JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Recognition of Indian Sign Language using SVM Classifier

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Abstract : Sign language is the medium of communication for the hearing impaired people. It uses gestures instead of sound to convey meaning. It combines hand-shapes, orientation and movement of the hands, arms or body, facial expressions and lip-patterns for conveying messages. Different types of project are done against deaf, mute, hard hearing people. A system with computer human interface is proposed for sign language recognition. But there is country wide variation available in that project. The main idea of this project is design a system which is useful for communication of that people with outside world in any public places, so that no need to interpreter in public places. In that project we need the isolated images in the form of database with Indian sign language of numeric sign. A regular camera is useful for acquiring this numeric sign. Principal Component Analysis (PCA) is used for pre-processing, in which the removal of redundant and unwanted data is done.

Index Terms - ***PCA, morphological processes, SVM classifier.***

I. INTRODUCTION

A Sign language is language of people who cannot hear properly and speak properly mean deaf and dump people. The sign languages are complete natural languages, with their own syntax and grammar. Signs are made of small set of elements (units) called as cheremes, analogous to the phoneme in speech. This is proposed as the basic structural units by which the signs of a sign language are represented. The signs are including the hand shapes, hand movements, and locations of the hands in relation to the body employed in a particular sign language. A sign is made of chereme and any two signs can be differentiated by at least one chereme. There are mainly two different approaches in sign language recognition - Glove based approach and vision based approach [8]. Sign language is helpful with communication between deaf, mute, hard hearing people and normal people. In normally, sign language is understandable for the signer and the person who know the sign language but it is so much difficult for who does not know the sign language or meaning of any gesture. [4].The strategy of the Eigenvector method consists of extracting the characteristic features.

The images of Indian sign language can be used as input and the system will display the English alphabet, which are the mute, deaf people want to tell. A regular camera is used for acquiring this sign. For developing this project we need numeric sign database with 26 English alphabets sign & 9 Numeric sign with proper images. In this project every word or every alphabet is assigned sign shown with a particular image. This image is in the form of .jpg so that we can easily use the database .This images are in static or dynamic form. Static gestures have fixed position of hand whereas dynamic gestures have movements of hands and body parts. The whole system of the vision-based sign language recognition is simpler than the data glove based approach which uses special input devices for tracking and digitizing hand and finger motions into multi-parametric data. These types of devices are very expensive and the users may feel uncomfortable when they communicate with these machines.

The vision based system helps to detect and track the gestures[8]. Since ISL is get recently standardized and also since tutorials on ISL gestures were not available until recently, there are very few research work that has happened in ISL recognition. Taking into consideration the challenges in ISL gesture recognition for that the proposed scheme uses PCA for feature extraction. Principal Component Analysis (PCA) (Rafael and Woods, 2002) is a well-known and one of the most successful techniques used in image recognition and compression for extracting feature and representing data. It is technique widely used in the area of pattern recognition, computer vision and signal processing. Principal component analysis (PCA), also known as Karhunen- Loeve expansion, is a classical feature extraction and data representation technique widely used in the areas of pattern recognition and computer vision such as face recognition. The purpose of PCA is to reduce the large dimensional of the data space (observed variables) to the smaller intrinsic dimensional of feature space (independent variables), which are needed to describe the data economically. This is the case when there is a strong correlation between observed variables. By discarding minor components, the PCA effectively reduces the number of features and displays the data set in a low dimensional subspace. In this study the feature extraction algorithm based on PCA is chosen. The coefficients of these methods are used as feature vectors which efficiently represent the appropriate extracted image.

In feature extracting image which consists of large amount of data can be automatically extracted from image and also it is the process which is useful for collecting feature and image classification. In feature extraction method the original image are

converted into grey scale. This excreted images are needed as input for classification. There are number of classifier techniques available which are used for classify the image. Classifier is the identification of input data with set of training data. In our work we use SVM classifier for image classification. SVM is a support vector machine used for supervised learning model with associated algorithm that analyzed data used for classification and analysis. SVM classifier is the method of performing the classification task.

2. Literature Review:

There are different theories used for Indian Sign Convention presented by different authors. The surveyed literature on Sign Convention is as follows:

In tamil sign letter Balakrishnan, G, Subha Rajam, [1] proposed a method. Which was recognizing a 32 set of combinations & 10 for each up and down position of fingers? This method is used for the up/down position of fingers which is converted into decimal numbers, this number is recognized in to the Tamil alphabet A set of database in the form of images of sizes 640×480 pixels are captured. Palm image extraction is used to convert RGB to grayscale images. The experiment result is 96.87%.

