Approach To The Sign Language Gesture Recognition Using PCA And SVM Classifier

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Abstract- *A hand gesture recognition system is the only way of communicating tool for deaf and dumb people, it provides a natural, innovative and modern way of nonverbal communication. Hand gesture recognition is the hot topic in Human Computer Interaction (HCI). Hand gesture recognition process having eight steps they are image acquisition, skin color based segmentation, removal of background, canny edge detection, and PCA Feature extraction, image classification using support vector machine classifier, training of data and testing of data to evaluate appropriate result. To achieve high accuracy and high performance with less complexity a Principal Component Analysis (PCA) algorithm technique is introduced in the proposed Hand gesture recognition. The application of this complete system is for impaired hearing people who can easily communicate with the world in form of text. In this research work the system is trained and tested with one hand and two hand successfully with detection accuracy more than 96.16%.*

Keywords- feature extraction; hand gesture recognition; skin color based segmentation; canny edge detection; Principal Component Analysis (PCA) algorithm; SVM classifier.

I. INTRODUCTION

There are only about 250 certified sign languages interpreters in India, translating for a deaf population of between 1.8 million and 7 million.(the wide range in population estimates exist because the Indian in 2017 census does not track the member of deaf people instead, it documents an aggregate member of people in disabilities)[10].There are about 70million deaf people who use sign languages as the first language and mother tongue to many hearing people and some deaf blind people (tactile sign language).Each country has one or sometimes two or more sign language, although different sign language can share the same linguistic root in the same way as the spoken languages do[9]. sign language has a great history and today in robotics field, this sign language is used. In order to interact with robots and also for sign language we use hand [1] [2] [3]. Gesture recognition is a hot topic today and it is also using IMU sensors [4]. Here we use Image processing which has wide field and in these days, it is trying to give solutions of maximum problems. Watermarking [5] [6] for security and discrete wavelet transform is one of the example of image processing.in this research paper, the hand gesture process is crossing eight steps and then we are able to find proper messages using hand gesture, these steps are as follows: image acquisition, skin color segmentation, training and testing of the image. Background subtractions, canny edge detection, PCA feature extraction and classification, support vector machine classifier. As we know that the way of living for the normal person and physically challenged person has become arduous and the only reason for this is the language understanding between two person. This physically challenged people's one of the most difficult way for surviving is that they cannot work with the normal society people because the proper communication between them is strenuous. These inability people are not able to do their basic schooling properly along with the normal people. Thus this becomes the main reason to have a different world for them and they are not able to mingle with the normal society people so can happily promise them an independent and happy life without the help of human translator to translate between the normal and physically challenged person.

Each hand gesture is defining a message in form of text. These messages are set according to the gesture. With a simple training anyone can remember the gesture. Basically it is good for impaired hearing people who cannot express their feeling to other. This system is able to recognize the gesture with efficiency of 96.16%. The eight steps of process which is used to identify the gesture is helping the system to give efficient results. The percentage of efficiency of identifying the gesture is better than the existing results from [1].

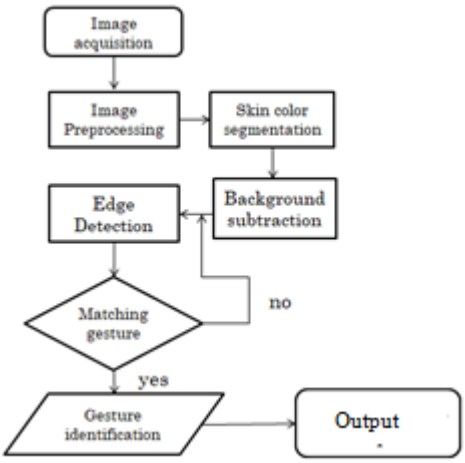


Fig 1 Flowchart of sign language recognition

The flowchart in the fig.1 is explaining the complete system in which all the necessary steps are consider. The flow chart has the following steps: image acquiring and preprocessing, skin color detection, background removal and then edge detection and extracting a meaningful gesture and after recognizing and extracting exact gesture, it converted into sign of that particular gesture has been successfully recognized.

