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# Design of Communication System to Interact With the Dumb & Deaf and Home Automation System Based On Hand Gesture Technology Using PCNN Algorithm

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**ABSTRACT**

In this paper, a gesture based sign language recognition system and a communication module is proposed using a novel technique for interacting with the dumb and the deaf. This system provides a two-way communication, where both the normal individual and the dumb or the deaf can communicate with each other without the help of an intermediate or translator. Here a load control prototype is also proposed for regulating the domestic appliances from anywhere out, in order to save energy. This prototype is an application of the hand gesture technology. The hand movements (gestures) are captured using an ordinary web camera. Preprocessing and feature extraction techniques are applied to capture and emphasis the precise detailing of the gesture. K-Nearest Neighbor (KNN) approach is used to extract only the gesture and to eliminate the background. PCNN algorithm is used for accurate classification of gestures into several area domains.

The proposed system is found to be superior in terms of feature extraction and communication rates.

***Index Terms:*** Feature extraction, KNN Segmentation, PCNN algorithm, gesture.

## 1. INTRODUCTION

In recent years, there has been a tremendous amount of research on hand gesture recognition. Gestures are the physical actions that convey some meaningful information. It includes movement of the hands, face, or other parts of the body. Gesture recognition enables humans to interface with the machine (human machine interaction) and interact naturally without many mechanical devices [1]. This could potentially make conventional input devices such as mouse, keyboards and even touch screens redundant. The series of gestures such as hand movements and facial expressions indicating words, are referred to as sign language[4]. It is a form of communication used mostly by people with impaired hearing.

Sign language recognition systems are used to convert sign language into text or speech to enable communication with people who do not know these gestures. Usually, the focus of these systems is to

**Figure 1: Some signs used in the sign language.**

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recognize hand configurations including position, orientation, and movements. Accordingly, these gestures are captured to determine their corresponding meanings, using two approaches: sensor-based and gesture based [2]. While the former entails wearable devices to capture gestures, it is usually a simple process. On the other hand, gesture-based approaches utilize cameras to capture the sequence of images. The latter is a more natural approach, with high accuracy and communication rates.

The existing system is a sensor-based Arabic sign language (ArSL) recognition model that includes alphabet recognition systems accomplishing lesser accuracies and linguistic datasets.

This system deals with a wearable sensor based gloves. Sensor-based recognition systems depend on instrumented gloves to acquire the gesture's information. In general, equipped sensors measure information related to the shape, orientation, movement, and location of the hand. A DG5-V Hand Gloves are better suited for this application because they contain flex sensors and a 3-D accelerometer [6].

In this system, the sensor-based gloves plays an important role. These wearable gloves consists of several motion sensors and an accelerometer.

The V Hand glove represent the amount of bend in each finger in addition to the hand acceleration and orientation[8]. Once the gloves are worn by the user, the gestures made by the user are sensed using these motion sensors and the accelerometer reads this gestures and passes the information to the micro controller attached to the computer system. Now the dataset received by the microcontroller is converted into a digital output. But the existing system deals with several drawbacks:

- It is difficult to go for the reverse process and convert the text into sign language.
- It requires an additional usage of sensor based gloves.
- It is also Costly and complex process.

Thus in order to overcome the drawbacks of existing system we go for the proposed system.

The basic idea in the proposed system is to develop a communication system that enables easy interaction between a normal individual having no idea about the sign language and the dumb or the deaf person trained thoroughly in sign language. The remainder of this paper is organized as follows. Section II describes the proposed system. Section III introduces the working process of proposed system. Section IV presents the simulation results. Hardware details are described in Section V. Section VI deals with the design of home automation system.. Section VII concludes the work.

## 2. THE PROPOSED SYSTEM

The proposed system is totally based on hand gestures. In this model a hand gestured communication prototype is developed that enables a normal individual to interact with the dumb or the deaf.

**Figure 2: Image of sensor based gloves**

This system is basically designed to help that section of community whom we generally treat as inferiors or disabled in the society, that is THE DUMB and THE DEAF. This system provides a two-way communication where both the normal individual and the dumb or the deaf can communicate with each other. All this is done using MATLAB software. Hand gesture represents ideas and actions using different hand shapes, orientation or finger patterns being interpreted by gesture recognition system & turns them into corresponding events. But recognizing hand gestures is really a challenging task as one of main goal of hand gesture recognition is to identify hand gestures and classify them as accurately as possible.