For static and dynamic alphabet sign RekhaJ, [2] proposed a system this system was used 23 static ISL alphabet signs from 40 different signers are collected as training samples and 22 videos are used as testing samples. The images are extracted by the method of Principle Curvature Based Region Detector. Multi class non-linear KNN are used as sign classifiers. The experiment result for static 94.4% and for dynamics it was 86.4%.

For PCA method Deora and Nikesh Bajaj, [3] proposed a system which shows, Hand gesture is one of the typical methods used in sign language for non-verbal communication. It is most commonly used by people who have hearing or speech problems to communicate among themselves or with normal people. Various sign language systems have been developed by manufacturers around the globe but they are neither flexible nor cost-effective for the end users. Different methods used for the feature extraction like HMM, SVM, Neural Network and PCA. The system is mainly implemented by using image preprocessing, segmentation, feature extraction and gesture recognition. PCA is used for feature extraction. Using PCA method we can reduce original variables into a lower number of orthogonal. Principal component analysis (PCA) is a statistical technique for reducing the dimensionality of a data set in which there are many interrelated variables, while retaining as much of the variation in the dataset as possible.

M. Geetha and U. C. Manjusha, [4] proposed Sign language is the most natural way of expression for the deaf community. The urge to support the integration of deaf people into the hearing society made the automatic sign language recognition, an area of interest for the researchers. This paper is proposes a novel vision-based recognition of Indian Sign Language Alphabets and Numerals using B-Spline Approximation. Gestures of ISL alphabets are complex since it involves the gestures of both the hands together. Algorithm approximates the boundary extracted from the Region of Interest, to a B-Spline curve by taking the Maximum Curvature Points (MCPs) as the Control points. Hence a translation & scale invariant feature vector is obtained from the spatial locations of the KMCPs in the 8 Octant Regions of the 2D Space which is given for classification.

Around 5% of world community in all parts of the world is using sign language as a medium of communication [5]. After analysis of work by different authors some drawback are found. The first drawback is dataset which is not in the standard form. Due to non standard datasets experiment conducted by researcher are not clear. The system which we are planned to used in public places different types of noises or background present in acquiring sign. The second drawback which we found is that all the databases were developed in some laboratory. So the laboratory required more processing power or higher cost.

In Indonesia northern Bali jungle village of “Bengkala” for generations, where a high percentage of residents are deaf. Bengkala has a higher than normal deaf-since-birth population for over seven generations. Today, 42 of Bengkala's almost-3,000 villagers have been deaf since birth.

3. The Proposed system:

The proposed system is shown in the figure 1. If no standard data set is available to experiment on automatic recognition of ISL gestures then Two data sets of ISL character signs are created. First set contains gestures belongs to single handed Indian Sign Language characters and the second set contains double handed gestures of Indian Sign Language. The details of acquiring of data set are given in data set creation section. The input images are pre-processed before fed into feature extraction and classification phases of the proposed system.The following A to F points gives the detailed explanation about the proposed methodology.

The proposed system is shown in the figure 1.

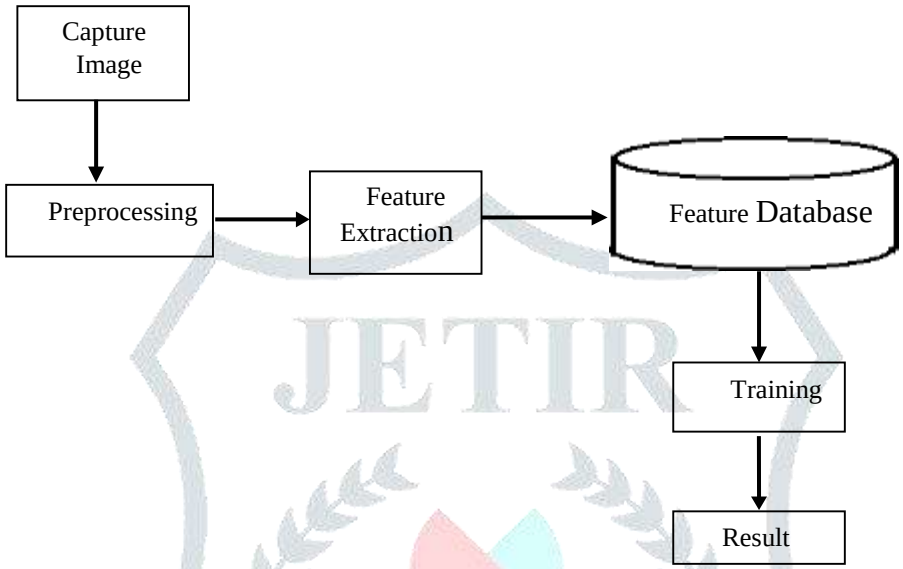

Fig. 1. Overview of proposed system

A. Input Sign Language Image:

In this datasets total 192 images of single & double handed are captured using digital camera. These images are in the form of 200X300 RGB pixel size. These images are collecting from different persons for each character. These images are divided into 32 classes; each class contains 6 samples of same class. We use this image in the JPG format because it is very easy to extract the image in different hardware and software environment. The datasets created for this experiment are images for each number. The memory required for this datasets are nearly 400MB. These images are flat rectangular shape in structure. The sample input image is shown in the fig.2