BLOCK DIAGRAM

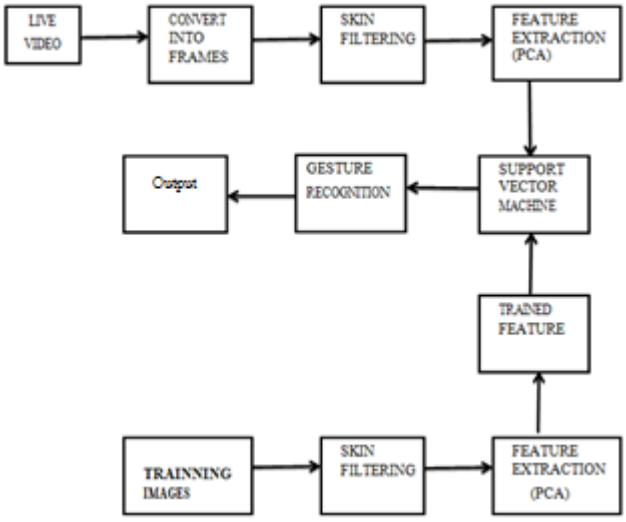


Fig 2 Block Diagram of Sign Language Recognition System

Fig 2 represents the complete block diagram of this system to understand clearly. The important point of this research paper is to filter-out skin color and to recognize skin color from the RGB image. RGB color image converted into gray scale image and then it again converted into binary image. Then using skin color based segmentation, it filters out the skin color from the image and then it extracts the region of interest from the image. After extracting ROI (Region of Interest), the background of the image subtracted from the image by the background subtraction method. Hand gestures from the binary image extracted by canny edge detector, Principal Component Analysis features of hand gestures with samples are extracted

STEPS TO RECOGNIZE SIGN LANGUAGE

A. Image Acquisition

The first step of this system is image acquisition. The image acquisition tool is the webcam of laptop. The acquired image size is set on 640x480. A complete set of images is taken from the web camera of the laptop. The entire images are taken with different light conditions to keep the system efficient. In this paper, the hand gesture that has to be recognizing by the system is used as the special hand gesture. So the dataset prepared by the images taken from the web camera is classified into two categories such as Category A and Category B.A set of 20 to 30 images are taken into account with different lighting conditions, different orientation are consider in Category A. A set of 20 to 30 images with different hand gestures like thumbs up and thumbs down has been taken in category B. Similarly the process is repeated with different gestures.

B. Skin Color Segmentation

After the collection of images from the web camera, the skin color based segmentation is done. All the RGB values containing three color matrices and each color holds three value of RGB value respectively. For the image color analysis, we are using tool of Python 3.6 version. First step of this category is to read the image in the python 3.6. Then observe three values of skin color in the RGB values. The skin color value in the data set has upper range of values and lower range of values. The upper range of values of RGB in the image with respect to skin color is [240 230 220] and lower RGB values in the skin color is [120 110 105]. We can easily recognize the skin colors in the image using the RGB values .Using the skin color values of RGB the color image is converted into binary image. The values which are greater than the RGB value consider as 1 and remaining considered as 0 in the image. Using this we consider all the pixels of the image converted into 0 and 1. The skin color automatically filtered out from the RGB image. The skin color above the limit value is converted into white pixels and all the values below the limit is converted into black pixels. The arm region is the area of interest for the binary image. So the unwanted objects except the area of hand region are eliminated from the binary. The skin color is segmented . Few of the examples are shown in fig. 3.

