ISSN:0975-9646

Indian Sign Language Recognition based on Histograms of Oriented Gradient

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***Abstract*— Hand gesture is an active area of research in the computer vision, mainly for the purpose of sign language recognition and Human Computer interaction. In this paper, a method for hand gesture recognition of Indian sign language is proposed. The accurate classification of hand gestures plays a vital role to develop an efficient hand gesture recognition system. To implement this approach we have utilized a simple web camera to capture hand gesture images. An attempt is made to propose a system to recognize alphabets characters (A-Z) and numerals (0-9) using Histograms of Oriented Gradients (HOG) features. The purpose is to implement the algorithm of extracting Histogram of Gradient Orientation (HOG) features and these features are used to pass in neural network training for the gesture recognition purpose.**

***Keywords*— Hand gesture, Human computer interaction, Neural network, Orientation Gradient, Sign language.**

I. INTRODUCTION

A hand gesture recognition system to recognize Indian sign language is introduced in this paper[1]. With the widespread use of computers in modern society, traditional human–computer interaction (HCI) technologies based on mouse and keyboard show their increasing limitations. Thus, research on multimodal HCI is becoming more and more important in real life. Sign language recognition (SLR), as one of the important research areas of HCI, has spawned more and more interest in HCI society. The goal of SLR is to provide an efficient and accurate mechanism to transcribe sign language into text or speech so that communication between the deaf and hearing society can come true[2]. The motivation for developing such helpful application came from the fact that it would prove to be of utmost importance for socially aiding people and it would help increasingly for social awareness as well[3].

There are number of sign languages spreaded across the world. The sign language used by those deaf and mute at a particular place is dependent on the culture and spoken language at that place. ISL differs in the syntax, phonology, morphology and grammar from other country's sign languages. Since ISL got standardized only recently and also since tutorials on ISL gestures were not available until recently, there are very few research work that has happened in ISL recognition[4].Here we propose a method for hand gesture recognition of Indian sign language alphabet and numerals. The signs considered for recognition include 26 letters of the English alphabet and the numerals from 0-9 [5]. Indian sign language alphabet and numerals are shown in Fig.1 and Fig.2 respectively.

II. LITERATURE REVIEW

Transition movement models (TMMs) [1] is proposed by Gaolin Fang, Wen Gao, and Debin Zhao to handle transition parts between two adjacent signs in large-vocabulary continuous SLR. For large-vocabulary continuous SLR, TMMs were proposed for continuous Chinese SLR. An approach is made to recognize alphabet characters dynamically from color image sequences using "Continuous Adaptive Mean Shift Algorithm (CAMSHIFT)" tracking algorithm stated in[2] by Sulochana M. Nadgeri, Dr. S. D. Sawarkar, Mr. A. D. Gawande. The algorithm used here is based on a robust nonparametric technique for climbing density gradients to find the mode(peak) of probability distributions called the mean shift algorithm.

A novel technique is proposed by Dipak Kumar Ghosh , Samit Ari to obtain a rotation invariant gesture image which coincides the 1st principal component of the segmented hand gestures with vertical axes The shape of the contour is an important property that can be used to distinguish of the static hand gestures from one class to another. The classification job is done via k-mean based radial basis function neural network (RBFNN) [6]. Ravikiran J, Kavi Mahesh, Suhas Mahishi, Dheeraj R, Sudheender S, Nitin V. Pujari stated an efficient algorithm[7] to identify the number of fingers opened in a gesture representing an alphabet of the American Sign Language and introduces a very effective and efficient technique for finger detection.

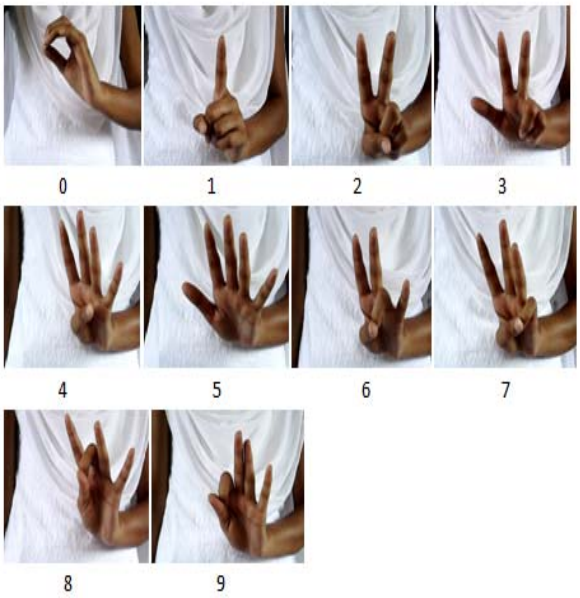

Fig 1. Representation of ISL numerals

Fig 2. Representation of ISL alphabets

III. METHODOLOGY

The proposed system is aimed to develop a sign language education and recognition platform for hearing impaired peoples and communication system for dumb people to convey their message. The main approaches for analyzing and classifying hand gestures for Human Computer Interaction (HCI) include Glove based techniques and Vision based techniques. The objective of the this work is to build a system that uses natural hand gestures as a modality for recognition in the vision-based setup.

