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A Vision Based Static Hand Pose, Hand Movement Recognition System For Sign Language Using Eigen Vector Theory In MATLAB

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Abstract. This paper presents a vision based system that provides a feasible solution to Indian Sign Language (ISL) recognition of static gestures of alphabets. It deals with images of bare hands, which allows the user to interact with the system in a natural way. An image is processed and converted to a Eigen vector that will be compared with the Eigen vectors of a training set mean of signs. The most important part of the recognition method is a feature extraction process using Eigen value algorithm in MATLAB coding. An image is processed and converted to a feature vector that will be compared with the feature vectors of a training set mean of signs. The system was implemented and tested using a data set of 650 samples of hand sign images; 25 images for each sign. The system recognizes one handed alphabet signs from Indian sign language (ISL). The proposed system achieved a recognition accuracy of 100 %.

Keywords: Indian Sign Language (ISL) Recognition System, MATLAB LAB, hand gesture recognition, Human Computer Interaction (HCI), feature extraction method. Graphical user interface (GUI).

1 Introduction

Through speech everyone can very convincingly transfer their thoughts and understand each other. It will be injustice if we ignore those who are deprived of this invaluable gift. The only means of communication available to the vocally disabled is the use of Sign Language**"[10].** The deaf and dumb language is a way of communicating with fingers and hands instead of mouth. It is used by people who are unable to speak or hear. The language is of two main kinds One method uses only one hand, while the other uses both hands. In both the methods, different finger positions stand for different letters of the alphabet. Gesture is nothing but a form of communicative conversation which can be used to impart information among people. But to get the meaning of gestures for being used in Human Computer Interaction it's

a big challenge. The aim of sign language recognition is to provide an easy, efficient and accurate mechanism to transform sign language into text or speech[23]. Sign languages are non verbal visual languages, different from spoken languages, but they serve the same function. The system is able to eliminate a major communication gap between the vocally disabled with common community. Although it is argued that a keyboard connected to the speech synthesizer could be used for this purpose, it is not the natural interface for signer and places an intermediary into the dialogue[1]. This paper presents a technique for vision based static hand gesture recognition system in ISL. In this technique, features are extracted from hand gesture images based on skin pixels through image compression using Eigen value to extract the feature value of the image from feature vectors. To make this hand gesture recognition system more user friendly, a GUI model has been designed. In this research work we try to make a system for Indian sign language.

2 Related work

Gestures, especially expressed by hands have become a popular means of human computer interface now days. To describe the shape of the hand, a number of methods for 2D shape representation and recognition have been used. In a hand gesture recognition system, hand detection is used to determine the hand‘s position, scale, and angle. Efficient inference on an ensemble of hidden Markov models can select the most probable sequence of candidate character detections to recognize complete words in ambiguous hand written text, drawing on character *n*-gram and physical separation models (Nicholas R.Howe, Shaolei Feng, R.Manmatha, 2009).

Experiments revealed that our system was able to recognize selected ASL signs with an accuracy of 92.3% (Qutaishat Munib, Moussa Habeeb, Bayan Takruri, Hiba Abed Al-Malik, 2007). Hand gesture recognition research has gained much attention because of its applications for interactive human–machine interface and virtual environments. A fast detection process of hand gesture and an effective feature extraction process using LLE algorithm are presented. Different light conditions and backgrounds (indoor) have been tested in order to evaluate the system‘s performance.

The major drawbacks of such techniques are they are very complex and highly sophisticated for developing an actionable procedure to make the necessary jigs and tools for any typical application scenarios. This problem can be overcome by pattern recognition methods having lower hardware and computational overhead. The system is able to eliminate a major communication gap between the vocally disabled with common community. This gives the limitation of one-way communication between the listeners and vocally disabled. This paper opens the door for research of translating the Hand gesture to Indian Sign Language.