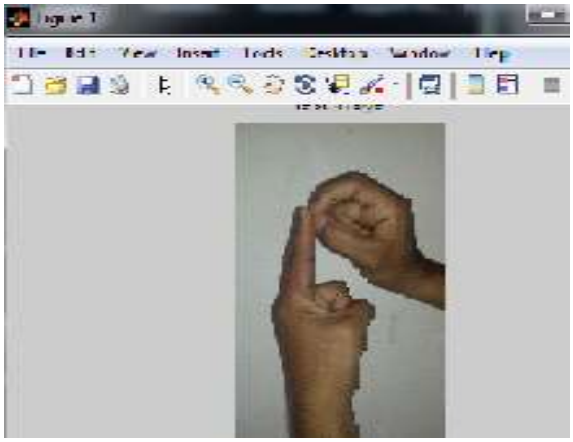

Fig.2. Input image

B. Preprocessing and Segmentation :

After collecting the database from user we need to preprocessed that images. Preprocessing images commonly used for removing low-frequency background noise, normalizing the intensity of the individual particles images, Firstly we convert RGB images into grey scale images by using MATLAB (rgb to gray converter). This will convert RGB images to high intensity Grey scale images. In this step we can perform segmentation and noise removal operation. The main aim of preprocessing is an improvement in input data (sign language images) that data suppresses unwanted distortions. Image preprocessing technique use the considerable redundancy in images . Neighboring pixel corresponding to one object in real image have adjusted some or similar brightness value. Neighboring pixel corresponding to one object in real image have adjusted some or similar brightness value.

Preprocessing consists of thresholding, erosion and dilation of collected data images.

C. Skin Thresholding:

Skin detection is used to search for the human hands and discard other skin colored objects for every frame captured from a webcam shown in fig 3. Image thresholding is used for extracting the significant or desired part of an image and removing the unwanted part or noise. The point operator of major interest is called thresholding which selects pixels that have a particular value, or that are within a specified range. With thresholding, the image can be segmented based on the color. This holds true under the assumption that a reasonable threshold value is chosen. A reasonable threshold value is the taken from the histogram of the original image. The point operator helps us to find objects in a picture if the brightness level or range is known, hence the object's brightness must be known.

After detecting skin area for every frame captured, we used contours comparison of that area with the loaded hand postures contours to get rid of other skin like objects exist in the image. If the contours comparison of skin detected area complies with any one of the stored hand gesture contours, a small image will enclose the hand gesture area only and that small image will be used for extracting the PCA features.

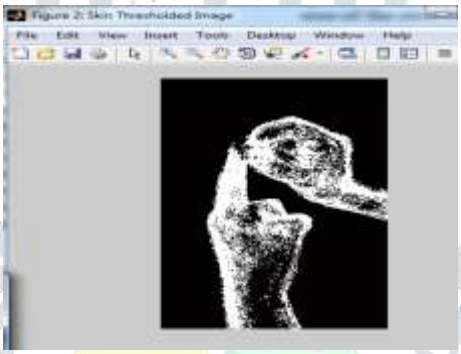

Fig.3 Thresholded image

D. Dilation and erosion:

Dilation and erosion are basic morphological operations. They are defined in terms of more elementary set operations, but are employed as the basic elements of many algorithms. Dilation is used to increase the object size where as erosion is used to diminish the size of the object. Both dilation and erosion are produced by the moving the mask around the image. The mask which is also called as structuring element or sub image or kernel (Lim, 1990) and (Soille, 2004) and it has both a shape and an origin. The following Eq. 1 and 2 are generally used for dilation and erosion:

$$\text{Dilation} = X \oplus S \quad (1)$$

$$\text{Erosion} = X \ominus S \quad (2)$$

Fig.4 Eroded image

Fig.5 Dilated image

E. Feature Extraction:

The input data which is to be processed is transformed into a reduced representation set of features. This is referred as feature extraction. Every image consists of large amount of data. This information can be automatically extracted from the images is called as feature extraction. Here we are using Principal component analysis method for extracting the features.

