Survey on Real Time Sign Language Recognition System: An LDA Approach

Suriya M[1], Sathyapriya N[2], Srinithi M[3], Yesodha V[4]
[1] Assistant Professor, Department of Information Technology, SNS College of Engineering, Coimbatore, India
[2,3,4] B.Tech(Information Technology), SNS College of Engineering, Coimbatore, India

Abstract

Sign Language Recognition is one of the most growing fields of research area. Many new techniques have been developed recently in these area. The Sign Language is mainly used for communication of deaf-dumb people. This paper shows the sign language recognizing of 26 hand gestures in Indian sign language using MAT LAB. The proposed system contains four modules such as: pre-processing and hand segmentation, feature extraction, sign recognition and sign to text and voice conversion. By using image processing the segmentation can be done. Some of the features are extracted such as Eigen values and Eigen vectors which are used in recognition. The Linear Discriminant Analysis (LDA) algorithm was used for gesture recognition and recognized gesture is converted into text and voice format. The proposed system helps to dimensionality reduction.

Keywords - *Hand Gesture Recognition; Human Computer Interaction; Euclidean Distance (E.D); Eigen Values; Eigen Vectors.*

I. INTRODUCTION

Sign Language is the most natural and expressive way for the hearing impaired people. People who are not deaf, never try to learn the sign language for interacting with the deaf people[1].This leads to isolation of the deaf people. But if the computer can be programmed in such a way that it can translate sign language to text format, the difference between the normal people and the deaf community can be minimized. Indian sign language uses both hands to represent each alphabet and gesture.ISL alphabets are derived from British Sign Language (BSL) and French Sign Language (FSL) [1].Most of the researchers in this area concentrate on the recognition of American Sign Language (ASL) since most of the signs in ASL are single handed and thus, complexity is less. Another attractive feature is that ASL already has a standard database that is available for use. When compared with ASL, Indian Sign Language (ISL) relies on both hands and thus, an ISL recognition system is more complex. The research works carried out by the researchers in the recognition of ISL is very less. Recently, more researchers have started doing research in this area. Here this proposed system is able to recognize the various alphabets of Indian Sign Language, this will reduce the noise and give accurate result.

Section 1 explains about the introduction of sign language and its function. Section 2 is about the literature review. Section 3 explains the sign language recognition system and its type. Section 4 shows the overview of the system. In which it explains about data acquisition, pre-processing, feature extraction and sign recognition processes. Section 5 shows the LDA algorithm and its approaches. Then section 6 and 7 shows the discussion and conclusion part.

II. LITERATURE REVIEW

Different approaches have been used by different researchers for recognition of various hand gestures which were implemented in different fields. Some of the approaches were vision based approaches, data glove based approaches, soft computing approaches like Artificial Neural Network, Fuzzy logic, Genetic Algorithm and others like PCA, Canonical Analysis, etc. The whole approaches could be divided into three broad categories- Hand segmentation approaches, Feature extraction approaches and Gesture recognition approaches. Few of the works have been discussed in this paper.

Anuja V. Nair , Bindu V. [3] in their paper they meant to replace sign language interpreters. Here they used important classification methods are Artificial Neural Networks (ANN), Support Vector Machine (SVM), Hidden Markov Models (HMM) for recognition.

Joyeeta Singha, Karen Das[1] in their paper they proposed a system using Eigen value weighted Euclidean distance as a classification technique for recognition of various Sign Languages of India. In this system they obtained 97% of recognition.

Shreyashi Narayan Sawant [11] in his paper they used principal component analysis algorithm. Here minimum Euclidean distance is calculated for sign recognition.

III. SIGN LANGUAGE RECOGNITION SYSTEM

Sign language recognition is an important application of gesture recognition. Sign language recognition has two different approaches

- Glove based approaches
- Vision based approaches.

A. Glove Based Approaches

In this category requires signers to wear a sensor glove or a colored glove. The task will be simplified during segmentation process by wearing glove. The drawback of this approach is that the signer has to wear the sensor hardware along with the glove during the operation of the system[3].

B. Vision based approaches

Vision based approach uses image processing algorithms to detect and track hand signs as well as facial expressions of the signer. This approach is easier to the signer since there is no need to wear any extra hardware. However, there are accuracy problems related to image processing algorithms and these problems are yet to be modified[3].

There are again two different approaches in vision based sign language recognition:

-3D model based
-Appearance based

3D model based methods make use of 3D information of key elements of the body parts. Using this information, several important parameters, like palm position, joint angles etc., can be obtained. This approach uses volumetric or skeletal models, or a combination of the two. In computer animation industry and for computer vision purposes, volumetric approach is better suited. This approach is very computational intensive and also, systems for live analysis are still to be developed.