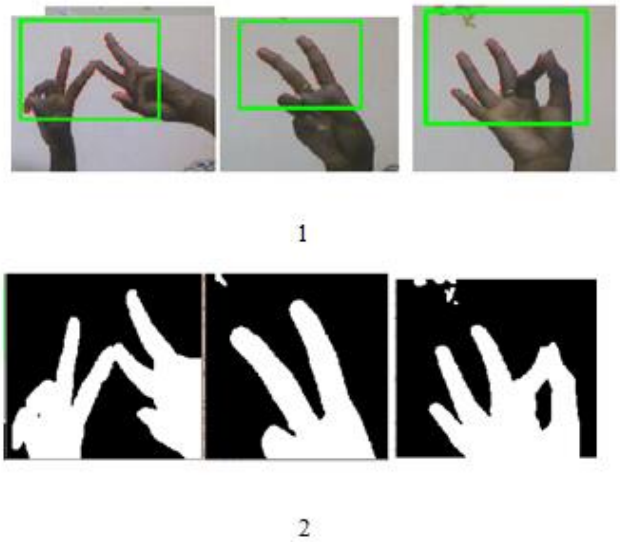


Fig. 3 Sample 1: (1) Input Acquisition (2) Skin color segmentation of Image

Fig.1 shows the complete flow of this system which is done in this research paper and Fig 3 shows the images captured and segmented. After capturing the input image which is said to be an image acquisition pre-processing is done and then it converts the image into a gray scale image. On the gray scale image, edge detection is done. For example in order to detect Tumor which is in circular shape so on circular edge detection to find specified size Tumor, after detecting circular we get are final output image with Tumor, the segmentation process will take place and then it will identify the region of interest in converted gray scale image. Normally segmentation has very large category and threshold segmentation [7] is one of them. The segmented MRI image of brain can also be used to identify the information about the tumor and tumor can be easily identified through it.

C. Recognition of Hand Gesture

Canny edge detection is used here after the extraction of the skin color in the data set. The hand gestures are divided into two different categories .The canny edge detection is used for classification, testing and training purposes. The existing method which is defined in [2] is as much complex but this method is simpler for the recognition method of gesture. This method is using Python 3.6 tool only and the user doesn't need to wear any gloves or doesn't need to carry any type of sensors

D. Feature Extraction

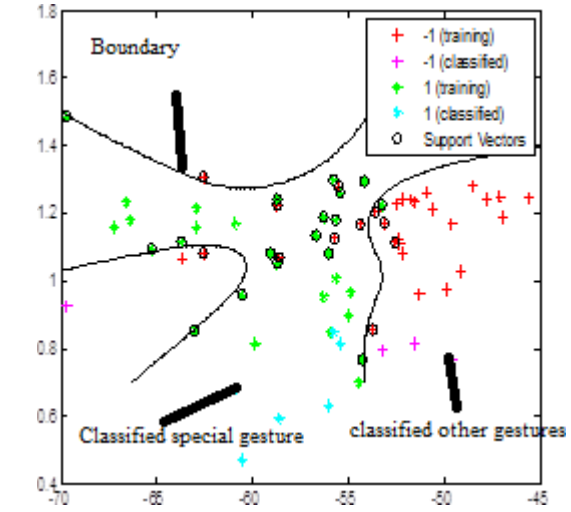
In this research paper feature extraction is done by using Principal Component Analysis (PCA) algorithm [8] which is the best algorithm to extract the entire required feature from the images of dataset dimensionality.

This method reduces data dimensionality by performing a covariance analysis between factors. As such, it is suitable for data sets in multiple dimensions, such as a large experiment in gene expression and image processing. Covariance is always measured between two factors. So with three factors, covariance is measured between factor *x* and *y*; *y* and *z*, and *x* and *z*. When more than 2 factors are involved, covariance values can be placed into a matrix. This is where PCA becomes useful.

PCA generally work to use orthogonal transform for converting the set of values or data with possible correlation into uncorrelated values and it is called principal component. Seven features require for the better results which extracted for the 100 images in the data set by the help of Principal Component Analysis. But only sixty images in the dataset for which skin color based segmentation apply so after apply PCA on the 60 images, it gives 60x7 matrixes. The seven PCA features are as follow: Mean; Entropy; Energy; Homogeneity; Correlation; Contrast; and standard deviation. In these PCA features, only best two features are selected for the training and testing purpose. Due to consideration of only two features, the matrix resolve in 100x2 matrix and this matrix will be used for the training and testing of next step.