3 System Architecture

Our system is designed to visually recognize all static signs of the Indian Sign Language (ISL), all signs of the A – Z alphabets. In the case of HCI, most interfaces only use one-handed gestures. In, the user executes commands by changing its hand shape to handle a computer generated object in a virtual reality environment . Fig 1 shows the Schematic View of Proposed Hand Gesture Recognition System for ISL.

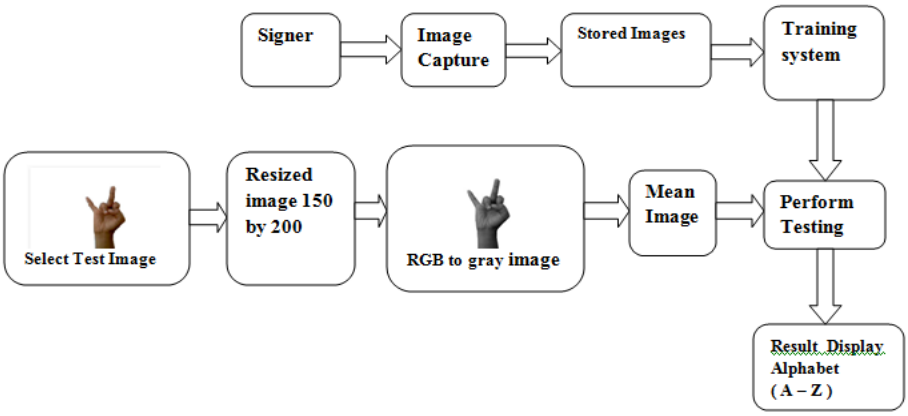

Fig 1:- Schematic View of Proposed Hand Gesture Recognition System for ISL

The hand must be tracked within the work volume to give positioning information to the interface, and gestures must be recognized to present the meaning behind the movements to the interface[2]. The proposed hand gesture recognition algorithm has following steps:-

- Image Capture.
- Stored images i.e ISL dataset.
- Image Preprocessing for Gesture Recognition.
- Feature Extraction of the processed image.
- Classification.

3.1 Images Capture

Our system uses images from a low cost web camera placed in front of the work area, see in fig1. The background is to be arranged in a white colour before taking right hand palm images. Our system does not rely on using any gloves or visual markings to achieve the recognition task. Instead, it deals with images of bare hands, which allows the user to interact with the system in a natural way and the distance between the hand and web camera is to maintained in 1 to 3 feet. All of the gesture/signs are

performed using one hand are shown in fig 2. The fig 2 shows the Equivalent English cue symbols for Database the symbols passed are the equivalent English characters.

