Gesture to English Letter Conversion for Sign Language

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Abstract --- Hand gesture recognition system received great attention in the recent few years because of its manifoldness applications and the ability to interact with machine efficiently through human computer interaction. Segmentation process is the first process for recognizing hand gestures. It is the process of dividing the input image into regions separated by boundaries.   It loads image, detects and recognizes static hand poses (i.e., "letters") and interprets pose in terms of gestures. The hand object is detected with a contour-based method. The static hand pose set corresponds to hand signs of Indian Sign language manual alphabet. Finally, by tracking hand poses, the pose is interpreted in terms of gestures.

I.   INTRODUCTION

There are many ways of communications used between humans and computer system. Among the different ways, gesture is considered as one of the most natural way in virtual reality system, they are powerful means of communication and they can economically convey the rich set of information. Gesture communication is a nonverbal communication. The image based input is a beneficial technique for communication or for the device control by identifying specific human gesture. The gesture recognition system is developed because of its intuitiveness and its capability of helping speaking and hearing impaired people. Gesture is meaningful movement from any part of human body (hand, facial expression, head). The natural way of communication mode is hand. Hand gesture recognition is mainly considered in man machine interaction and between deaf and dumb people using sign language. Gestures can be static (posture) or dynamic (sequence of postures). Static images require less computational complexity and dynamic images are more complex. In our project we focus on static hand images. There are different methods in acquiring the information for gesture recognition. Some methods use hardware devices like data glove and colour markers and other methods are based on appearance of hand using skin colour for segmentation and extracting the necessary features. Data glove provide very accurate measurement of hand shape but are difficult to wear and very expensive, they are connected by wires that restrict the freedom of movement. Coloured gloves are easy to put on and are very cheap. In vision based gesture recognition bare hands are used for making the gesture. In our project we use vision based gesture recognition

Figure 1. Data glove and coloured glove respectively.

Figure 2. Bare hand gestures used in vision based recognition system.

 Standard Sign dialects (SL) are known as deaf and mute dialects. They are gestural dialects that contain typical encoded messages for passing on the data without the discourse channel. SLs are novel in some ways and they can't be composed like talked dialect. With its own vocabulary and linguistic use SLs differs from nation to nation. Indian Sign Language (ISL) is a dialect utilized by Indian tragically challenged group. Considering the ISL this system focuses on hand gesture recognition followed by text synthesis.

Since vision-based methodology is more appropriate than customary information glove, we utilize vision-based methodology in this anticipate for translating Indian Sign Language utilizing hand methodology. A Hand Gesture Recognition System comprises of four modules: Gesture procurement, Tracking and division, Feature extraction and description, Classification and acknowledgment. An endeavor is made to investigate the need and inspiration of ISL which will give openings for work to hearing and talking debilitated individuals in IT area, commercial enterprises and government segment. Hand motion acknowledgment (HGR) turns into an exceptionally difficult issue due to its complex verbalized structure comprising of numerous associated connections and joints. Hand assumes dynamic part in gesture based communication. In HGR framework a decent arrangement of components, description and representation are required. The real undertaking in this framework is description of the signal.

Figure 3. Block diagram of Gesture Recognition System

The first step is data acquisition in which we acquire input data. This step is more important and it should be as perfect as possible for efficient hand gesture recognition. We need to select a suitable input device for information securing. A portion of the information gadgets are glove, marker and hand pictures from webcam, stereo camera, kinect 3D sensor. In our project we use bare hand images from the database easily and naturally as a input to the system. There is no external hardware cost.

The next step is Gesture Modeling, which is the most important step and the achievement of hand acknowledgment relies on upon this progression. There are four stages in the motion demonstrating: hand division, sifting/clamor evacuation, edge/form recognition and standardization. Hand division implies hand limitation i.e. to find the hand part. There are different techniques for hand division, those group the picture into two homogeneous part, forefront containing hand and foundation containing the rest. It is extremely testing to find the hand inside messed foundation. Some of the popular methods for hand segmentation are: Thresholding, skin-based, subtraction, colour normalization, salt and pepper, edge detection or contour detection, cropping operation and many more. In our project we are using contour based segmentation method.

The third step is feature extraction in which we extract the required features of the image based on our application. Furthermore, these elements are bolstered as contribution to the order calculation for characterization. In our project we use chain code of the contour as a feature. The extraction of features for each hand image is unique which are independent of human hand size and light illumination is important. The Recognition stage is the fourth step in which we recognize the gesture. The proper selection of features and classification algorithm affects the recognition stage. The widely used method is Neural Network. In our project we are using ANN classifier for classification purpose.

Table 1. Classification of HGR system

Group	Type
Application area	Communication via gestures, Robot control, Tracking Gesture, Games.
Hand movement	Static, Dynamic
Hand image acquisition	Camera, Data Glove, Colour Glove, Video
Number of hands used	One hand or two hands
Input parameters	Appearance based, low level components, 3D hand model
Sign Modality	Commutative, Manipulative

Table 2. Comparison of Models

Methods	Data Glove-Based	Vision-Based
User ease	Less	High
Cost	High	Less
Hand skeleton	Highly limited	Less limited
Calibration	Extremely important	Not important
Portability	Lesser ability	Highly portable

II. SIGN LANGUAGE IN INDIA

In writing, it was found that the quantity of hearing and talking hindered individuals in India, is more than different nations. More than one million hard of hearing grown-ups and around half million hard of hearing youngsters use ISL for correspondence. Hard of hearing and unable to speak individuals, who stay in towns, don't have admittance to gesture based communication. However in huge urban communities over the Indian subcontinent, hard of hearing individuals don't utilize standard gesture based communication, though they use their own sign language. For the implementation of ISL in education systems, many awareness programs and extensive work has been done.