E. Classification

Training of images for this system is very important because only due to training, this system will be able to identify the correct gesture and then it will recognize the correct message of the gesture. Support vector machine classifier has kernel function which is used for training of different gesture images. Support vector machine also support non-data also. As discuss above, the dataset is classify into two category such that category A and category B. Category A dataset images are those type of images which have a gesture to use in Banking security and The category B images related to all the other hand gesture. Support vector machine classifier will train the dataset according to the category. Using SVM all the different gestures is recognized. This method separated the two categories with boundary. Support Vector machine identify the categories of the image and map according to it. In fig. 4, it is clear that the red dots and green dots are separated with a boundary.



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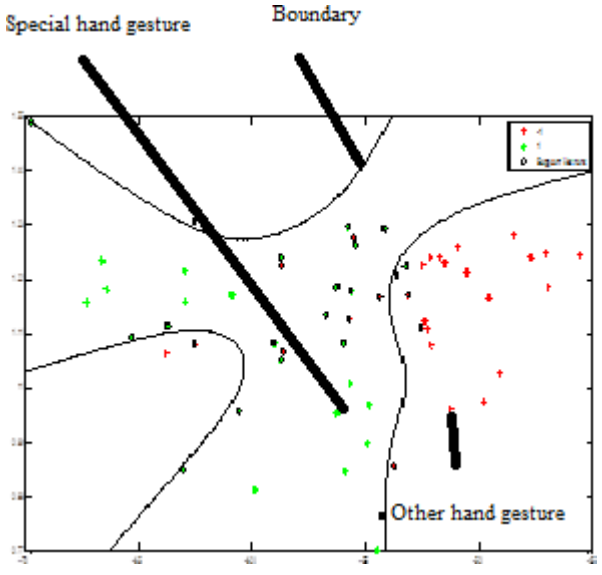

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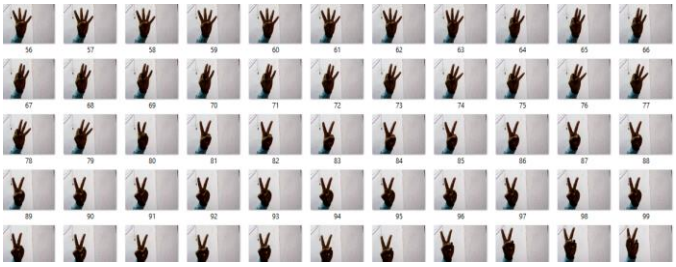
Fig. 4. (1) Dataset training for Sign Language recognition (2) Dataset testing for Sign Language



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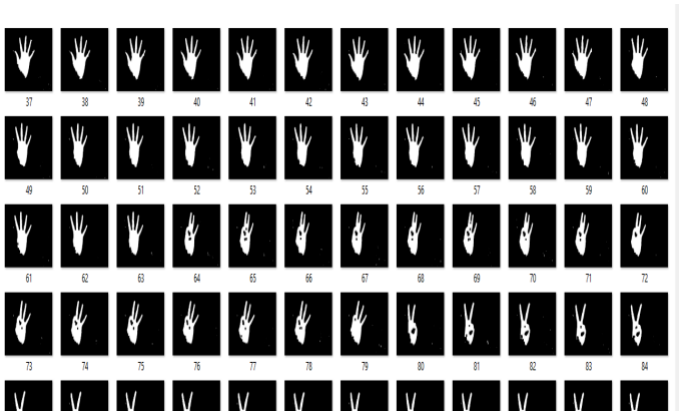

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Fig. 5.1,2 Different gesture for sign language in frames

The system is trained for hand gestures it is recognizing the hand gesture with accuracy rate of 96.16 %. All the hand gesture is identified or recognize by SVM classifier. The gesture which has been recognized for security purpose is keeping in Category A and all other hand gesture is keeping in category B. The category B hand gesture further trained and tested by the SVM classifier. The system is designed for more than one gesture system. Anyone can set more than one gesture for security reasons and this system will support it. This message of hand gesture can be decode in the form of text . The particular message can be embedded in the system for particular gesture.

F. Support Vector Machine

Support Vector Machines (SVM) is based on the abstraction of decision planes those interpret decision boundaries. The resolution plane is one that separates the set of objects which have non identical class memberships. A formulaic example is shown in the illustration below.