PCA:

Linear Discriminant Analysis (LDA), Independent Component Analysis and PCA are some of the techniques used for feature extraction, among them PCA is powerful method in image formation, Data patterns, similarities and differences between them are identified efficiently.

The other main advantage of PCA is dimension will be reduced by avoiding redundant information, (Daugman, 1993) without much loss. Better understanding of principal component analysis is through statistics and some of the mathematical techniques which are Eigen values, Eigen vectors. PCA is a useful statistical and common technique that has found application in fields such as image recognition and compression. Principal Component Analysis (PCA) is a mathematical procedure that uses linear transformations to map data from high dimensional space to low dimensional space. The low dimensional space can be determined by Eigen vectors of the covariance matrix.

PCA Algorithm

Following are steps involve;

Step 1: Column or row vector of size N2 represents the set of M images (B1, B2, B3…BM) with size N*N

Step 2: The training set image average (μ) is described as

$$\mu = \frac{1}{m}\sum_{n=1}^{M} Bn \qquad (1)$$

Step 3: the average image by vector (W) is different for each trainee image

$$Wi = Bi - \mu \qquad (2)$$

Step 4: Total Scatter Matrix or Covariance Matrix is calculated from Φ as shown below:

$$C = \sum_{n=1}^{M} wnwnt = AAT, \qquad (3)$$

where A= [W1W2W3…Wn]

Step 5: Measure the eigenvectors UL and Eigen values λL of the covariance matrix C.

Step6: For image classification, this feature space can be utilized. Measure the vectors of weights

$$\Omega T = [w1, w2, \ldots, wM'], \qquad (4)$$

whereby,

$$Hk = UkT (B - \mu), k = 1, 2, \ldots, M' \qquad (5)$$

Feature Vector-

In machine learning and pattern recognition feature vector is a n-dimensional vector consist of numerical vector which represent some object. Many algorithms require feature numerical representation of object. When representing the image feature value shows the pixel of image or whole object in images. Feature vector are equivalent to vector of variable used in linear process. It is just a vector consisting of multiple element or feature. Examples of features are color component length, area, circularity, grey level intensity, magnitude, direction it's depend on which feature is useful for application.

Fig.6 Extracted image

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F. SVM Classifier:

There are many types of classifier Technique available we use SVM classifier to identify the image. SVM is a support vector machine used for supervised learning model with associated algorithm that analyzed data used for classification and analysis by using Extracted features. SVM classifier is the method of performing the classification task. The support vector machine searches for the closest path which we call "support Vector". Once it found the closest point then the SVM draw a line for connecting them. The support vector machine then declares best separating line which bisect and perpendicular to connecting line. We perform classification by finding the hyper plane for differentiate between two classes. Support vector machine are simply the coordinate of individual observation.

4. Results and Discussion

The data set divided into two groups, one used for training and other for testing. The training set consists of 70% of the aggregate data and remaining 30% are used as testing means for training we are using images captured from 6 different person and for testing images captured from 2 different person numeric as well as alphabets. We also perform experiments on same (30% or 70%) dataset which is training as well as testing for SVM classifier. The overall accuracy of the proposed method as given below

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$$\text{Accuracy} = \frac{\text{Total No. of Patterns} - \text{No. of false result Patterns}}{\text{Total No. of Patterns}} \times 100\%$$

from total 64 testing images 61 images are correctly recognized so the accuracy of this proposed method 95.31% using PCA features and SVM classifier

Table1.Accuracy of Sign language

Image	Accuracy in %	Image	Accuracy in %
	100%		66.67%
	100%		100%
	100%		100%
	83.33%		66.67%

Table 2 Result comparison with other methods

Sr. No.	Method proposed by	Accuracy obtained
1	Balakrishna, G. and P. S. Rajam. 2012[1]	96.87%.
2	Rekha J., J. Bhattacharya and S. Majumder. 2011[2]	86.4%
3	Divya Deora and Nikesh Bajaj 2012 [3]	90.65%
4	M. Geetha and U. C. Manjusha 2012[4]	90%
5	Proposed method	95.31%

5. Conclusion and future scope

This Recognizing system is capable of Recognizing Alphabetical and numerical sign with high accuracy using SVM (Support Vector Machine) Classifier. The experimental result is shown that the system is used as “working System” in regular ISL Recognition.

Future Scope

The system can be useful for ISL Static alphabetical and numerical sign. the system is not useful for complete system. For complete system we have to include ISL word or sentences in future. Also other feature extraction algorithms like Wavelet transform, Invariant moments, Shape lets descriptors and other existing methods can be included in conducting experiments for improvement in the results. Other classifiers like Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) or a combination of these classifiers can be included in conducting experiments to improve the recognition rate. Also we can convert the text output as a sound signal for easy identification.

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