The etymological work on ISL started in 1970 with the commitment of group of scientist from America and Vasishta et al. It was found that ISL is indigenous to the Indian subcontinent and it is a dialect in its own privilege and brought about four lexicons somewhere around 1977 and 1982. Obviously 75% 0f signs were same over the locale. In 1998 , research from Germany looked at sign from better places crosswise over Indian subcontinents, including locales like Kerala, Jammu and Kashmir, Orissa, Bhopal, Chennai, Bangalore and Darjeeling. She found that almost 75% of signs are same

across different places [1]. Further the research was taken out by Zeshan and Vasishta [1]on advancing ISL showing courses, punctuation, instructor preparing program that was authorized by the Rehabilitation Council of India in 2002 []. In India there are numerous ISL cells working for use and consciousness of ISL furthermore showing courses of ISL. Ali Yavar Jung National Institute for Hearing disabled, Mumbai discharged "Essential course in INDIAN SIGN LANGUAGE" [1]. It was found that there are 405 idiotic and hard of hearing schools in India after a study was made. All of the schools utilize their own particular local gesture based communication as instructing and learning help, in this manner, diverse ISL cells and NGO made an attention to utilize standard ISL as instructing help to help Indian hard of hearing and unable to speak group to break the correspondence hole between them.

Here are some wrong convictions about gesture based communication described in ISL writing [1]:

➤ " SL is same everywhere throughout the world"
➤ " SL is just a sort of gesturing, it has no grammar and it is not a complete language"
➤ "It is talked dialect dependant. It is a exhibition of talked dialect of hands"
➤ "It is a dialect of hands as it were"
➤ "SL is invented by other individuals to help deaf and mute "
➤ " Signed Hindi or Signed English is superior then ISL"

To beat these wrong convictions, there is a need to create ISL translation framework to help Indian tragically challenged with the assistance of HCI and to make them proficient and self-subordinate.

Here are the significant focal points of ISL interpretation:

➤ Use and consciousness of PC interface through ISL interpretation.
➤ ISL interpretation ease the education and training for deaf and dumb people.
➤ Using technology for serving mankind.
➤ By including physically impeded individuals in our day by day life, social aspects like humanity can increase in individual mind.
➤ The same system can be used by blind people by amplifying it for voice interface.

GESTURE BASED COMMUNICATION INTERPRETATION SYSTEM

Gesture based communication is not an all inclusive dialect. SL acknowledgment is a multidisciplinary research range that incorporates design acknowledgment, PC vision, characteristic dialect handling and brain science. The run of the mill engineering for gesture based communication understanding framework is appeared in the figure beneath. This model is for changing over signal into English letter for ISL (to be comprehended by typical individuals). This is helpful for educated listening to weakened individuals. The dialect handling engine is required in this model which depends on specific dialect rules. Transformation of signal to letter includes the zone of PC vision, design acknowledgment, picture handling and dialect preparing with semantic study.
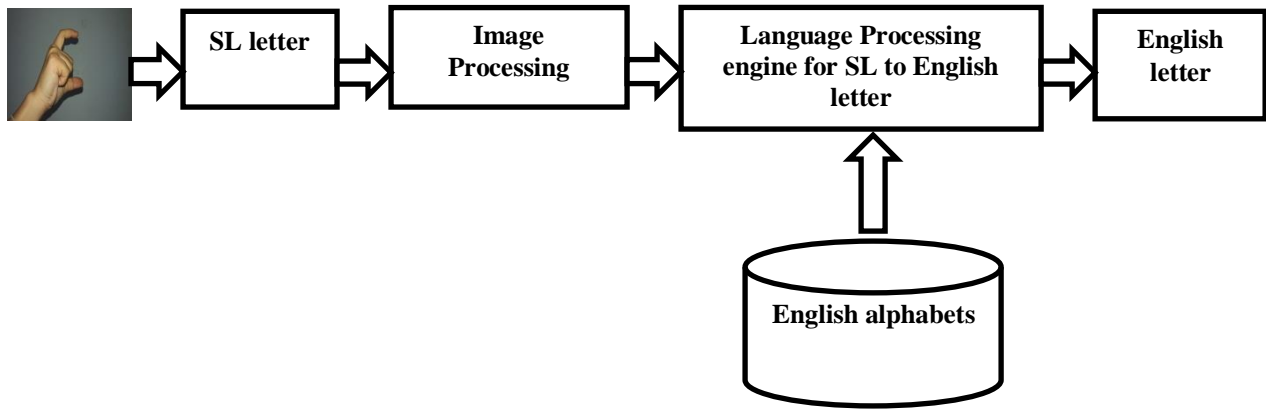
Figure 4.A Sign Language Interpretation System

Table 3. Survey on different sign language system

Sign Language	Modality	Subset of sign language considered	Reference
Indian Sign Language(south Indian sign language)	Hand	Tamil letters (12 vowels and 18 consonants)	[5]
Arabic SL	Hand	23 Arabic words	[9]
American SL	Hand	A-Z alphabets	[11]
American SL	Hand	26 manual alphabets	[14]
Indian Sign Language	Hand	ISL alphabets and numbers	[12]
American SL	Hand & Face	22 sign vocabulary	[15]
Brazilian SL	Hand	Latin letters	[13]