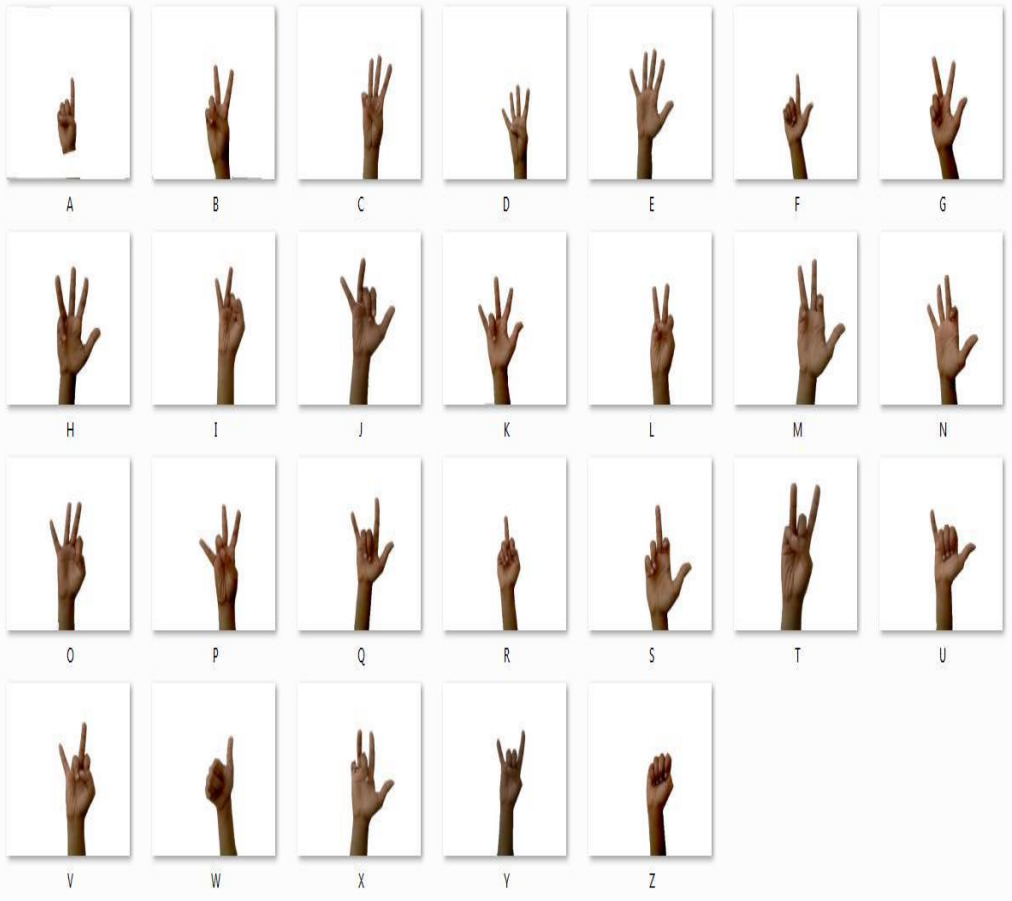

Fig 2:- Equivalent English cue symbols for Database the symbols passed are the equivalent English characters.

In ISL, there are 26 alphabets, Our algorithm focuses only on static signs for the alphabets. Since there are no resources to download ISL alphabet image dataset, so we make our own dataset for ISL recognition because there are no restriction to make a hand gesture recognition for sign language.

3.2 Stored Images (ISL Dataset)

The Indian Sign Language database has been made on our own by capturing images with the help of a digital web camera (Dell INSPIRON 15). Signs of alphabets (A-Z) are shown in fig2. Each image is taken through web camera in different positions for 25 times for each alphabet . Thus we stored 650 images in a separate data set. The

data set used for training and testing the recognition system consists of grayscale images for all the 26 gestures listed in Fig. 1. The samples were taken from camera with various distance and orientations. The obtained data set, thus can demonstrate the capabilities of our feature algorithm.

3.3 Image preprocessing for gesture recognition

Having an underlying system for the hand in a particular pose assist the feature extraction task. Knowledge of the location of features within the previous gestures can be used to define a narrow search window for finding the features in the current gesture. Since images are taken with a web cam, they have different sizes and different resolutions. So in image preprocessing, resized the image and convert RGB to gray scale using MATLAB commands. We convert RGB color images into gray scale images here for ease of segmentation problem.

a) **Resized he image**

Images of signs were resized to 150 by 200 , by default, __imresize‘‘ uses nearest neighbor interpolation to determine the values of pixels in the output image but other interpolation methods can be specified. This procedure reduces the amount of data needed to be processed while keeping the layout the same. Size normalization is applied to the training images in the database as well as implemented in the program to get test samples of varying sizes normalized into the standard output size.

b) **Convert RGB to gray scale**

If the RGB image is 24-bit, each channel has 8 bits, for red, green, and blue—in other words, the image is composed of three images (one for each channel), where each image can store discrete pixels with conventional brightness intensities between 0 and 255. The RGB color space (Red, Green and Blue which considered the primary colors of the visible light spectrum) is converted through gray scale image to a binary image. Many images come in color and certain operations in MATLAB are only defined on grayscale Images. Use the function rgb2gray to covert them to grayscale. You will also have to change the class of the image from uint8 to double in order to perform operations with the data. For example :-

I = imread(' . Any file format name for example JPG, tiff ');
grayImage = rgb2gray (I); imshow(grayImage).