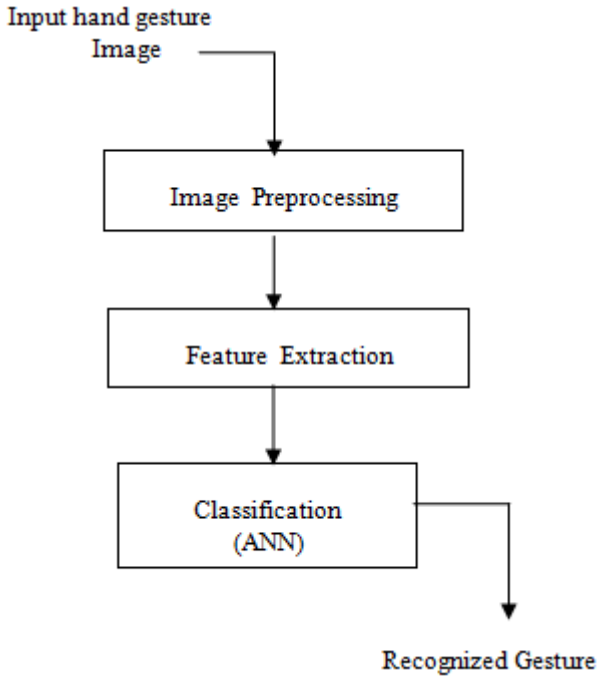

Fig 3. Block diagram of hand gesture recognition system

The proposed hand gesture recognition method translates the fingerspelling in Indian sign language to textual and audio form.

- Image Preprocessing
- Feature Extraction
- Classification

A. Image Preprocessing

The image scene and information should not be altered by local changes due to noise and digitization error. Hence to satisfy the environmental scene conditions, preprocessing of the raw data is highly important.For noise removal fspecial() is used.

H = FSPECIAL('gaussian',HSIZE,SIGMA)

It returns a rotationally symmetric Gaussian lowpass filter of size HSIZE with standard deviation SIGMA (positive). HSIZE can be a vector specifying the number of rows and columns in H or a scalar, in which case H is a square matrix.

Image preprocessing includes the set of operations on images whose goal is the improvement of the image data

that suppresses undesired distortions or enhances some image features important for further processing.

B. Feature Extraction

Good segmentation process leads to perfect features extraction process and the later play an important role in a successful recognition process [8]. There are many interesting points on every object which can be extracted to provide a "feature" description of the object. Under different scene conditions, the performance of different feature detectors will be significantly different. The nature of the background, existence of other objects (occlusion), and illumination must be considered to determine what kind of features can be efficiently and reliably detected. For the recognition of ISL, an algorithm to find Histogram of Oriented Gradient is implemented.

Histograms of Oriented Gradients:

Histogram of Oriented Gradients (HOG) are feature descriptors used in computer vision and image processing for the purpose of object detection. The technique counts occurrences of gradient orientation in localized portions of an image. The essential thought behind the Histogram of Oriented Gradient descriptors is that local object appearance and shape within an image can be described by the distribution of intensity gradients or edge directions. HOG features are calculated by taking orientation histograms of edge intensity in local region [8].The implementation of these descriptors can be achieved by dividing the image into small connected regions, called cells, and for each cell compiling a histogram of gradient directions or edge orientations for the pixels within the cell. The combination of these histograms then represents the descriptor.

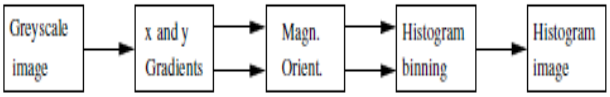

Fig. 4 Image histogram computation

The algorithm is implemented as follows:

1) Gradient Computation

The first step of calculation is gradient values computation. The most common method is to simply apply the 1-D centered, point discrete derivative mask in one or both of the horizontal and vertical directions. specifically this method requires filtering the gray scale image with the following filter kernels.

For the x direction, x = [0 -1 1]

For the y direction y = [0 1 -1] which is the same as x but transposed and multiplied by –1.

Then convolution is performed on image vectors to form Dx= I * X and Dy= I * Y

C = CONV(A, B) convolves vectors A and B. The resulting vector is of length MAX([LENGTH(A)+LENGTH(B)-1,LENGTH(A),LENGTH(B)]). If A and B are vectors of polynomial coefficients, convolving them is equivalent to multiplying the two polynomials.

C = CONV(A, B, SHAPE) returns a subsection of the convolution with size specified by SHAPE:

'full' - (default) returns the full convolution,

'same' - returns the central part of the convolution that is the same size as A.

'valid' - returns only those parts of the convolution that are computed without the zero- padded edges.