The proposed system of hand gestured communication module deals with several methodologies like KNN SEGMENTATION and the PCNN algorithm.

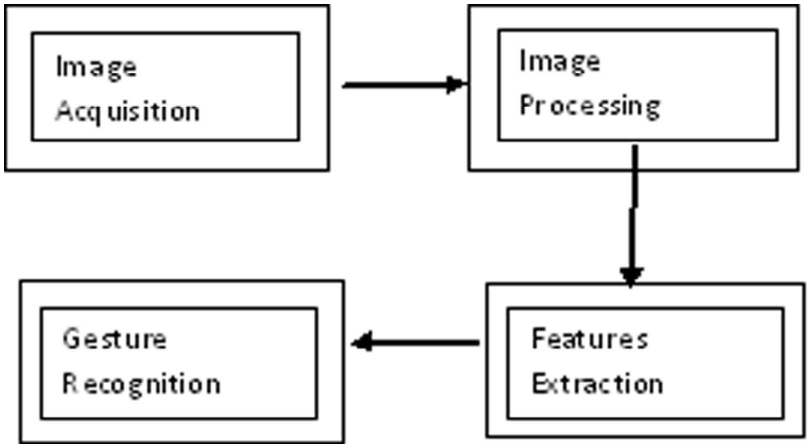


**Figure 3: Block diagram of hand gesture recognition system**

## 2.1. KNN Segmentation

The KNN segmentation stands for K NEAREST NEIGHBOUR algorithm. This algorithm is used to extract the hand image (gesture) from the background. In this algorithm as per the K means law, a primary node in the gesture is chosen at random and from that particular node the testing analysis begins. The K node now begins to compare all the nearest and the neighboring nodes. When it finds the match of the nearing node to be same, it goes for the next nodal analysis.

But in case if the primary node and the neighboring node have a mismatch, this algorithm concludes that the particular node not matching with the primary node is a point outside the hand region and thus eliminates that node considering it to be the unwanted background area. The KNN segmentation is used to segment the hand region and the outer background region.

## 2.2. PCNN Algorithm

The PCNN algorithm also termed as PULSE COUPLED NEURAL NETWORK is the key algorithm used in this project.

In this project hand gestures are used, these gestures are raw in form and sequential in nature hence PCNN proves to be a suitable algorithm for classification of these raw databases (gestures). This algorithm is mainly used to classify the gestures into several area domains. There are various types of neural networks for classification, pulse coupled neural networks is chosen because this algorithm (PCNN) deals with pulses that is zeroes (0's) and ones (1's). In this hand gestured communication model, first an image is captured, that image is later converted into binary image with only 0's and 1's that is only black and white image. On this binary image PCNN algorithm is applied.

Thus for each and every gesture we get an area range and that particular gesture made by any individual falls within the defined range.

Hence PCNN algorithm is used for classifying gestures into definite area intervals.

## 3. WORKING PROCESS OF THE PROPOSED MODEL

The proposed model has a very simple working operation. This undergoes various steps to complete the functioning.

### 3.1. Image Capturing of Gesture

The first and the foremost process in this communication system is capturing the image of a particular gesture.

Using a web camera multiple images of a particular gesture is taken. Multiple images of a particular gesture is taken so the area range of that particular gesture can be determined. After capturing the image, preprocessing and segmentation is done.