Appearance-based systems use images or videos as inputs. They directly interpret from these videos/images. They don't use a spatial representation of the body. The parameters are derived directly from the images or videos using a template database. Some templates are the deformable 2D templates of the human parts of the body, particularly hands. Deformable templates are sets of points on the outline of an object, used as interpolation nodes for the object's outline approximation[3]. Figure 1 explains about the sign language of 26 gestures.

Fig 1: 26 Gestures of Sign Recognition

IV. SYSTEM OVERVIEW

A simple block diagram of a sign language recognition system is shown in Figure. An external webcam, digital camera or inbuilt webcam in the laptops can be used to capture the training images. This images are stored in a database. The database can be either created by the researcher himself or an available database can be used. Most of the sign language recognition systems classify signs according to hand gestures only or in other words, facial expressions are excluded. In this sign language recognizing process involve four steps. They are data acquisition, pre-processing, feature extraction, and sign recognition. The following diagram shows the overview of Indian sign language recognition system.

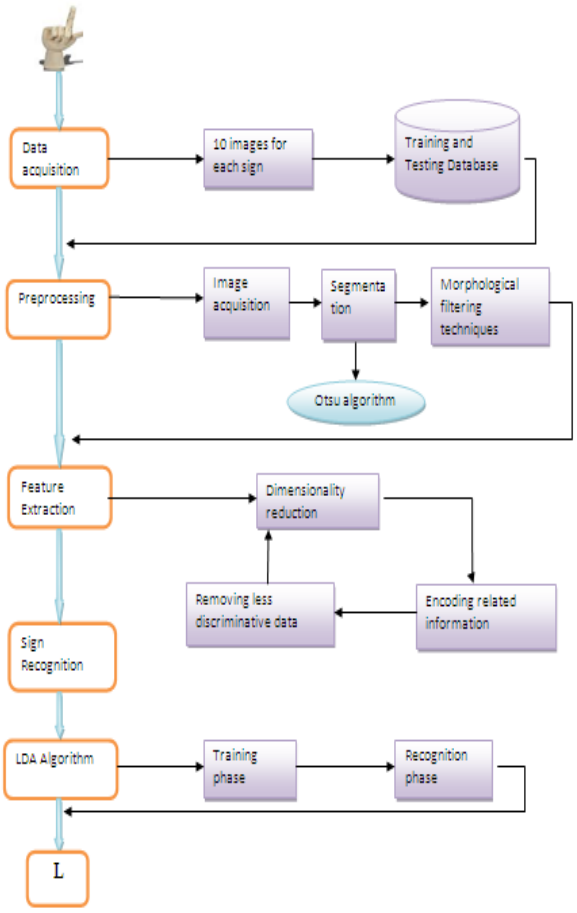

Fig 2: System Overview of Indian Sign Language Recognition System

The above diagram explains the following process,

A. Data Acquisition

To achieve a high accuracy for sign recognition in sign language recognition system, 10 images will be taken for each 26 signs[2]. These images are included in training and testing database. The captured image at a distance is adjusted by the signer to get the required image clarity.

B. Pre-Processing

Pre-processing consist image acquisition, segmentation and morphological filtering methods.

1) Image Acquisition

This is the first step of pre-processing. This is the process of sensing of an image. So in an image acquisition, image is sensed by 'illumination'. It will also involves pre-processing such as scaling. In image acquisition the image will be captured by camera.

2) Segmentation

Segmentation is the process in which image is converted into small segments so that the more accurate image attribute can be extracted[4]. If the segments are properly autonomous(two segments of an image should not have any identical information) then representation and description of image will be accurate and while taking rugged segmentation, the result will not be accurate. Here the Segmentation of hands is carried out to separate object and the background. Otsu algorithm[2] is used for segmentation purpose. The segmented hand image is represented certain features. The following figure shows the segmented of hand image.

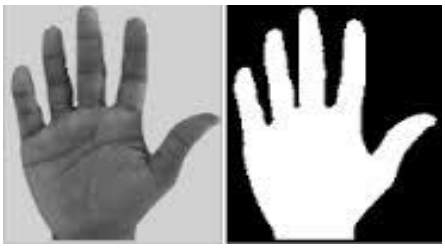

Fig 3: Segmented Image

3) Morphological Filtering

It basically deals with tools for extracting image components that are useful for representation and description of shape. Definitely the output of this process are image attribute. The following image shows the filtered form of segmented image.