LENGTH(C) is MAX(LENGTH(A)-MAX(0,LENGTH(B)-1),0).

After calculating x,y derivatives (***DX*** and ***DY***), the magnitude and orientation of the gradient is also computed: Dividing the two resulting matrices (images) *Dx* and *Dy* element by element and then taking the atan ($\tan^{-1}$),this will give the gradient orientation.

$$|G| = \sqrt{Dx^2 + Dy^2}$$

$$\Theta = \arctan \frac{Dy}{Dx}$$

The orientation in radian is converted to degrees which returns values between [-180°,180°]. Since unsigned orientations are desired for this implementation, the values which are less than 0° is summed up with 180°.

2) Orientation Binning

The second step of calculation involves creating the cell histograms.Each pixel within the cell casts a weighted vote for an orientation based histogram channel based on the values found in the gradient computation. Angle histogram is created which is a polar plot showing the distribution of values grouped according to their numeric range. Each group is shown as one bin. Figure below shows an example of orientation histogram.

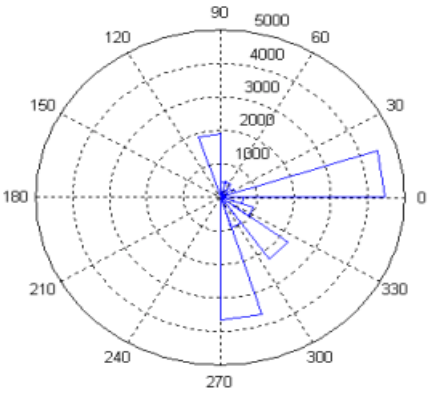

Fig. 5 Orientation histogram

C. Classification

The feature vector obtained from the feature extraction step is used as the input of the classifier that recognizes the sign[1]. Training and generalizing are the most basic and important properties of the neural networks. Hence ,Artificial neural network is used as the classification tool. Most of the researches use ANN as a classifier in gesture recognition process[9]. Different network models exist for training the neural net and depending on the feature vectors, the best neural net training method is chosen. In the training phase, the user

shows hand gestures which were captured using Image Acquisition Toolbox of MATLAB and USB based web camera[10].

Feedforward backpropagation neural network is used widely for classification purpose. As the algorithm's name implies, the errors propagate backwards from the output nodes to the input nodes. Technically speaking, backpropagation calculates the gradient of the error of the network regarding the network's modifiable weights. As the algorithm's name implies, the errors propagate backwards from the output nodes to the input nodes. Technically speaking, backpropagation calculates the gradient of the error of the network regarding the network's modifiable weights.

The procedure of teaching algorithm is as follows:

a. The structure of the network is first defined. In the network, activation functions are chosen and the network parameters, weights and biases, are initialized.
b. The parameters associated with the training algorithm like error goal, maximum number of epochs (iterations), etc, are defined.
c. The training algorithm is called.
d. After the neural network has been determined, the result is first tested by simulating the output of the neural network with the measured input data. This is compared with the measured outputs. Final validation must be carried out with independent data.

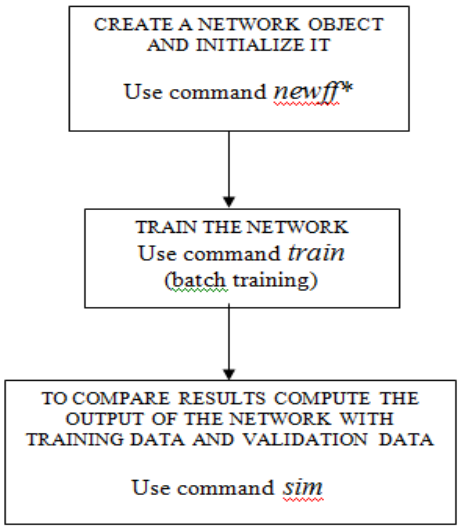

Fig. 6 Basic Flow diagram for NN

The MATLAB commands used in the procedure are *newff, train* and *sim.* The MATLAB command *newff* generates a neural network, which is called *net.*

$$net = newff(\underbrace{PR}_{\text{min,max values}}, [\underbrace{S1\ S2...SNl}_{\text{size of the } i\text{th layer}}], \{\underbrace{TF1\ TF2...TFNl}_{\text{activation function of } i\text{th layer}}\}, \underbrace{BTF}_{\text{training algorithm}})$$

IV. Conclusions

The Histogram of Oriented Gradient based method is for the recognition of hand gestures for Indian sign language is presented in this paper.Histogram orientation has the advantage of being robust in lighting change condition. The features extracted from the sign image are used to train a feed forward neural network that recognizes the sign. The system is able to recognize 36 hand gestures which represents the alphabets from A to Z and numbers from 0 to 9. As the method implements completely by using digital image processing technique so the user does not have to wear any special hardware device to get features of hand shape. Developing such system translating sign language to text/voice format can be proved very useful for physically imapaired people of india.

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