This example, describes the objects belonging either to category RED or GREEN. The Partition line defines the frontier on the right part of which all gadgets are GREEN and to the left part where all the objects are RED. Any new object like the white circle which falls to the right side which is labeled as GREEN (or classified as RED should it fall to the left of the separating line) .

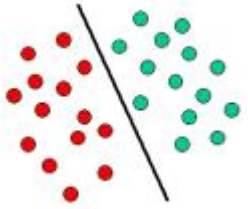

Fig: 6 Basic SVM classifier

The below is a classic example of a linear classifier, i.e., a classifier that separates a set of objects into their respective groups (GREEN and RED in this case) with a line. Most classification tasks, however, are not that simple, and often more complex structures are needed in order to make an optimal separation, i.e., correctly classify new objects (test cases) on the basis of the examples that are available (train cases). This situation is depicted in the illustration below. Compared to the previous schematic, it is clear that a full separation of the GREEN and RED objects would require a curve (which is more complex than a line). Classification tasks based on drawing separating lines to distinguish between objects of different class memberships are known as hyper plane classifiers. Support Vector Machines are particularly suited to handle such tasks.

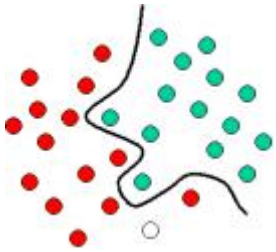

Fig 7 linear classifier

SVMs can be used to solve various real world problems:

- SVMs are beneficial in context and computing classified as their practices considerably debase the demand for labeled training instances in both the standard inductive and transductive settings.
- Categorization of images can also be accomplished using SVMs. Exploratory effects reveals that SVMs acquires considerably larger search accuracy than traditional interrogatory cleaning schemes after just three to four rounds of relevance feedback.
- This is also true of image segmentation systems, including those using a modified version SVM that uses the favored access of as conjectured by Vapnik Hand-written appearances can be identified using SVM.
- The SVM algorithm has been broadly used in the biological and other sciences. They have been employed to categorize proteins with up to 90% of the compounds classified correctly.
- Permutation tests based on SVM mass have been conjectured as a working for assimilation of SVM imitations. Support vector machine mass have also been used to annotate. SVM models in the past. Posthoc interpretation of support vector machine models in order to identify features used by the model to make predictions is a relatively new area research with special significance in the biological sciences.

G. Digital Image Processing

Image processing is the assay and manipulation of a digitized image, especially in order to improve its quality. To perform image processing on digital images, digital image processing is used as the computer algorithms. Digital image processing is modeled in the form of multidimensional systems. It acquiesce much more variegated algorithms which is to be applied to the input and avert from the difficulty and hence, can Offer both more disenchanted performance at simple tasks, and it also includes implementation of methods. So the Digital image processing is more advantageous than analog image processing.