According to above commands , it converts the truecolor image RGB to the grayscale intensity image. rgb2gray converts RGB images to grayscale by eliminating the hue and saturation information while retaining the luminance. The fig3 shows the stored data set are converted into gray images .i.e. black and white images.

Fig 3 :- All 26 RGB to gary scale gesture

3.4 Feature Extraction

Feature extraction is an essential part of pattern recognition system with a direct effect on the result. Feature extraction involves image analysis and preprocessing. Feature extraction involves simplifying the amount of resources required to describe a large set of data accurately. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (e.g. the same measurement in both feet and meters) then the input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input

data in order to perform the desired task using this reduced representation instead of the full size input. Then, the Eigen Value algorithm is apply for each region.

a) Eigenvector theory

The purpose of which is to reduce the size of the images to be recognized from a high to a lower dimension. While lowering the dimensionality in the set, using the eigenvector method also highlights the variance within the set. The simplfied method is to input of MATLAB is given below :-

$$[V, D] = eig(A)$$

Here, D is an NxN matrix with our eigenvalues on its diagonal and V is an NxN matrix with columns that represent eigenvectors.So, their values satisfy the equation:

$$A*V = V*D$$

Or if we want to look at one eigenvalue/eigenvector at a time:

$$A*V(i, :) = D(i, i)*V(i, :)$$

This stands for A times the i-th column of V (an eigenvector) equals the i-th row/i-th column entry of D (which of course falls on the diagonal), time the column of V.

b) Practical implementation

To create a set of Eigen hand gesture, one must :-

1. The pictures constituting the training dataset should have been taken under the different lighting conditions. They must also be all re-sampled to a common pixel resolution ($r \times c$). It is assumed that all images of the training set are stored in a single matrix T, where each column of the matrix is an image.
2. The average hand posture Y has to be calculated and then subtracted from each original hand posture in X.
3. The eigenvectors of this covariance matrix are therefore called eigen hand gesture or eigen hand image. They are the directions in which the images differ from the mean image. Usually this will be a computationally expensive step (if at all possible), but the practical applicability of eigen hand gesture stems from the possibility to compute the eigenvectors of **S** efficiently, without ever computing **S** explicitly, as detailed below.
4. The *D* x *D* covariance matrix will result in *D^2* eigenvectors, each representing a direction in the $r \times c$-dimensional image space. The eigenvectors (eigen hand image or eigen hand gesture) with largest associated eigenvalue are kept.

