural Network (ANN) for recognizing hand gestures [7-11]. Even a Hidden Markov Model is also utilized for gesture recognition [12-16].

The aim of our proposed work is to develop a real time system capable of establishing a communication link between mute people and hearing people using gestures.

To build such a system, it is important to have knowledge of the existing techniques which mute people are using for their communication. These days' researchers are focused on developing a socially relevant product, but it is a bitter fact that there have not been any significant advances regarding the communication of mute people. Even now many mute people use translators to deliver their message, but it often makes them uncomfortable, but without translator they are in a whole other class of society by no means to convey their message or even to communicate.

II. SYSTEM IMPLEMENTATION

This system is based on image processing which is used to remove communication barriers between mute and hearing people. It is obviously hard for a hearing person to communicate with a mute person without a translator, but occasionally, a mute person may not have their translator with them, then our system may become useful in this situation. Our proposed system can generate some common speech patterns like "HELLO" or "HOW ARE YOU" using hand gesture by counting the number of fingers.

Hardware model is comprised of a camera interfaced with a Raspberry Pi Module. It is a processing unit for our system and is capable of handling image processing based applications such as this one. A speaker is interfaced with its analog or audio output, for delivering speech pattern to a hearing person by identifying the specific gesture performed by a mute person, via a camera. The software is developed in MATLAB 2016a in which Simulink is utilized, to create the procedure and upload to Pi Module. The reported work uses Pi for the application because of its availability, ease of use and small size. Fig. 1 represents the hardware model and the components used to build it.

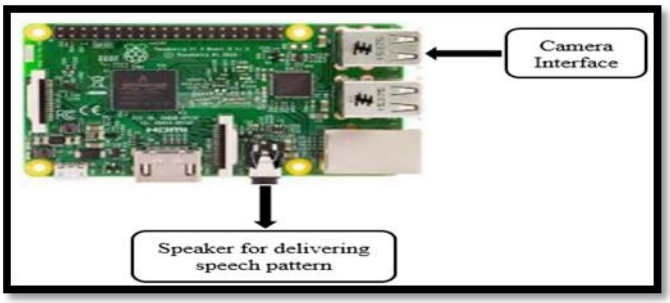

Fig. 1: System Hardware.

[1]Department of Electronic Engineering, Sir Syed University of Engineering & Technology, Karachi, Pakistan. nomasida@ssuet.edu.pk
[2]Department of Telecommunication Engineering, Sir Syed University of Engineering & Technology, Karachi, Pakistan. ali124k@hotmail.com
[3]Department of Electronic Engineering Sir Syed University of Engineering &Technology, Karachi, Pakistan. ffarooq@ssuet.edu.pk
[4]Department of Electronic Engineering Sir Syed University of Engineering &Technology, Karachi, Pakistan. mqadri@ssuet.edu.pk

III. GESTURE RECOGNITION ALGORITHM

Before the hardware implementation of the system, we first need to device an algorithm to identify the gesture by counting the number of fingers. After the frame extraction from the live video stream, it undergoes some filtering to remove the background noise and to only display the hand in a binary image, median filter is most reliable in reducing the noise in this application. All the processing is performed using the binary image, so it is imperative to convert the image in binary format.

At this point we have acquired a clean binary image displaying the hand, now we implement the morphological operators on this image like opening, closing and bottom-hat filtering. Opening operator performs the erosion and then dilation afterwards using the predefined close structural blocks. The purpose of the bottom - hat filtering is the basically subtract the morphed image using morphological operators and the original image. After the application of these morphological operators, median filter is introduced once again to further eliminate any noise occurred from the morphological operation.

Finally, the total number of fingers, are identified by finding out the centroids of the objects and in final acquired image after filtering. Fig. 2 is a basic flow of an algorithm implemented.