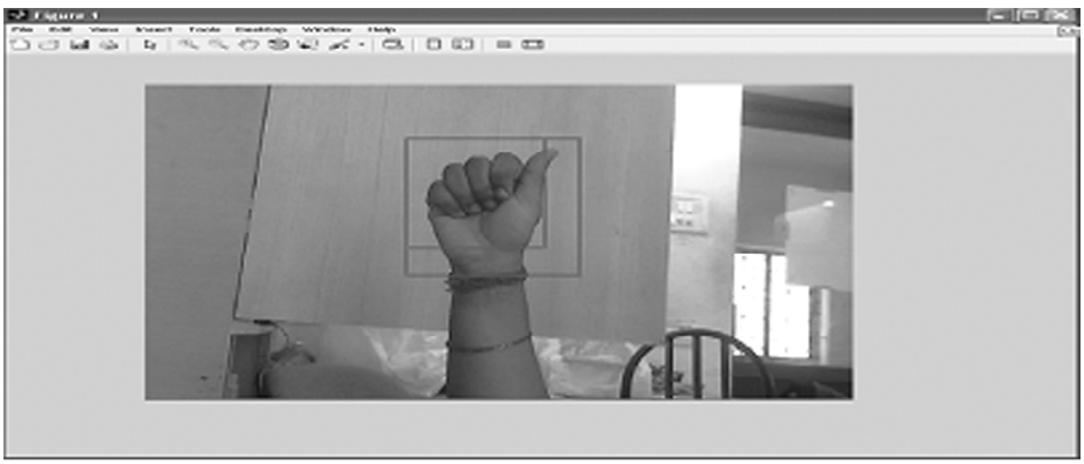

**Figure 4: Screenshot of image captured by the web camera**

### 3.2. Preprocessing

Preprocessing is the initial phase where the image captured is cropped, in order to get the image alone and to eliminate the background. In preprocessing phase the gesture is cropped and thus the gesture is obtained within a square region. After getting the cropped image, this color image is converted into gray and finally the gray image into binary.

Thus the various stages of preprocessing are:

- CROPPING THE IMAGE
- ELIMINATING THE BACKGROUND
- CONVERTING COLOR IMAGE INTO GRAY
- CONVERTING GRAY IMAGE INTO BINARY.

### 3.3. Segmentation

In segmentation, the left out background area is segregated that resides within the square region of processed image.

Here, a median filter is used to extract the background, and to eliminate that area KNN SEGMENTATION algorithm is used.

**Figure 5 (a): color image of the gesture**

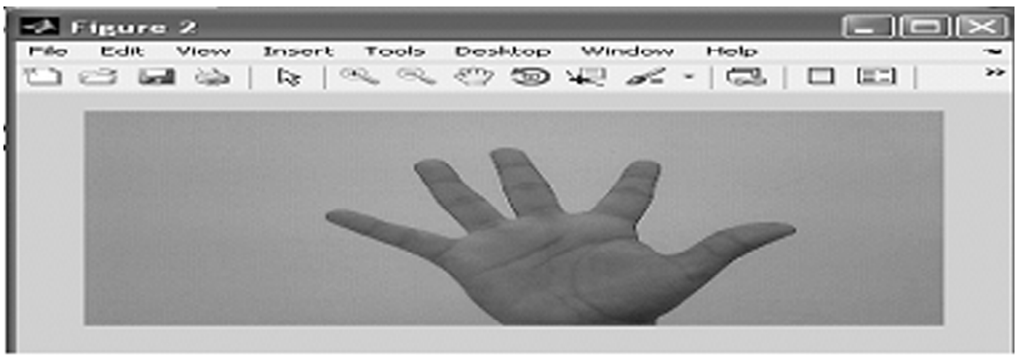

**Figure 5 (b): gray image of the gesture**

**Figure 5 (c): binary image of the gesture.**

This KNN algorithm fixes a primary node in the gestured image and then starts analyzing the neighboring nodes. When the primary node and the testing node match each other the algorithm considers it as the part of gesture and goes for the next nodal analysis.

But in case of any mismatch found between the primary node and the testing node, the algorithm concludes it as a background region and segregates it from the gesture region.

### 3.4. Feature Extraction

Once the segmented image is obtained, feature extraction is done to know about the details of the captured gesture.

Feature extraction details the following:

- SHAPE OF THE GESTURE
- ORIENTATION

- CENTRIOD LOCATION
- EXTREMUM POINTS
- INTRIMUM POINTS
- AREA DOMAIN.

This step is used to find and extract features of Region of Interest (ROI). The convex hull algorithm is used here to connect the contours. When the convex hull is drawn around the contour of the hand, it fits set of contour points of the hand within the hull. This algorithm gives information about the centroid point, extremum and intrimum points and about the shape of gesture.