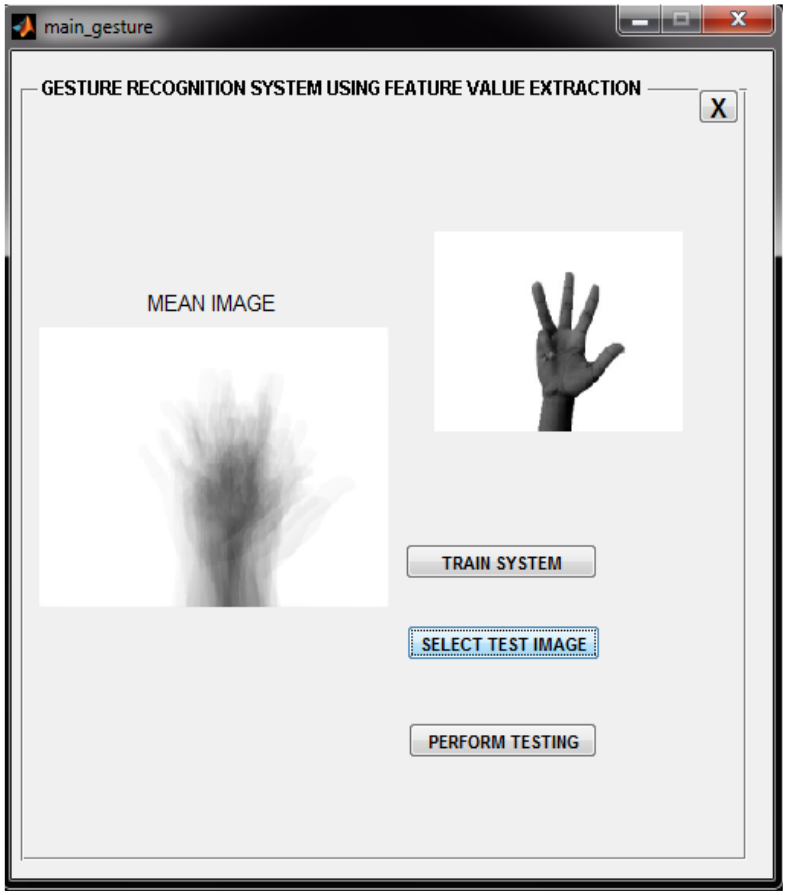

Fig 4 :- New hand gesture subtracted form mean image

These eigen hand gesture can now be used to represent both existing and new hand gesture. We can project a new (mean - subtracted)hand gesture and there by record how that new hand gesture differ from the mean handed gesture shown in fig4. If small, say 100 × 100, grey scale images are used, each image is a point in a 10,000-dimensional space and the covariance matrix S is a matrix of 10,000 × 10,000 = 108 elements. However the rank of the covariance matrix is limited by the number of training examples: if there are N training examples, there will be at most $N - 1$ eigenvectors with non-zero eigen values.

3.5 Classification

Classification it is the last stage in the recognition system. The choice of classification algorithm it is highly depending on the recognition system. There are many classifiers

working for hand gesture classification[22]. A Graphical User Interface (GUI) has been created to automatically train and recognize the gestures as shown in the fig 5 below :-

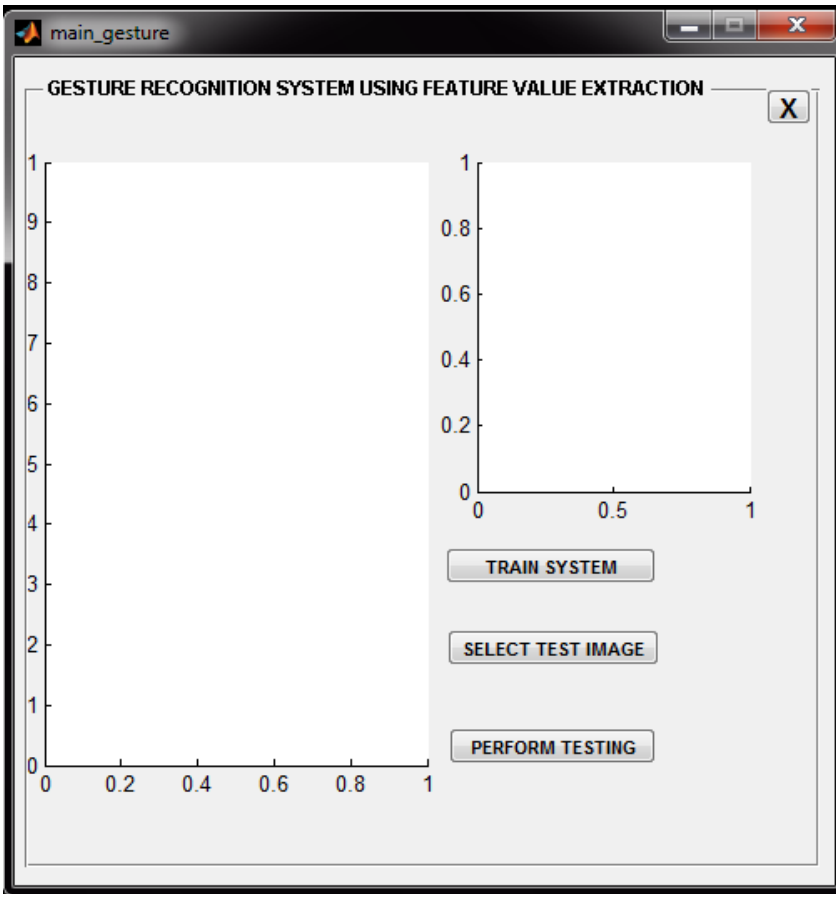

Fig 5:- GUI model of hand gesture system using feature extraction for sign language