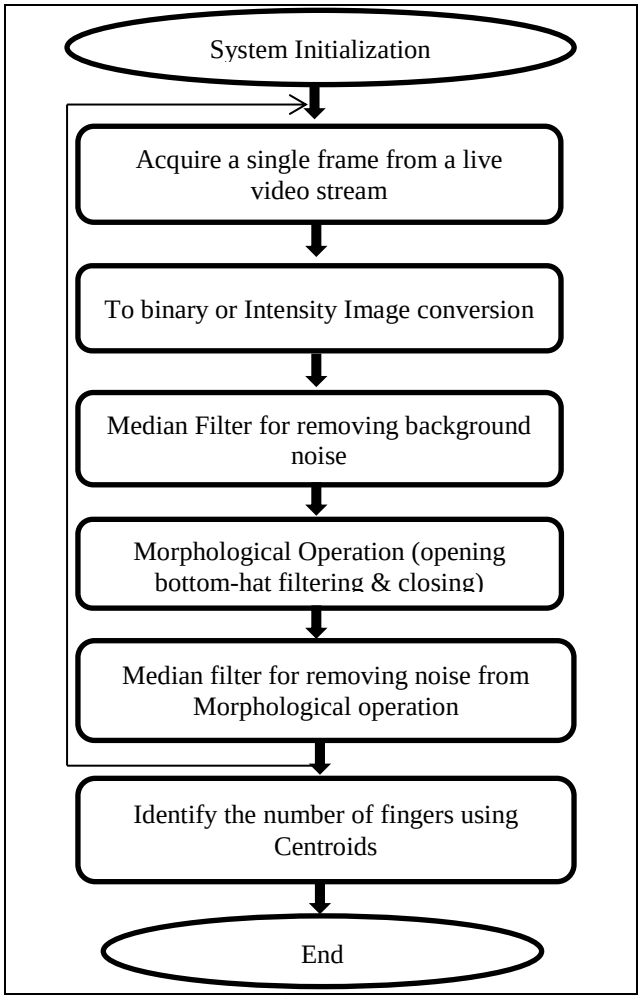

Fig. 2: Algorithm of Hand Gesture Recognition

IV. RESULTS

For the basic speech, we have already developed some speech patterns that are common in everyday verbal communication using MATLAB as given in Fig. 3 and Fig. 4, they are "HELLO" and "NICE TO MEET YOU". Each of the gestures has their own speech pattern which can easily be performed by the hands.

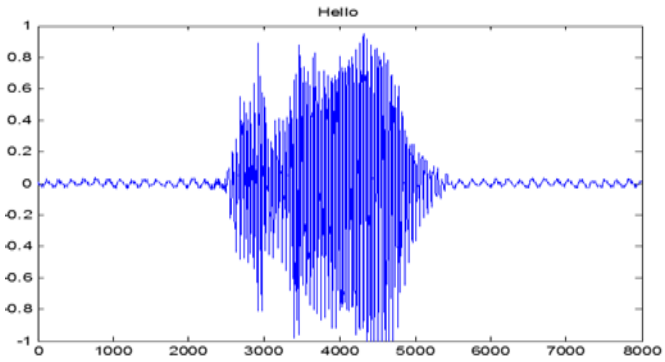

Fig. 3: "Hello" Speech Pattern

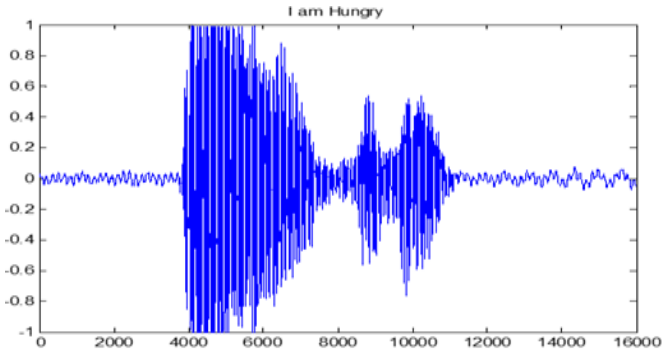

Fig. 4: "NICE TO MEET YOU" Speech Pattern

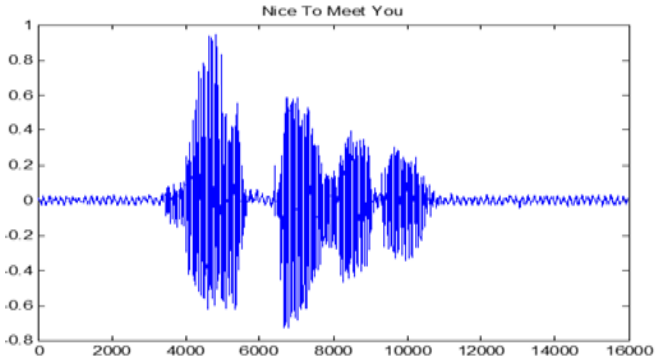

Fig. 5: "I AM HUNGRY" Speech Pattern

The gesture recognition part is displayed in Fig. 6 in which the one finger is open. It has four images the first image is one we acquire after filtration. Second image is deeply eroded and dilated, the third image is a bottom-hat filtered output. Final image actually represents the finger detection using bounding centroids of the existing objects.

Table-1 represents the figure count with respect to the speech pattern that will be played if we pose the specific gesture. Each of the images in Fig. 7, 8, 9 and 10 represents the same gestures with different fingers to determine different speech patterns as shown in Table I.