### 3.5. Area Range Determination

After having the details of the captured gesture area is determined. This is done using PCNN algorithm. The PCNN algorithm classifies the gestures into definite area range. This area interval defines a specific region where a particular gesture lies. Irrespective of the color, brightness, texture and size of the hand, a particular gesture made by any individual lies within the specified interval determined by the PCNN algorithm.

### 3.6. Training

Training phase solely depends on the user. In training, the user trains all the gestures as per his/her wish. The gestures or symbols used by the user are not the universal signs and hence the dumb or the deaf is not aware of the sign shown by the user and its meaning. Thus the user is in need to train the system, such that each time a gesture is shown its corresponding meaning automatically appears on the screen and the dumb or the deaf, seeing the visual is able to understand what the user wants to convey.

In training phase, to each and every gesture a corresponding sentence is allocated. So every time a gesture is captured and run on the MATLAB software, the corresponding meaning of that particular gesture is displayed. That is whenever the camera captures an image, as per the training it understands to which word or sentence the particular gesture corresponds and hence it displays a digital output on the screen.

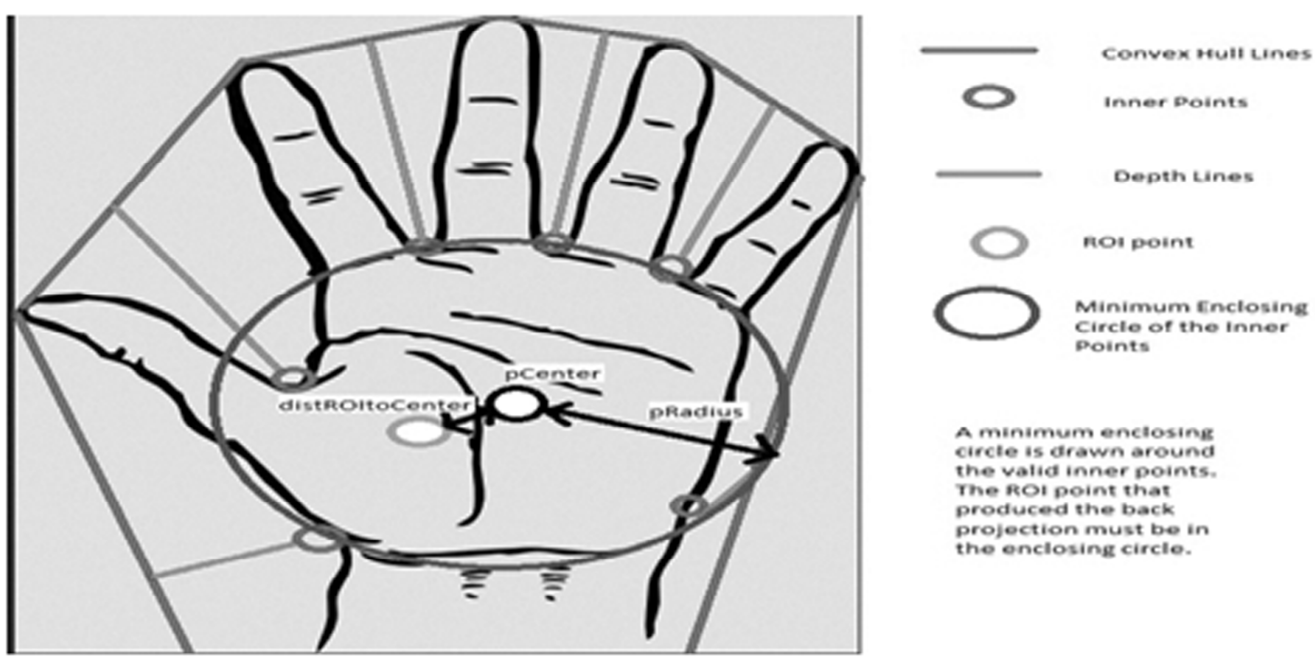


**Figure 6: Region of interest (ROI) with convex hull algorithm.**

### 3.7. Testing

The final stage of working process is testing. In testing phase, the gesture is run to see whether the particular sentence assigned to the gesture during training phase is obtained or not. For testing, a graphical user interface (GUI) in MATLAB editor is designed.