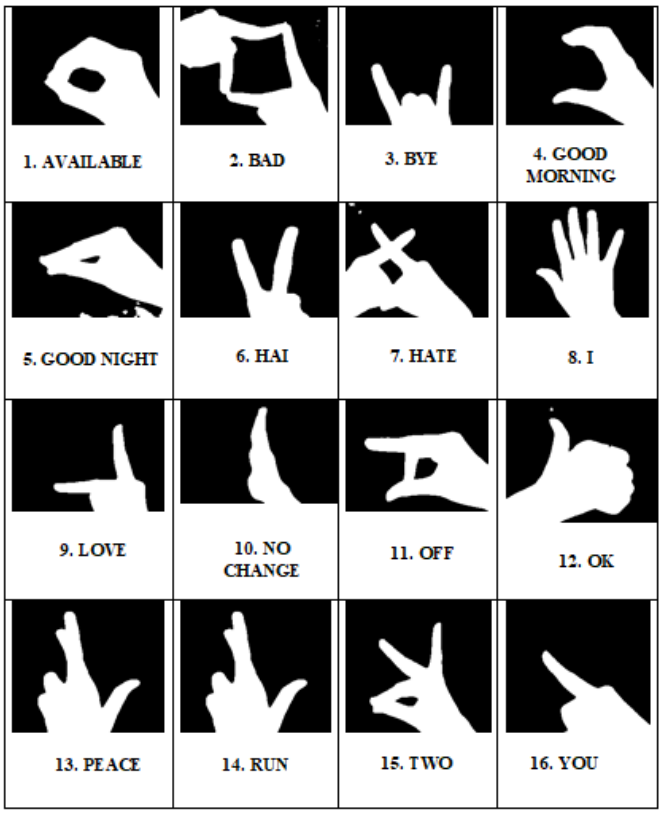

Fig 8 Different hand gesture for sign language recognition

Fig 8 shows the stored database for 16 gestures .All the 16 gesture is identified by SVM classifier .Totally 1616 image in training phase and 3216 images in testing phase this above graph gives the performance evaluation of all the gestures which shows the good level of average 96%.

Digital image processing uses some techniques Includes:

- Hidden Markov models
- Image restoration

- Linear filtering
- Neural networks
- Anisotropic diffusion
- Partial differential equations
- Pixilation
- Independent component analysis
- Principal components analysis
- Self-organizing maps
- Wavelets

II. RESULTS

This research paper is basically beneficial for the deaf people. We have proposed a live video which is given as input for both training and testing phases. After that this video is converted into frames and the frame is resized individually. After that the skin is filtered by using gray illumination algorithm. Then Morphological feature extraction is performed for both train and test frames. The matching between train and test features are find to recognize the gesture. Support vector machine is used for gesture recognition. Finally, the character text (gesture recognition output) is given as output.

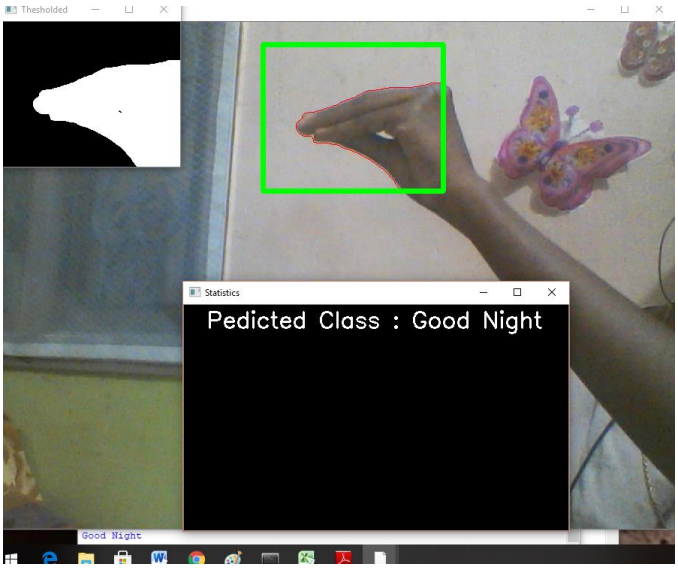

Fig: 9 Recognition of hand gesture

If we set a particular message in terms of v text on the particular gesture then it should be easy to memories for the deaf people and they will easily communicate with our environment.

In future, the system can be extended by adding more number of words and sentences of different languages of sign language which is more useful for communication between deaf and mute people and normal people.

In this research article, different hand gesture position is recognized and each hand gesture recognized after training and testing of the system with average accuracy of 96.16.5 %. This much of percentage came after testing it on SVM. The accuracy of this system is compared with Yang Quan [1] and obtains a better result than [2].

III. CONCLUSION

We have proposed an efficient system of sign language recognition from hand gesture with eight simple steps such as image acquisition, skin color based segmentation, background subtraction, canny edge detection, PCA features extraction, classification images using support vector machine classifier, training and testing of samples in which different hand gestures is taken into account. The hand gesture has been successfully recognized with an accuracy of 96.16 %. This designed system can be used for security purpose and also for deaf peoples for sign language. This system is successfully implemented and the prototype is in developing mode.

In future, the system can be extended by adding more number of words and sentences of different languages of sign language which is more useful for communication between deaf and mute people and normal people. Next generation gesture interface will be designed to interact with mobile phones and other smart devices using gestures with our hands and fingers in three dimensions.

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