Table I: Gestures with respect to common Daily Life Speech Patterns

Number of Fingers in a Gesture	Speech Pattern
1	Hello
2	Nice to meet you
3	I am hungry
4	Yes
5	Excuse me

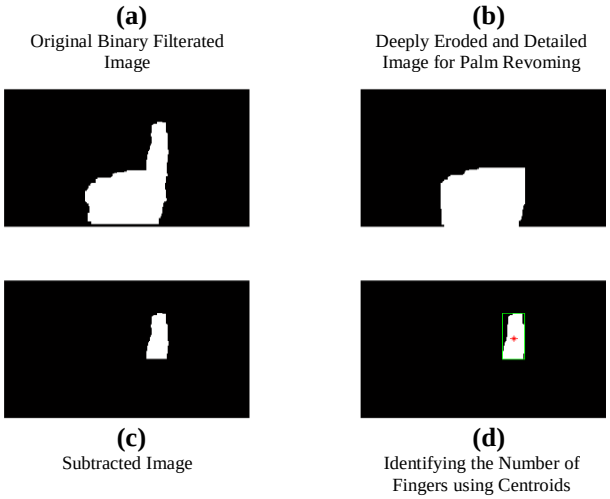

Fig. 6: Detection of One Finger

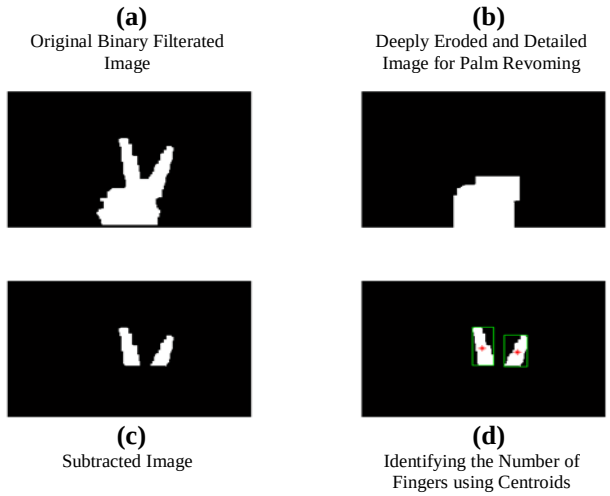

Fig. 7: Detection of Two Fingers

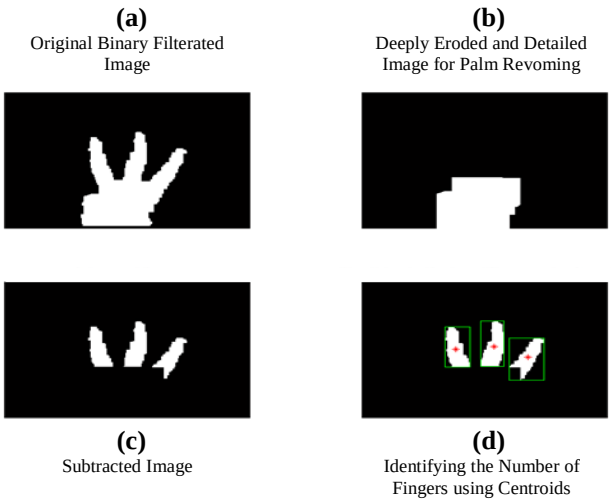

Fig. 8: Detection of Three Fingers

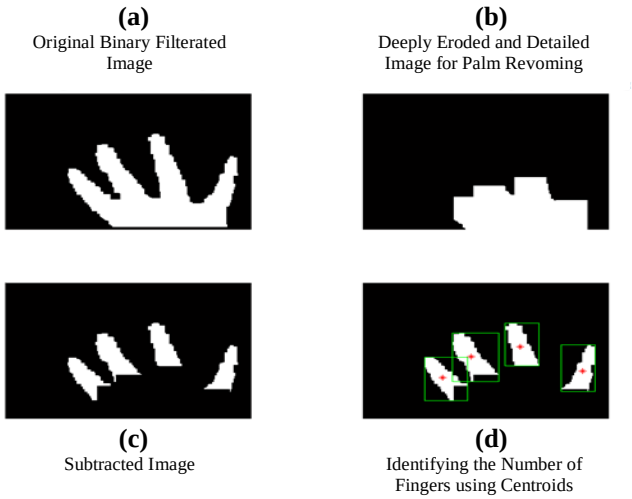

Fig. 9: Detection of Four Fingers

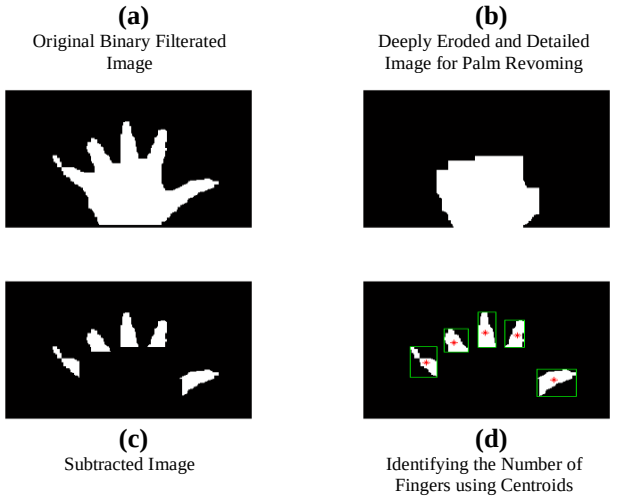

Fig. 10: Detection of Five Fingers

V. CONCLUSION

Visual gestures have been an integral part of communication between people for a very long time. Usually most of them are originated from the face or by hand but are not limited to them. In this system, we have proposed a verbal communication system, capable of performing a desired speech patterns that are commonly used. The system developed for such application is cheap, easy to implement and is very useful for mute people. All the results accumulated are extracted in real time and the system is designed to perform smoothly and with minimum errors.

REFERENCES

[1] Shi, Y., & Tsui, T An FPGA-based smart camera for gesture recognition in HCI applications In Asian conference on Computer vision Springer, Berlin, Heidelberg. . (2007, November). (pp. 718-727).

[2] Park, I. K., Kim, J. H., & Hong, K. S An implementation of an FPGA-based embedded gesture recognizer using a data glove in Proceedings of the 2nd international conference on Ubiquitous information management and communication (2008, January). (pp. 496-500). ACM.

[3] Gupta, A., Sehrawat, V. K., & Khosla, M FPGA based real time human hand gesture recognition system Procedia Technology. 6, 98-107. (2012).

[4] Kim, J. H., Thang, N. D., & Kim, T. S. "3-d hand motion tracking and gesture recognition using a data glove. In Industrial Electronics, 2009". ISIE 2009. IEEE International Symposium on (2009, July). (pp. 1013-1018). IEEE.

[5] Meng, H., Pears, N., & Bailey, C. A human action recognition system for embedded computer vision application. In Computer Vision and Pattern Recognition, 2007. CVPR'07. IEEE Conference on (2007, June). (pp. 1-6). IEEE.