This GUI shows all the processing and segmentation phases on a single screen and it also displays the sentence assigned to it digitally.

## 4. SIMULATION RESULTS

The raw databases (gestures) were tested and the following results were viewed. After running the program codes and showing the gestures in front of the camera we get the following output results.

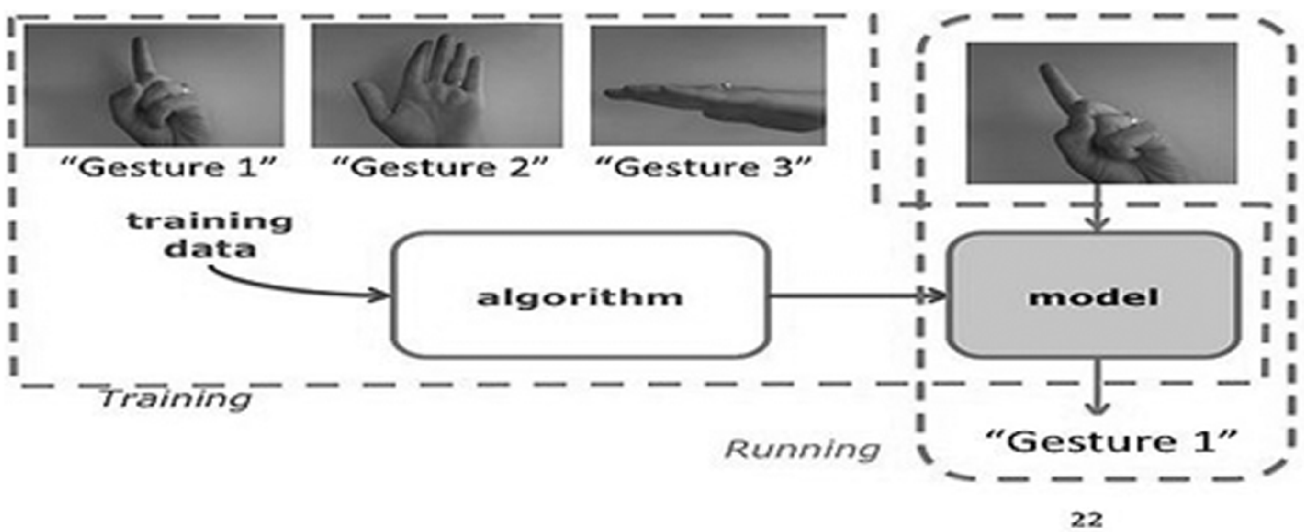


**Figure 7: Images of trained gestures**

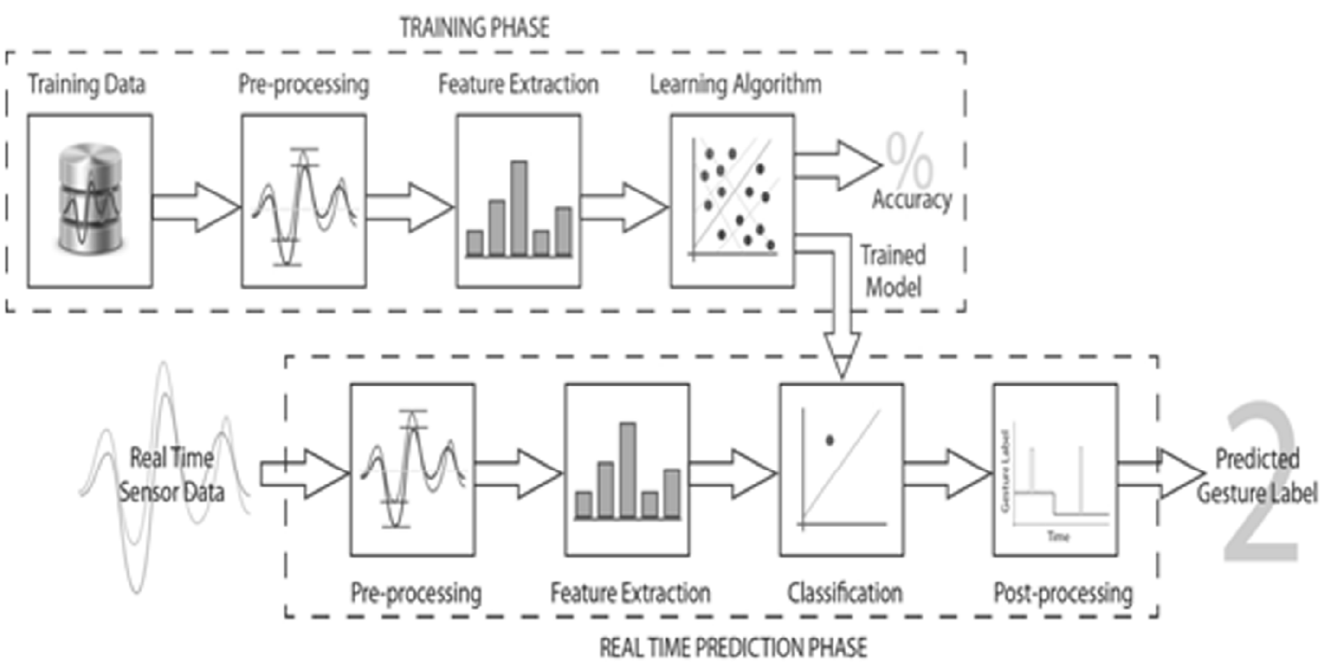


**Figure 8: Block diagram of training and testing phase**

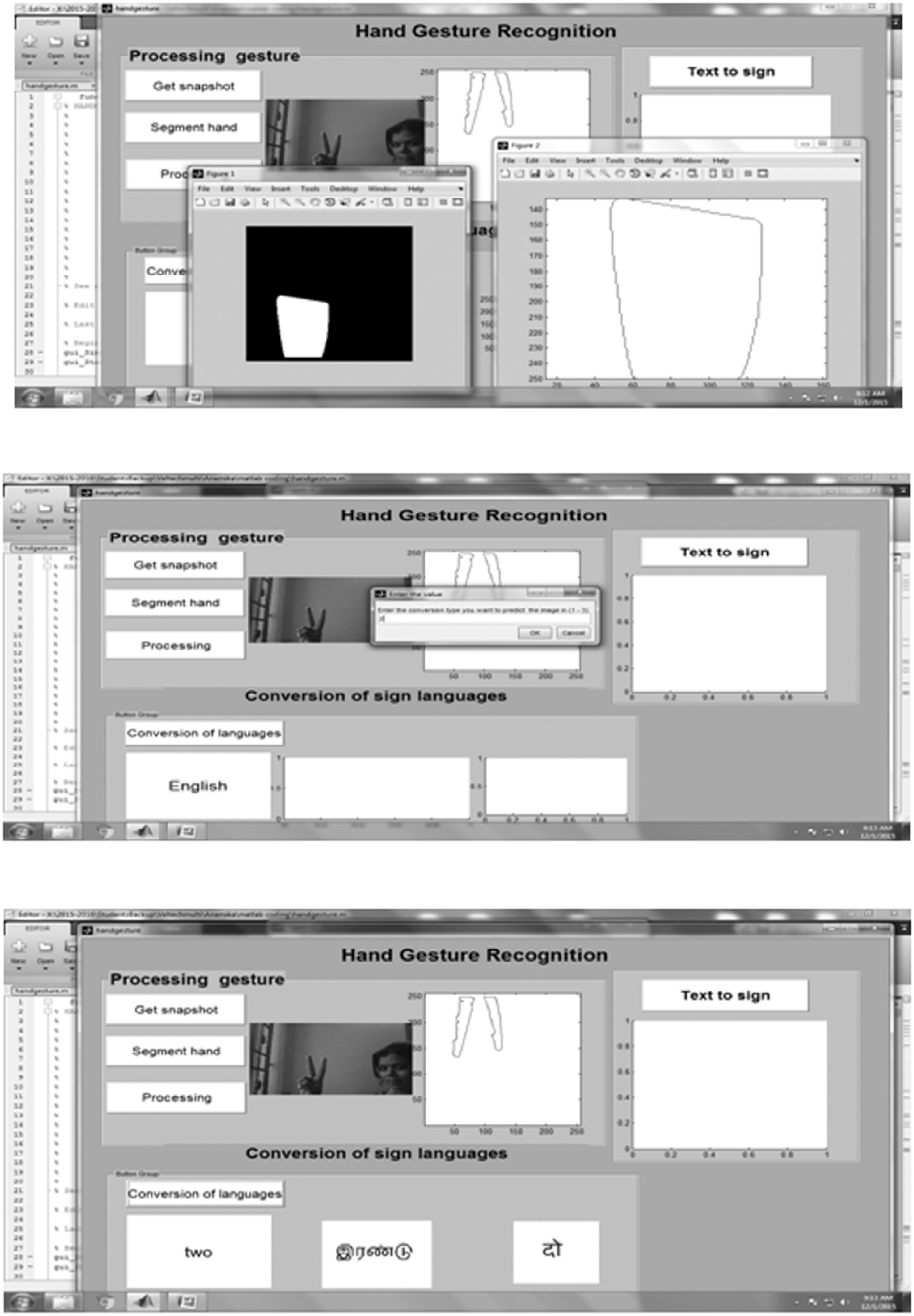


**Figure 9: screenshot of gesture corresponding to number “two”.**

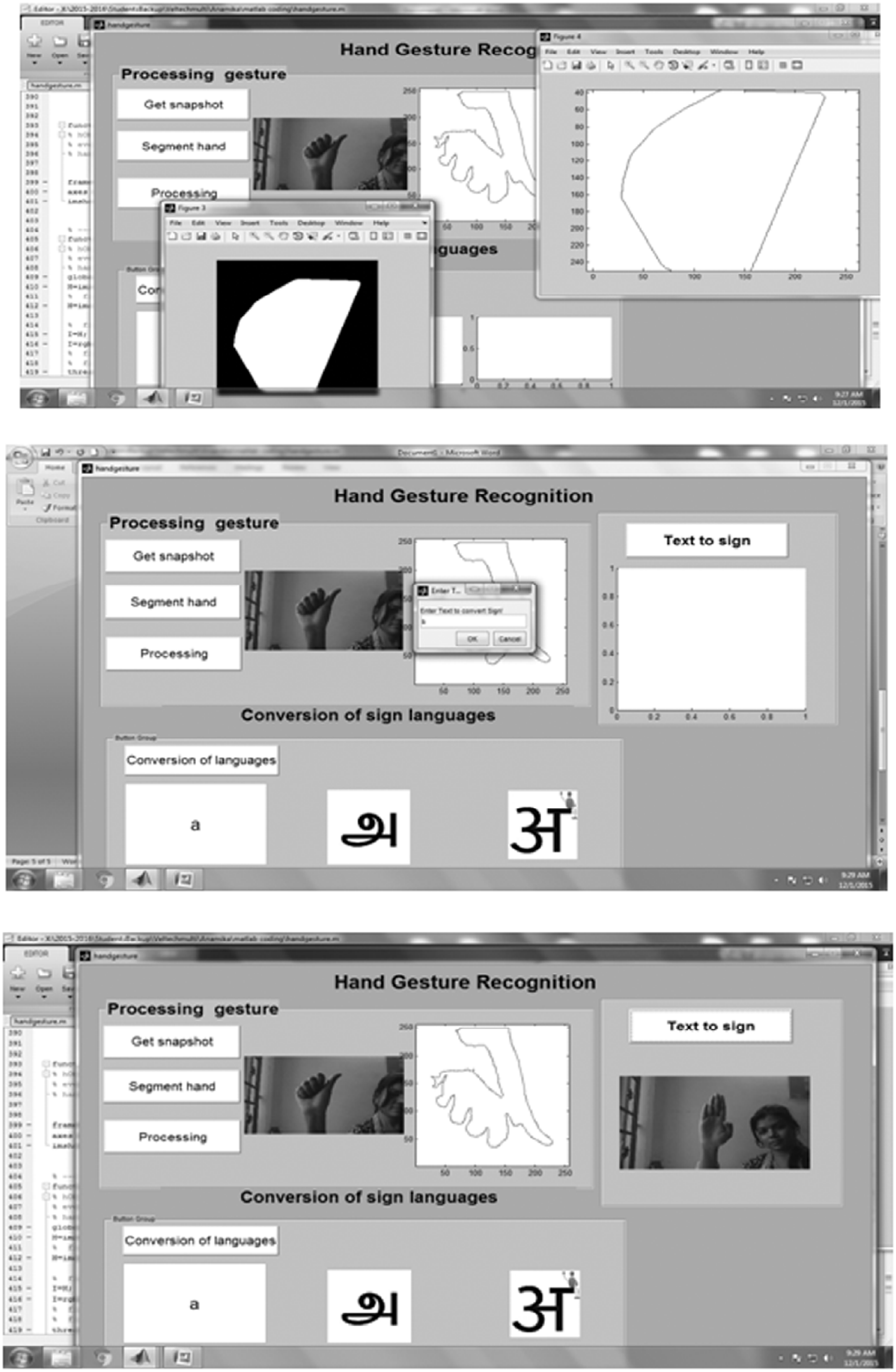


**Figure 10: Screenshot of gesture corresponding to word "a".**

## 5. CONCLUSIONS

A framework for hand gestured communication system is proposed that proves out to be fruitful for interacting with the dumb and the deaf without