By the review, it was found that there is a connection amongst signal and discourse. Signs supplant discourse expression going from gesture to communication via gestures. Indian Sign Language is a visual-spatial dialect. It contain semantic data as hands, arms, head/body, face developments and stances. Like discourse direct is dynamic in talked dialect, visual divert is dynamic in communication via gestures. Figure.5, demonstrates the ISL progressive system. It is sorted into 1) Manual (hand shape, hand area, introduction and developments) 2) Non-manual (outward appearance, eye stare and head/body stance). In ISL, there are both one gave and two gave signs which might be static and element. Some sign contain both hands dynamic in two gave sign (sort 0) and some sign may contain predominant hand more dynamic than non-overwhelming hand (sort 1).It advisable to go through respective SL hierarchy before begin to design any sign language. Figure.6, describes Indian Sign Language manual alphabet set.
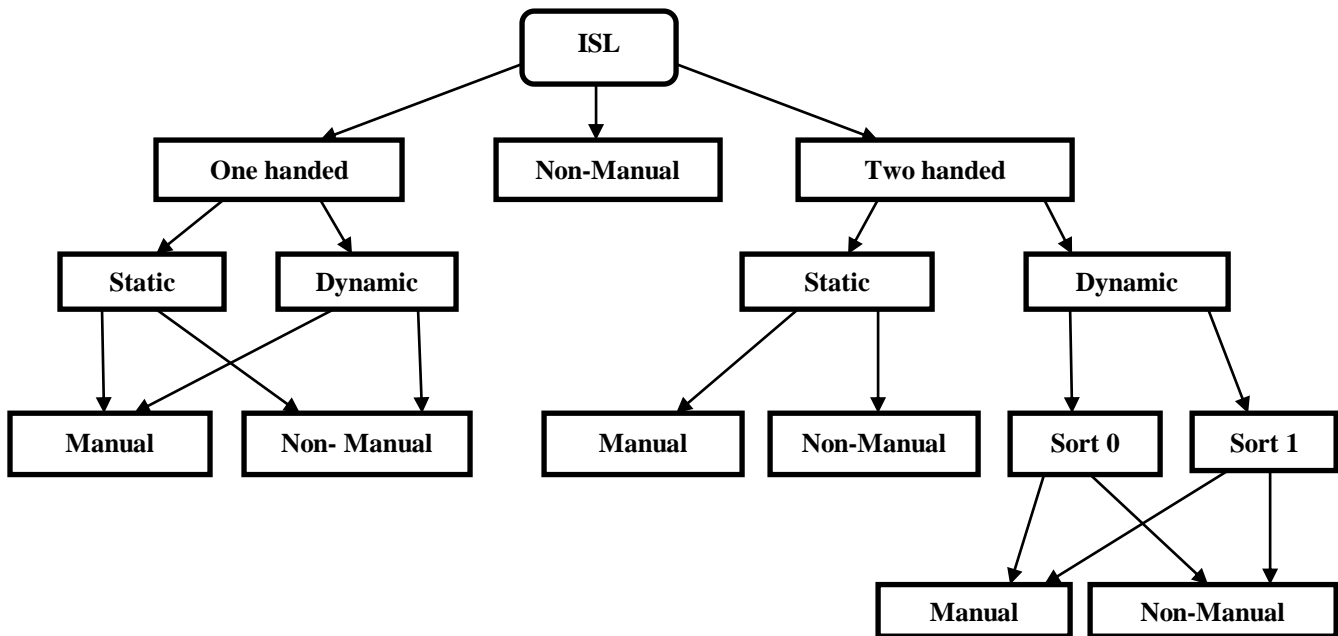
136

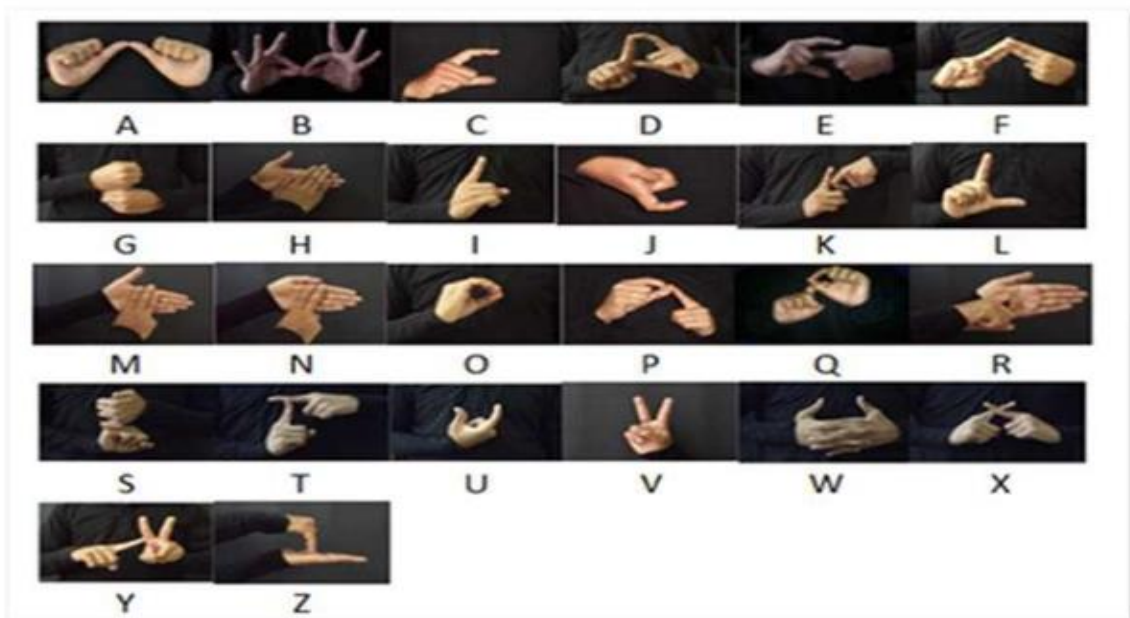**Figure 5. A ISL type hierarchical classification.**