[6] Lee, D. H., & Hong, K. S, Game interface using hand gesture recognition. In Computer Sciences and Convergence Information Technology (ICCIT), 2010 5th International Conference on (2010, November). (pp. 1092-1097). IEEE.

[7] Ahsan, M. R., Ibrahimy, M. I., & Khalifa, O. O Electromygraphy (EMG) signal based hand gesture recognition using artificial neural network (ANN). In Mechatronics (ICOM), 2011 4th International Conference On (2011, May). (pp. 1-6). IEEE.

[8] Nagi, J., Ducatelle, F., Di Caro, G. A., Cireşan, D., Meier, U., Giusti, A.,... & Gambardella, L. M. Max) pooling convolutional neural networks for vision-based hand gesture recognition. Signal and Image Processing Applications (ICSIPA), 2011 IEEE International Conference on (2011, November). (pp. 342-347). IEEE.

[9] Cho, H., Choi, H. R., & Kim, T. Feature Based Weighted Neural Network for Hand Gesture Recognition (2016).

[10] Palmur, N., & Pushpalata, K. N. Hand gesture recognition for HCI based on artificial neural network. Gesture. 2 (04) (2016).

[11] Pyo, J., Ji, S., You, S., & Kuc, T Depth-based hand gesture recognition using convolutional neural networks. In Ubiquitous Robots and Ambient Intelligence (URAI), 2016 13th International Conference on (2016, August) (pp. 225-227). IEEE.

[12] Di Benedetto, A., Palmieri, F. A., Cavallo, A., & Falco, P. A hidden Markov model-based approach to grasping hand gesture classification. In Advances in neural networks (2016). (pp. 415-423). Springer, Cham.

[13] Deo, N., Rangesh, A., & Trivedi, M." In-vehicle hand gesture recognition using hidden Markov models. In Intelligent Transportation Systems (ITSC), 2016 IEEE 19th International Conference on (2016, November). (pp. 2179-2184). IEEE.

[14] Premaratne, P., Yang, S., Vial, P., & Ifthikar, Z. Centroid tracking based dynamic hand gesture recognition using discrete Hidden Markov Models. Neurocomputing", 228, 79-83. (2017).

[15] Yu, M., Chen, G., Huang, Z., Wang, Q., & Chen, Y. "Continuous Gesture Recognition Based on Hidden Markov Model. In International Conference on Internet and Distributed Computing Systems (pp. 3-11). Springer, Cham. (2016, September).

[16] Verma, T., & Kataria, S. M. Hand Gesture Recognition Techniques, A Review. International Research Journal of Engineering and Technology (IRJET), 3 (4), 2316-2319. (2016).