the help of an intermediate. This proposed system provides a two-way communication where both the normal individual and the dumb or the deaf can interact with each other with full ease. Here the hand gestures captured by the user are assigned with a text language, after processing, these text languages are displayed on the screen and thus allows the dumb or the deaf to understand what the user wants to convey. This also gives an opportunity to the dumb or the deaf to interact with the normal individual. Thus a communication module that enables easy interaction between a normal individual and a DUMB or DEAF by converting the hand gestures into simple text language is proposed.

An application prototype based on the hand gesture technology is also designed to control home appliances even if the user is somewhere outside, which not only makes the user's life easy but also saves energy.

## REFERENCES

[1] Noor Tubaiz, Tamer Shanableh, Khaled Assaleh, "Glove-Based Continuous Arabic Sign Language Recognition (ArSL) In User-Dependent Mode" *IEEE Transaction on HUMAN MACHINE SYSTEM* vol. 11, no. 16, pp. 170-183, 2015.

[2] M. Mohandes, S. Deriche "Vision-based gesture recognition: A review," *Lecture Notes Comput. Sci.*, vol. 1739, pp. 103–115, 2012.

[3] S. Peter, Rosie Thales, James Parker "Hidden Markov model for sign language recognition: A review," *in Proc. 2nd Hellenic Conf. AI, SETN-2002, Thessaloniki, Greece*, Apr. 11–12, 2013, pp. 343–354.

[4] P. Dunne, S. Thomson and R. Hoppel "A survey on sign language recognition" *in Proc. Frontiers Inform. Technol., 2012*, pp. 95–98.

[5] R. Maria, S. Miang, H. Florence, T. Berlin, "HMM based hand gesture recognition: A review on techniques and approaches," *in Proc. 2nd IEEE Int. Conf. Comput. Sci. Inform. Technol., 2009*, pp. 433–437.

[6] S. Aliyu, M. Zourob, " A survey of glove-based systems and their applications", *IEEE Trans. Syst., Man, Cybern. C, Appl. Rev.*, vol. 38, no. 4, pp. 461–482, Jul. 2008.

[7] T. Westeyn, H. Brashear, A. Atrash, and T. Starner, "Georgia tech gesture toolkit: Supporting experiments in gesture recognition," in Proc. 5th Int. Conf. Multimodal Interfaces, 2010, pp. 85–92.

[8] X. Zhang, X. Chen, Y. Li, V. Lantz, K. Wang, and Yang, "A framework for hand gesture recognition based on accelerometer and EMG sensors," IEEE Trans. Syst., Man Cybern., Part A, Syst. Humans, vol. 41, no. 6, pp. 1064–1076, Nov. 2011.

[9] W. Gao, G. Fang, D. Zhao, and Y. Chen, "A Chinese sign language recognition system based on SOFM/SRN/HMM," Pattern Recognition., vol. 37, no. 12, pp. 2389–2402, 2012.

[10] W. Kong and S. Ranganath, "Towards subject independent continuous sign language recognition: A segment and merge approach," Pattern Recognition., vol. 47, no. 3, pp. 1294–1308, 2014.