Figure 6. The ISL Manual Alphabets

II.   LITERATURE SURVEY

Sufficient amount of research work has been done in order to determine techniques, advantages, disadvantages and application areas and issues with respect hand gesture recognition. During survey we came across following:

- Significance of ISL as an interpretation language: The different strategies, methods accessible for vision based hand signal acknowledgment. The author has written that the way to bridge the gap between the communication of hearing impaired and normal people is to use deaf assistive system.
- Various methods are discussed including Neural Network, HMM, fuzzy c for gesture recognition and orientation histogram for feature representation. The author says for element signals HMM instruments are reasonable and they have demonstrated its effectiveness for robot control, NN are used as classifiers, they have presented the application areas and issues of gesture recognition and the discussion of recent recognition system and they have given the summary of some selected systems.
- This paper portrays the brief examination of foundations, division strategies, highlights utilized and acknowledgment techniques and the downsides and necessity for immaculate hand acknowledgment framework.
- The author explains the tools for category technique consists of FSM, PCA, HMMs and ANNs. He offers the outline of reputation machine framework with the demonstration of foremost three levels of popularity gadget by using detection of hand, extraction of required capabilities from hand photograph and popularity of the gesture made by way of a user.
- The various techniques and technology aspects inherent to posture and gesture-based recognition and for performing accurate recognition. The pros and cons of both the methods are discussed as well. The various types of methods that are used for hand sign and posture recognition are compared. It has examined the applications that have used hand gesture and posture interface.
- The system intended for children education for recognizing basic shapes based on chain code. Chain code is suitable for simple shapes composed of straight line segments in specified direction. As the proposed algorithm counts corners and checks angels, the rotation and scaling are not an issue. The algorithm and its implementation describes merits of recognition of large number of shapes.

III. PROBLEM DEFENITION AND PROPOSED METHODOLOGY

The main objective is to design method to recognize and match the hand gestures which are stored in the database, the input is given using bare hands and are loaded from the database, process it to a better shape matching with Indian Sign Language (ISL). Later this recognized gesture is converted to letter making it easy for the people to understand the gesture, made by the person unable to speak and hear. The basic concept involves the use of chain code algorithm that represents the outline of an object composed of pixels. The computer analyse the gesture by taking it from the database and synthesizes the text for the corresponding letter, for normal people to understand

After literature survey the problem definition is concluded as **"Gesture to English Letter Conversion for Sign Language".** The main aim of this project is to help people who are unable to speak, hear and express themselves to others. This software recognizes the hand gestures used in standard sign language and converts it to the English letter, so that easily they can interact with the people..

3.1 PROPOSED METHOD

Architecture of the proposed model

The architectural design shows the conceptual model of application. We initially load the image from the database. The loaded image is than compared with the image that is stored in the database. Once the image is accurately or approximately matched with stored database image, its corresponding letter is obtained.
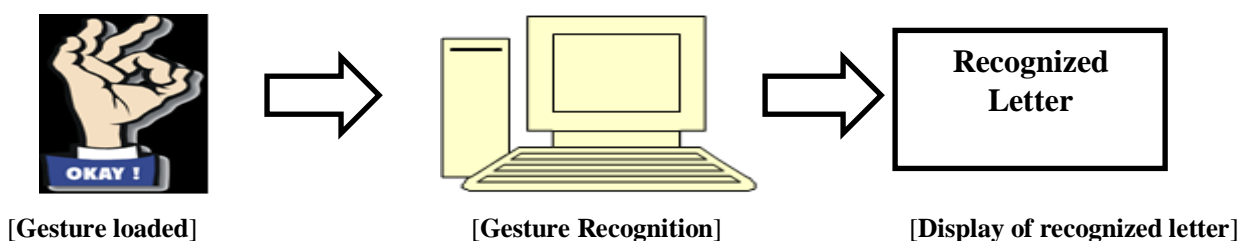

[**Gesture loaded**]   [**Gesture Recognition**]   [**Display of recognized letter**]

Figure 7. Architectural design of Hand gesture recognition system

Proposed Model:

Load Image

Getting the input image from the database

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Segmentation

Extracting only hand position

↓

Feature Extraction

Extracting the contour of the image

↓

Pattern Matching

Matching captured and stored images

↓

Gesture Recognition

Recognizing the gesture

↓

Text Conversion

Getting the text of gesture
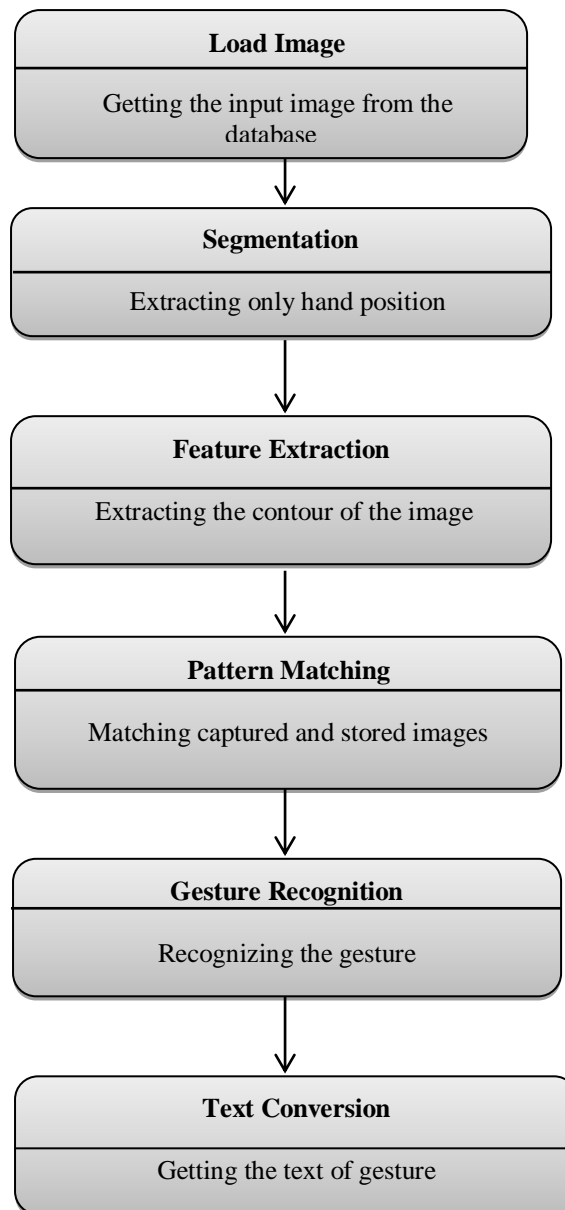
Figure 8. Proposed model

The proposed method of our project is explained above. The three main processes that take place during implementation are: Hand segmentation, Feature extraction and Classification. These three steps are explained in this chapter in detail. This chapter explains the method we have used for segmentation of hand and features we have extracted and the method used for classification.

Load Image: Get the images from the database. The images are collected and stored in the database.

Segmentation: Get the pixels of the image showing the skin colour for image processing and converting RGB image into grey level. Hand segmentation refers to find the hand inside the picture. there are numerous strategies for hand section

and they all classify the photograph in two homogeneous components, foreground containing hand and historical past containing rest. There are two sorts of backgrounds, uniform and cluttered. To discover the hand effectively within cluttered heritage is very crucial. but heritage isn't always critical in records acquisition using devices like facts glove, key board-mouse and many others. For the reason that we're acquiring the photo from the database, we want to have an uniform heritage.

Skin-primarily based Segmentation: the hand pores and skin coloration may be used to split the hand from background using RGB or grey or HSV shade area illustration. it is especially used to split foreground from background with appreciate to predefined variety of the shade. In our challenge, we are converting the RGB hand photo into gray degree photograph.
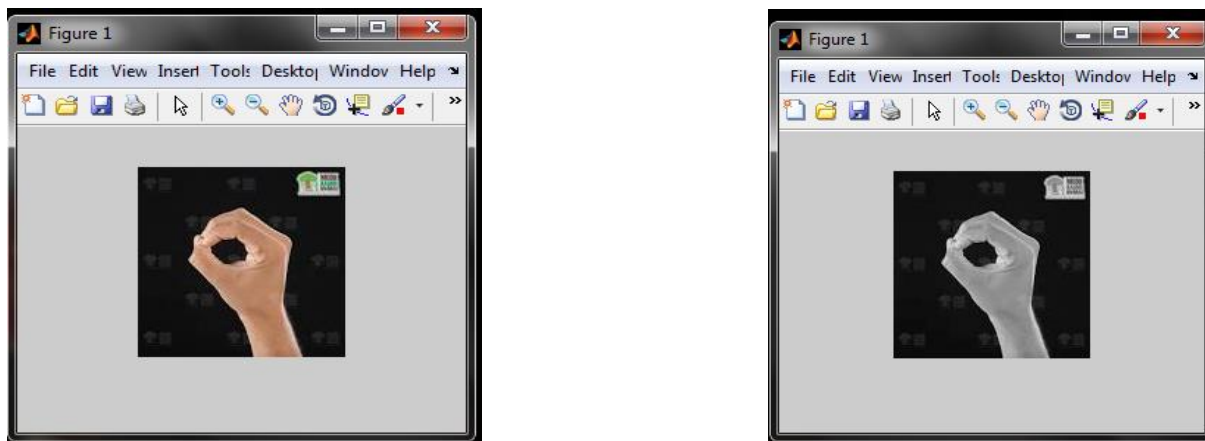

Figure 9. Conversion of RGB image to Grey-level image.

Feature Extraction: The required features are extracted from the hand image**.** In our project we are taking contour of the hand as a feature. The contour of the hand is extracted in this step. Features are critical detail for hand gesture recognition. There can be a huge wide variety of functions like shape, texture, contour, motion, distance, orientation, centre of gravity and many others, that may be used for hand gesture popularity. Gestures may be known the use of geographical capabilities like hand contour, finger suggestions, finger detection. However those are not usually to be had and dependable because of occlusions and illuminations. The non-geometrical capabilities like color, texture also are to be had for popularity however they're not adequate for the motive.