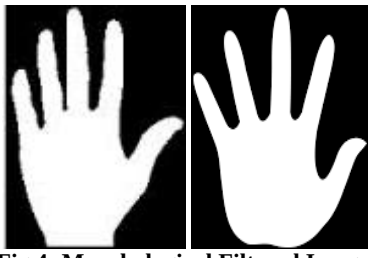

Fig 4: Morphological Filtered Image

The feature extracted from the segmentation operation used for gesture recognition morphological filtering technique is are used to remove the noise from the images so that can get a smooth contour [4]. The pre-processing operation is done on the stored database.

C. Feature Extraction

Feature extraction is a method of reducing data dimensionality by encoding related information in a compressed representation and removing less discriminative data[4]. Feature extraction is vital to gesture recognition performance. Therefore, the selection of which features to deal with and the extraction method are probably the most significant design decisions in hand motion and gesture recognition development. Here principal component is

used as main features. The following figure explains the feature extraction method.

Fig 5: Feature extraction method

D. Sign Recognition

Sign reorganization using LDA is a dimensionality reduction technique based on extracting the desired number of principal components of the multi-dimensional data. The gesture recognition using LDA algorithm that involves two phases

- Training Phase
- Recognition Phase

The following diagram shows the dimensionality reduction technique.

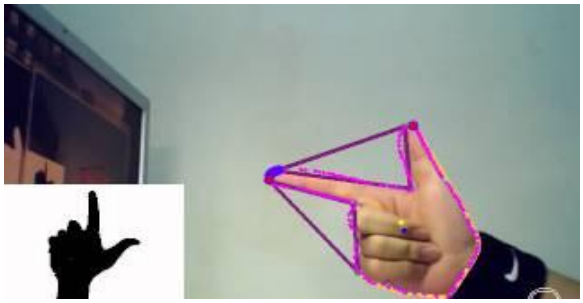

Fig 6: Dimensionality Reduction

During the training phase, each gesture is represented as a column vector. These gesture vectors are then normalized with respect to average gesture. Next, the algorithm finds the eigenvectors of the covariance matrix of normalized gestures by using a speed up technique that reduces the number of multiplications to be performed. Lastly, this eigenvector matrix then multiplied by each of the gesture vectors to obtain their corresponding gesture space projections [2].

In the recognition phase, a subject gesture is normalized with respect to the average gesture and then projected onto gesture space using the eigenvector matrix. Finally, Euclidean distance is computed between this projection and all known projections. The minimum value of these comparisons is selected for recognition during the training phase.

Finally, recognized sign is converted into appropriate text and voice which is displayed on GUI

V. LDA ALGORITHM

Linear discriminant analysis (LDA) is a generalization of Fisher's linear discriminant, a method used in statistics, pattern recognition and machine learning to find a linear combination of features that characterizes or separates two or more classes of objects or events. The resulting combination may be used as a linear classifier, or, more commonly, for dimensionality reduction before later classification.

LDA is also closely related to principal component analysis (PCA) and factor analysis in that they both look for linear combinations of variables which best explain the data. LDA explicitly attempts to model the difference between the classes of data. PCA on the other hand does not take into account any difference in class, and factor analysis builds the feature combinations based on differences rather than similarities. Discriminant analysis is also different from factor analysis in that it is not an interdependence technique: a distinction between independent variables and dependent variables (also called criterion variables) must be made.

LDA works when the measurements made on independent variables for each observation are continuous quantities. When dealing with categorical independent variables, the equivalent technique is discriminant correspondence analysis.

A. LDA Approach

1. Compute the d-dimensional mean vectors for the different classes from the dataset.
2. Compute the scatter matrices (between class and within-class scatter matrix).
3. Compute the eigenvectors (e_1, e_2, ...,e_d) and corresponding eigenvalues (λ_1, λ_2, ..., λ_d) for the scatter matrices.

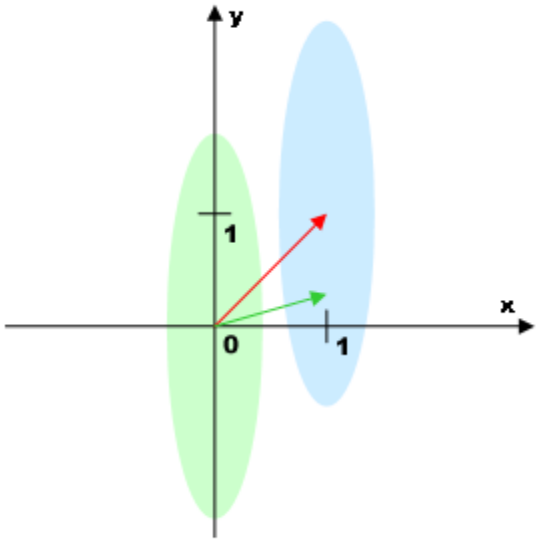

Fig 7: LDA Approach

The above diagram explains about the LDA approach.

