

# Real Time Visual Recognition of Indian Sign Language using Wavelet Transform and Principle Component Analysis

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**Abstract:** Sign language is a mean of communication among the deaf people. Indian sign language is used by deaf for communication purpose in India. Here in this paper, we have proposed a system using Euclidean distance as a classification technique for recognition of various Signs of Indian sign Language. The system comprises of four parts: Image acquisition, pre processing, Feature Extraction and Classification. 31 signs including A to Z alphabets & one to five numbers were considered in this paper.

**Index Terms:** Indian Sign Language (ISL), Principle Component Analysis (PCA), Sign Language Recognition (SLR)

## I. INTRODUCTION

Sign language is the natural ways of exchanging information among the deaf. It has been observed that deaf people are facing difficulty to interact with normal people. The purpose of sign language recognition system is to provide an efficient and accurate system to convert sign language into text so that communication between the deaf and normal people can be more convenient. Sign language consists of vocabulary of signs in exactly the same way as spoken language consists of a vocabulary of words. Indian sign language (ISL) is sign language used in India. ISL involves both static and dynamic gestures, single as well as double handed gestures, in addition to this the hands involved in gesturing may have complex motion. Some signs include facial expressions too. Because of these difficulties, less research work has been carried out on ISL recognition system [1] A thorough literature survey covering almost all the aspects of the Sign Language Recognition is necessary to build an ISL recognition system.

## II. LITERATURE SURVEY

Gesture recognition is a form of interaction between human and computer. It was proposed by Myron W. Krueger in the middle of 1970s. With the passage of time it has become very important research area. Different approaches have been used by researchers for building an efficient SLR system. Pre processing is the first step of SLR system. It is necessary

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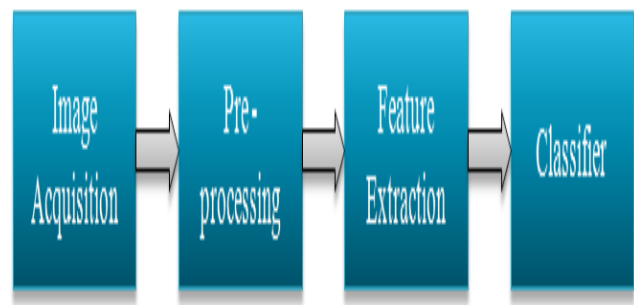
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because images may be taken in different lighting environment, with different cameras of varying resolution. Filtering can be the first step in pre processing. gesture recognition involving 60 different dynamic gestures. Recognition was performed using the Viterbi algorithm to estimate maximum likelihood state sequences. The recognition accuracy of 82.17% was achieved. Jyotee sinha has used Euclidean distance for classification. Accuracy obtained was 97% with satisfactory speed.

## III. SYSTEM OVERVIEW

Many researchers have been done on SLR system for different applications, but they all agree with the main structure of the recognition system. These phases are image acquisition, pre-processing, features detection and extraction, and finally the classification. This structure is illustrated in Fig.1.



**Fig.1. Block Diagram of SLR System**

In this system input images are captured by camera. Images are resized to reduce the computational efforts in image processing. We have used skin detection after background subtraction, to detect the hand from the acquired image. After pre processing we obtain the binary image.

Fig.2 shows some pre processed images of different alphabets of ISL.



**Fig.2. Pre Processed Image of C,4,3,A,D**

**Table. I Effect of Noise on One Handed Database Images**

ISL alphabet	Amount of salt & pepper noise( in percentage) up to which sign has been identified correctly									
	10	20	30	40	50	60	70	80	90	100
C	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
I	Yes	Yes	Yes	No	No	No	No	No	No	No
J	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
L	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
O	Yes	Yes	Yes	No	No	No	No	No	No	No
U	Yes	Yes	No	No	No	No	No	No	No	No
V	Yes	Yes	No	No	No	No	No	No	No	No
W	Yes	Yes	No	No	No	No	No	No	No	No
One	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Two	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Three	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Four	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Five	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No

For feature extraction we have used haar transform with Principle component Analysis .Principal Component Analysis, or simply PCA, is a statistical procedure concerned with elucidating the covariance structure of a set of variables. In particular it allows us to identify the principal directions in which the data varies.

Method for dimensionality reduction using PCA

Step 1: Get some data

Here dataset images consisting of A to Z alphabets and one to five numbers after pre processing are used.

Step 2: Subtract the mean

For PCA to work properly, we have subtracted the mean from each of the data dimensions. The mean subtracted is the average across each dimension. This produces a data set whose mean is zero.

$$\Phi_i = X_i - E[X]$$

Step 3: Form the co variance matrix  $A = [\Phi_1 \Phi_2 \dots \Phi_M]C = AA^T$

Step 4: Compute the eigenvalues of C:  $\lambda_1 > \lambda_2 > \dots > \lambda_N$

Step 5: Compute the eigenvectors of C:  $u_1, u_2, \dots, u_N$

Since C is symmetric,  $u_1, u_2, \dots, u_N$  form a basis, (i.e., any vector  $x$  or actually  $(x - \bar{x})$ , can be written as a linear combination of the eigenvectors)

Step 6: (Dimensionality reduction step)

Here we keep only those terms corresponding to the K largest eigenvalues. Largest eigenvalue indicate maximum data variation in the direction of eigenvector. Classifier is required in order to recognize various hand gestures. Here Euclidean distance based classifier is used. Euclidean distance was found out between the Eigen vectors of the test

image and the corresponding Eigen vectors of the database image. Minimum distance indicates the similarity between the test image & the database image. In this way sign is identified.

**IV. EXPERIMENTAL RESULTS**

Table I. and Table II. Shows the effect of salt & pepper noise on database images.

Table I shows the effect of noise on recognition of one handed database images. Here salt & pepper noise is added on database images and results for the same are analyzed. We can see that all one handed alphabets images have been identified correctly even though 20% noise is added. Some images are identified correctly after adding noise up to 60 to 70%.



Table .II Effect of Noise on Two Handed ISL Database Signs

ISL alphabet	Amount of salt & pepper noise (in percentage) up to which sign has been identified correctly									
	10	20%	30%	40%	50%	60%	70%	80%	90%	100 %
A	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
B	Yes	Yes	Yes	Yes	No	No	No	No	No	No
D	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
E	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
F	Yes	Yes	Yes	No	No	No	No	No	No	No
G	Yes	Yes	No	No	No	No	No	No	No	No
H	Yes	Yes	No	No	No	No	No	No	No	No
K	Yes	Yes	No	No	No	No	No	No	No	No
M	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
N	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
P	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Q	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
R	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
S	No	No	No	No	No	No	No	No	No	No
T	No	No	No	No	No	No	No	No	No	No
X	No	No	No	No	No	No	No	No	No	No
Y	No	No	No	No	No	No	No	No	No	No
Z	No	No	No	No	No	No	No	No	No	No

Table.2 shows the effect of noise on two handed sign. We can see that recognition rate of 72% is obtained .Also some of the images have been identified correctly even 70% noise is present.

### V. CONCLUSIONS

As real time images taken with a digital camera, they may have different sizes and resolutions. So image pre-processing is required. The feature extraction facilitates to reduce the computational time. For designing a flexible SLR system; the features of an image which are invariant to scaling, translation and rotation are necessary. PCA gives satisfactory results when used with haar transform.

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