In our project we are using contour of the hand as a feature. The contour of the particular gesture is extracted. We draw a contour plot from grey scale image with the help of commands on MATLAB software
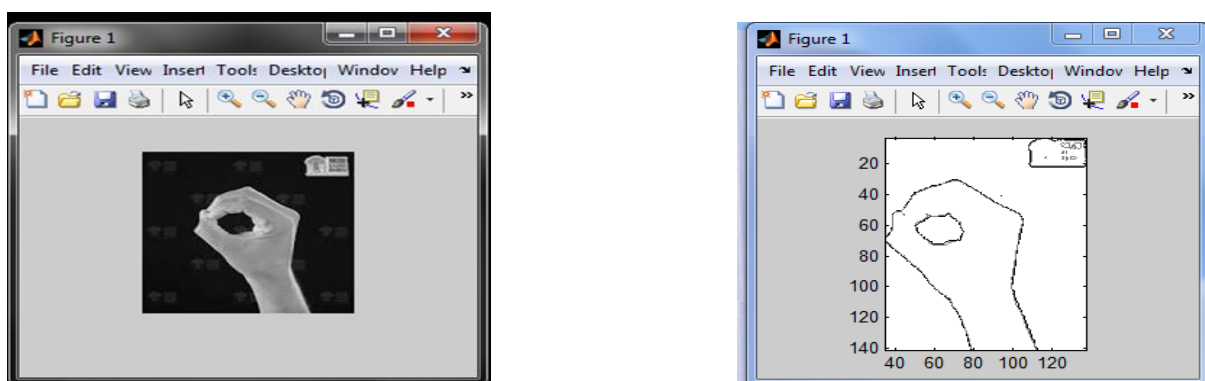

Figure 9. Extraction of contour of hand image from grey scale image.

Pattern Matching: Suit the contour received for the captured gesture with the contour received for the images in the database. whether the matched value is higher than or same as threshold value then we conclude that each the gestures are identical.

Gesture Recognition: The extracted features are sent into NN to recognize a specific gesture and getting the textual representation of matched gesture.

Neural Network Classification: The extracted features are given as inputs to pre-trained neural network for automatic classification of gestures. BPNN, SVM, Radial basis functions, K-nearest neighbours are some well-known neural networks. Neural network is chosen as a classification tool because of its well-known technique as a classifier for several real applications. In our project we are using Artificial Neural Network which is a NN classifier for classification purpose.

Artificial Neural Network: ANN are distinctly natural electronic network of neurons based on neural shape of mind. It system the record one by one and learn by comparing their class of record with the acknowledged real class of record. If the mistake occurs in preliminary classification of first record, it's far fed back into the network.

A neuron in an ANN is:

- A set of inputs (xi) and associated weights (wi).
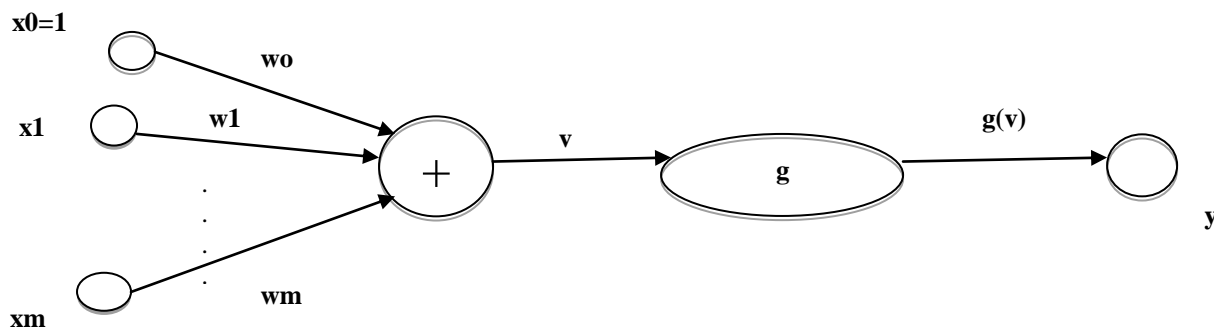- A characteristic (g) that sums the weights and maps the consequences to an output (y).

Figure 10. Structure of NN classifier

Neurons are constituted into layers: input, hidden and output layer. The input layer is made from no longer full of neurons, however rather consist of record's values that are despatched as inputs to the following layer of neurons. the second is hidden layer, there are several hidden layers in a single neural network. The ultimate layer is output layer, which consist of one node for each class. A single sweep forward through the network effects in assigning the value to every output node, and record is assigned to the class node with maximum value.

In this phase, the ideal class for each record is understood (supervised mastering) and output nodes are assigned correct value-1 for the node corresponding to the precise class and zero for others. it is for this reason feasible to examine the network's calculation value for output nodes to those accurate values, and calculate an errors time period for every node. these errors terms are then used to regulate the weights within the hidden layers in order that, hopefully, at some point of the following iteration the output values could be in the direction of the correct values.
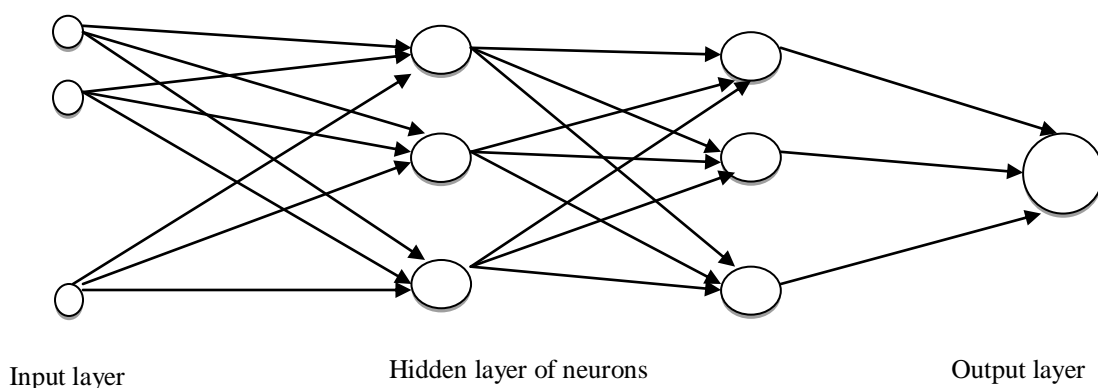
Figure 11. NN with one input layer, one output layer and two hidden layers.