The sign language recognition program can be executed by two different ways in the GUI. There are 3-step push button method in the GUI. The first method is through a single – step push button in the panel ―TRAIN SYSTEM‖ and the second step is run by through the second push button in the panel ― SELECT TEST IMAGE‖ and the third step run bye third push button ― PERFORM TESTING‖. There detail functioning are :-

(A) Training A MATLAB based synthesizer

- Obtain, initially set of hand posture images (training dataset).
- Calculate the Eigen hands from the training dataset, keeping only the N Eigen vectors that have a similar to the highest Eigen values.

- Calculate representation of each hand posture image in hand space.

(B) Select Test Image

It is used for executes the test image which we want to test with the help of gesture recognized system (or compare with the mean image).

(C) Perform Testing

- Project input hand posture image.
- Compare the selected test hand posture image with the mean image and give the o/p in equivalent English character or alphabet.

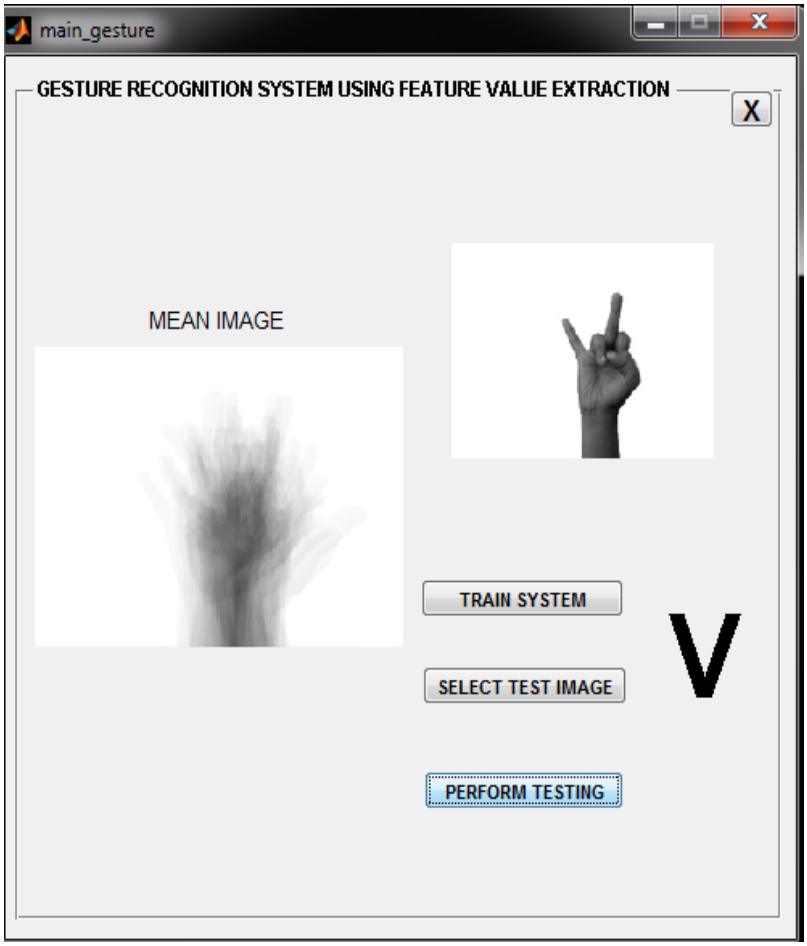

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Fig 6 :- Example on GUI simulating sign 'V'

we have created a GUI that helps in finding out the results. An example is shown in Figs. 6 and 7 respectively