4. Sort the eigenvectors by decreasing eigenvalues and choose k eigenvectors with the largest eigenvalues to form a d×k-dimensional matrix W (where every column represents an eigenvector).

5. Use this d×k eigenvector matrix to transform the samples onto the new subspace. This can be summarized by the equation Y = X × W (where X is an n×d-dimensional matrix; the ith row represents the ith sample, and Y is the transformed n×k-dimensional matrix with the n samples projected into the new subspace).

VI. DISCUSSION

In Indian sign language the recognition operation will be done only by using PCA(Principle Component Analysis) algorithm. Here in this proposed system, the recognition operation is done by using LDA(Linear Component Analysis) algorithm. This implementation consists of training phase and testing phase. In this training phase the number of images per gesture was varied from five to ten for analysis.

This LDA algorithm is proposed for noise reduction. The following diagrams explains the difference of noise rate between LDA and PCA algorithm.

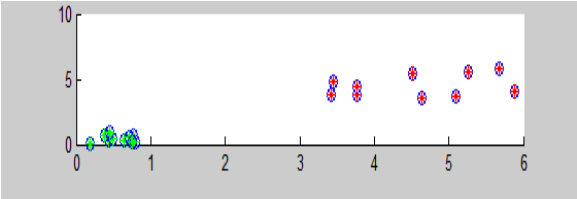

Fig 8: Input for Performing Recognition Operation

The above figure shows the input for performing the recognition operation. This input will be applied for both the LDA and PCA algorithm.

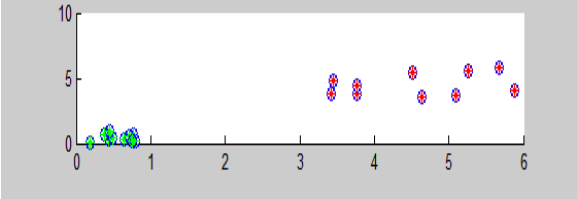

Fig 9: Output of PCA algorithm

The above figure explains the output of PCA algorithm. By using PCA algorithm for that input , the above output will be obtained.

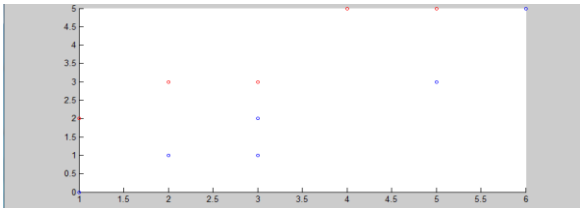

Fig 10: Output of LDA algorithm

The above diagram shows the output of LDA algorithm. When applying the LDA algorithm for the input, the output will be like this. By using this algorithm the noise rate is reduced here.

The following diagram shows the variation between PCA and LDA algorithm. This variation is shown by using graph format.

Efficiency of Recognition(in %)	
PCA	LDA
5	10
20	24
31	35
50	55
60	62

Fig 11: Values Given for PCA and LDA Algorithm

The table shows the values given for PCA and LDA algorithm for perform recognition operation.

Based on these values the graph will be plotted. By using the graph the efficiency rate of both algorithm will be identified.

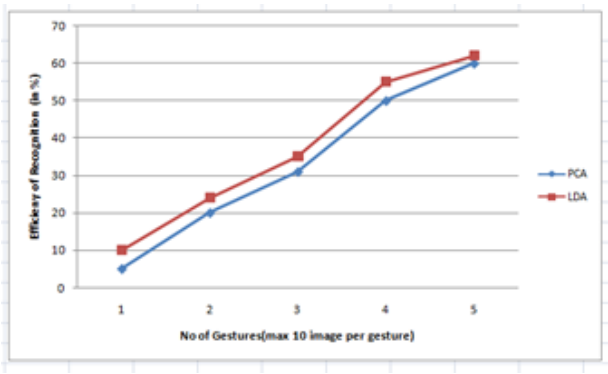

Fig 11: Efficiency Rate of LDA Algorithm Over PCA Algorithm

The above diagram shows the efficiency rate of LDA algorithm over PCA algorithm. Based on the input and output of LDA and PCA algorithm the graph is generated. From this graph the efficiency rate will be increased in LDA algorithm by reducing the noise rate.

VII.CONCLUSION

Recent research works have focused mainly on the recognition of static signs of ISL from images or video sequences that have been recorded under controlled conditions. By using LDA algorithm for sign recognition operation the dimensionality will be reduced. Due to dimensionality reduction the noise will be reduced and with high accuracy. In future this project will be enhanced by determining the numbers which will be shown in words.

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