Iterative learning process: It is a key feature of NN where in statistics are offered to the network one by one, and weights associated with the input value re adjusted every time. After all classes are offered, the process is repeated. At some stage in this segment, the network trains by using adjusting the weights to predict accurate class label of input samples. Benefit of NN is their high tolerance to noisy information, and capability to classify sample on which they have no longer been trained. Back propagation set of rules is a most famous NN algorithm proposed in 1980s. As soon as a network has been designed for particular utility, that network is prepared to get trained. To start this procedure, initial weights are chosen randomly. Then the learning manner starts. The network processes the data in training set one at a time, the usage of weights and functions in hidden layers, and then it compares the resulting outputs against the preferred outputs. Errors are propagated returned via the gadget, making the system to regulate the weights for software to subsequent record. This process takes place time and again as weights are tweaked. For the duration of this phase, the identical set of data, is processed oftentimes as the relationship weights are constantly refined. There should be sufficient records available to create a validation set.

Text Conversion: Get text of the particular gesture.

EXPERIMENTAL RESULTS

Here the results of the proposed methodology have been discussed in detail considering several examples of the images. The dataset is collected from taking the pictures of different hand gestures using handheld devices. The dataset consists of 260 images of hand gestures resembling Indian Sign Language alphabets. The proposed methodology for gesture recognition system has been evaluated for various samples dealing with various issues for different images. The recognition method accuracy is shown in the confusion matrix below. The system is efficient and insensitive to the variation in size and colour, noise, blur, orientation and other degradation.

The experimental results of testing various hand gestures of Indian Sign Language manual alphabets are given below:
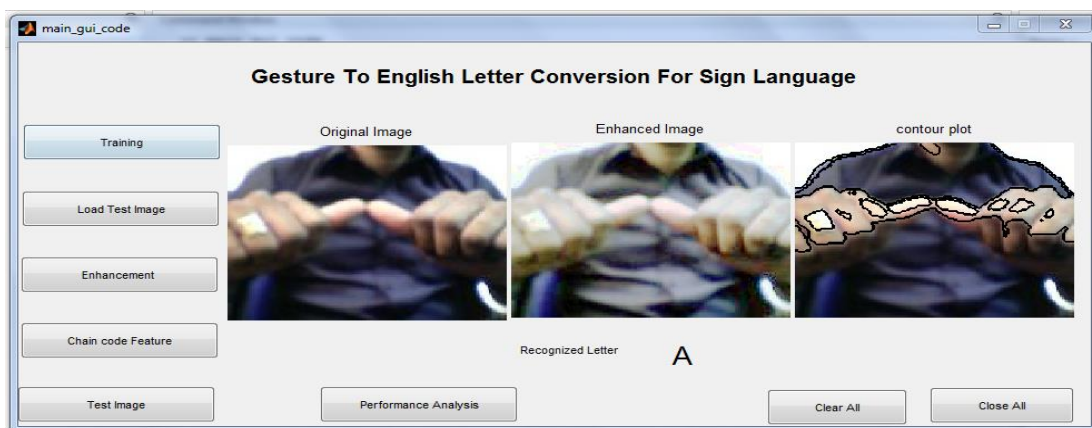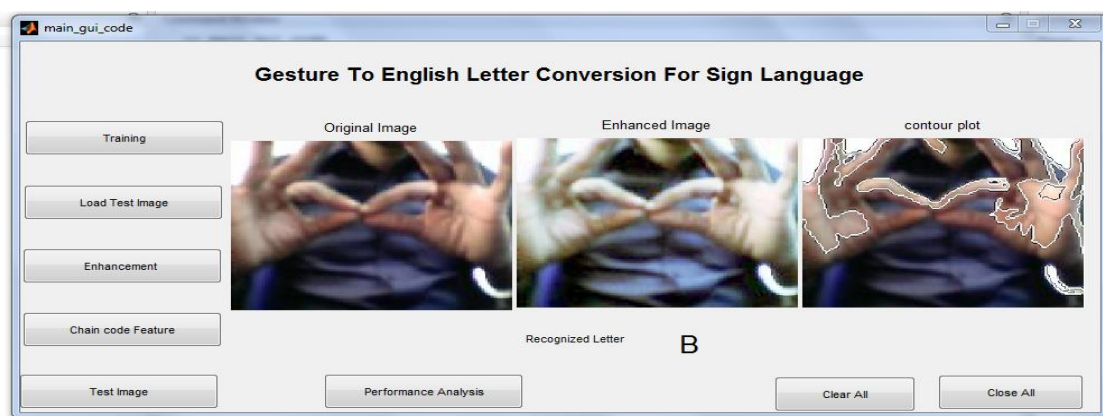
Figure 12 . A hand gesture of a letter 'A'.