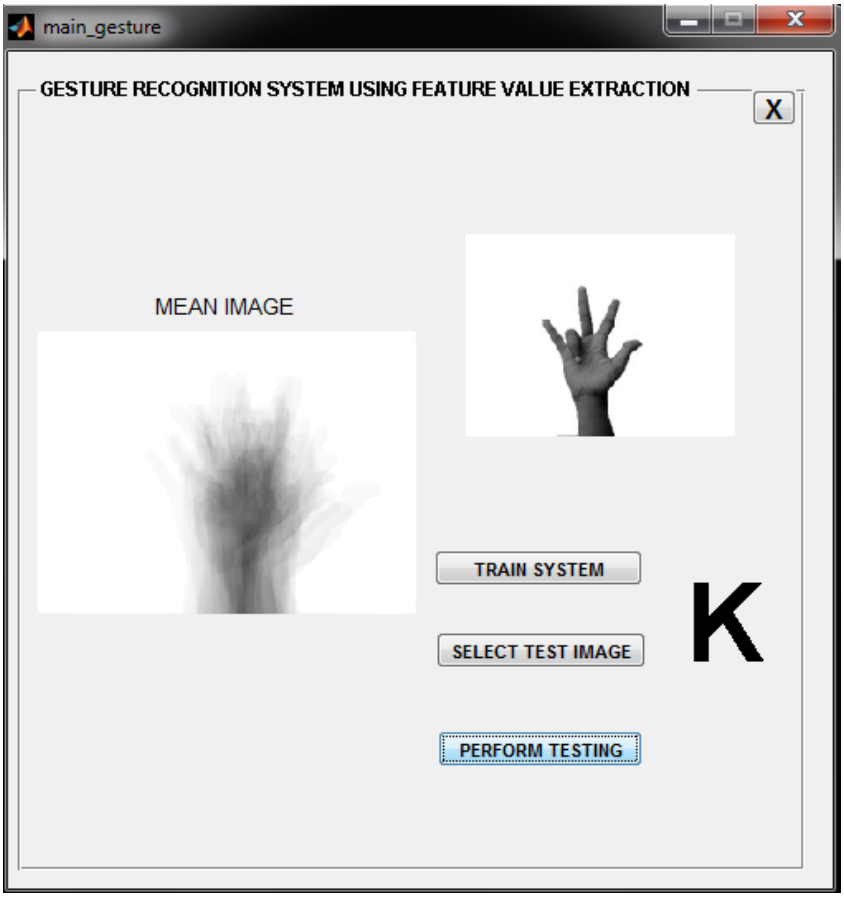

Fig 7 :- Example on GUI simulating sign 'K'

4 Recognition rate

We evaluate the performance of the system based on its ability. The recognition rate is defined as the ratio of the number of correctly find hand posture image to the total number of hand posture image, i.e.

$$\text{Recognition rate} = \frac{\text{Number of correctly find hand posture image}}{\text{Total number of hand posture image}} \times 100\ \%$$

5 Conclusions and future work

In this work, we developed a system for the purpose of the recognition of a subset of the Indian sign language. The Primary focus of this system is to examine image processing as a tool for the conversion of Indian Sign Language (ISL) gesture in to digital text.

The system is suitable for complex ISL static signs. Experimental results of the system showed that the system is capable of recognizing English alphabets effectively with no need for any additional hardware such as gloves or sensors. Feature extracting part depends on Eigen algorithm which is tolerant to gaps in feature boundary descriptions and it is relatively unaffected by image noise. The proposed system was able to reach a recognition rate 100% using MATLAB . In future, there can be many possible improvements that will broaden the scope of this work.

- Extending the system to be able to deal with dynamic signs is an attractive point for future work using only MATLAB coding.
- The system deals with images that have a uniform background.

Looking for possible changes in the environment by designing a new system that works in real-time environment.

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