Figure 13. A hand gesture of a letter 'B'
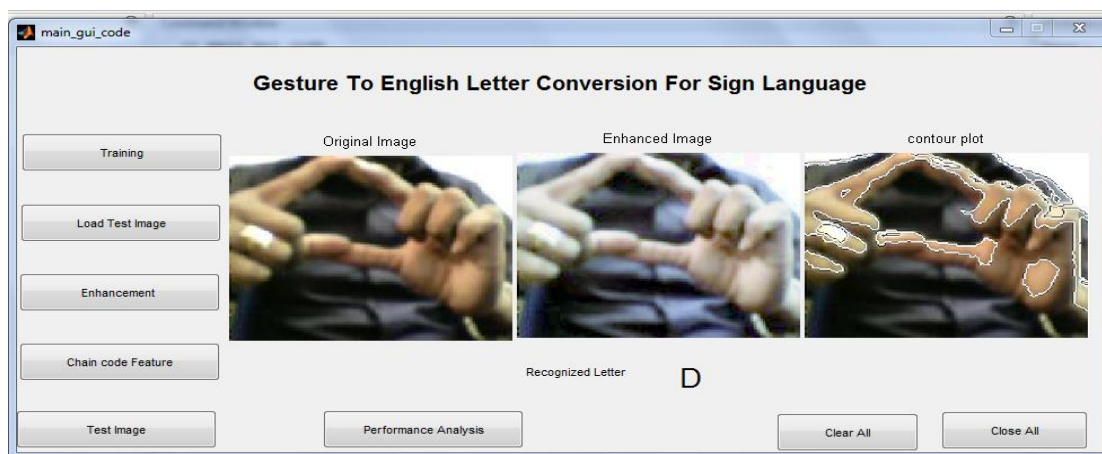

Figure 14. A hand gesture of a letter 'C'

Figure 15. A hand gesture of letter 'D'

Figure 16. A hand image of invalid gesture
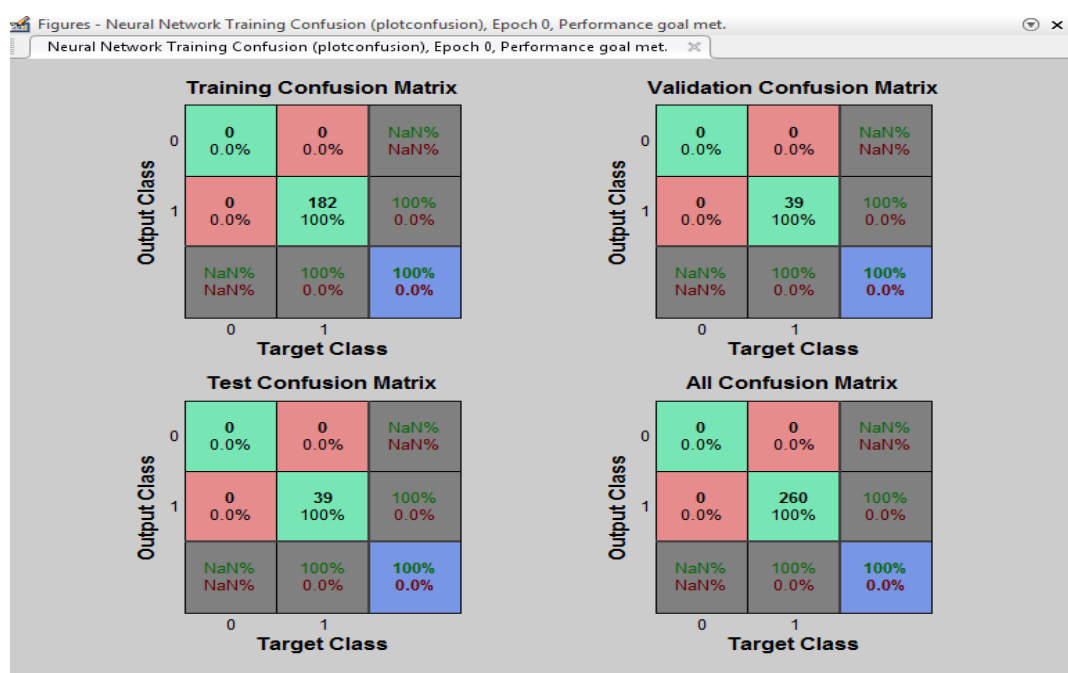
System Performance Analysis

Figure 17. Confusion matrix

The experiment is performed on 260 images (10 images for each class where there are total 10 classes) where in 182 are samples are used for training (7 images per class are trained) and testing is done on 39 (3 images per class are tested) hand samples. The following figure shows Neural Network Training Confusion matrix of overall performance of the system.

CONCLUSION

Hearing impaired people use sign language to communicate with each other. So people who do not understand the sign language will find difficult to converse with them. Usually sign language interpreters bridge this gap and mediate such conversations, but their availability may not be round the clock. Here we are making an attempt to facilitate such conversations without having a dependency on qualified interpreters. In this system, user will select any sign language gesture from database. The system will take these gestures and compare these images with the stored standard gestures in the database. If comparison is successful then corresponding letter will be identified and presented to user. Any gesture can be taken randomly as input, system will still be able to recognize the gesture and present the corresponding letter.

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