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Real Time Static Hand Gesture Recognition System in Simple Background for Devanagari Number System

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***Abstract*— Hand gesture recognition is one of the key techniques in developing user-friendly interfaces for human-computer interaction. Static hand gestures are the most essential facets of gesture recognition. User independence is among the important requirements for realizing a real time gesture recognition system in human-computer interaction. Applications of hand gesture recognition range from teleported control to hand diagnostic and rehabilitation or to speaking aids for the deaf. In today's era of communication, sign language is one of the major tools of communication for physically challenged people. This paper proposes a system of hand gesture recognition for Devanagari Sign Language (DSL) Number System with comparison of feature extraction techniques, Discrete Cosine Transform (DCT) & Edge Oriented Histogram (EOH).**

***IndexTerms*— DSL, Discrete Cosine Transform, Edge Oriented Histogram, Hand gesture, Human-Computer interaction.**

I. INTRODUCTION

Since the introduction of the most common input devices, not a lot have changed. This is probably because the existing input devices are adequate. It is also now that computers have been so tightly integrated with everyday life, that new applications and hardware are constantly introduced. The means of communicating with computers at the moment are limited to keyboards, mice, light pen, trackball, keypads etc. These devices have grown to be familiar but inherently limit the speed and naturalness with which we interact with the computer. [1]

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Recently, there has been a surge in interest in recognizing human hand gestures. Hand gesture recognition has various applications like computer games, machinery control (e.g. crane), and thorough mouse replacement. One of the most structured sets of gestures belongs to sign language. In sign language, each gesture has an assigned meaning (or meanings).
Computer recognition of hand gestures may provide a more natural-computer interface, allowing people to point, or rotate a CAD model by moving their hands. Hand gestures can be classified in two categories: static and dynamic. A static gesture is a particular hand configuration and pose, represented by a single image. A dynamic gesture is a moving gesture, represented by a sequence of images. Since the proposed system supports real time processing of images where the response time should be less, it is focused on the recognition of static images.
Image recognition is an essential field in man-machine interaction. It is a technology of making machines understands human behaviors. Hand gesture is a natural way of communication between human and machine. [6]
The user should sense no appreciable delay between, when he or she makes a gesture or motion and when the computer responds. The computer vision algorithms should work for different people. Deaf people use sign language as an alternative to spoken language; it uses hand gestures which are considered by deaf people as their natural way of communication.

Most conventional approaches to hand gesture recognition has employed external devices such as data gloves, sensors and so on. However for more natural interface, hand gesture must be recognized from visual images without any external devices. [5]

II. FLOW OF HAND GESTURE RECOGNITION SYSTEM

In this section, the flow of hand gesture recognition system algorithm is presented as shown in Fig. 1. The stages of our proposed system can be summarized as follows: image acquisition, image pre-processing, feature extraction by using Edge Oriented Histogram or Discrete Cosine Transform and gesture recognition.

The hand image of resolution 160*120 is first captured using Web-cam (Fig. 2). A hand region is then extracted from the captured image using blob centroid method. Then the Features are extracted from this image. Then this running image is compared with training images. Hand Gesture recognition system uses a closer match for the hand gesture. [4]

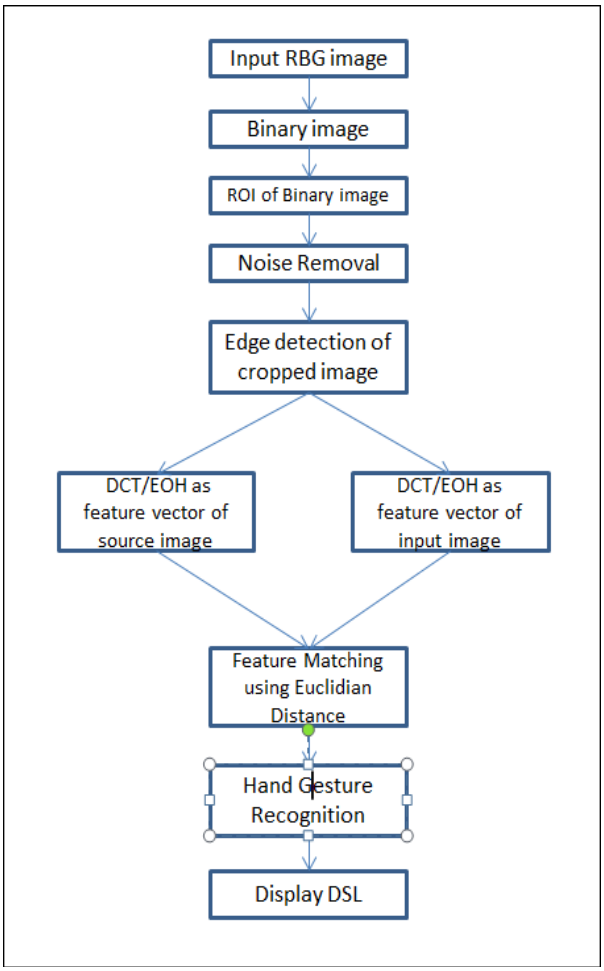

Fig 1: Flow of Hand Gesture Recognition System

Fig 2: Web Cam

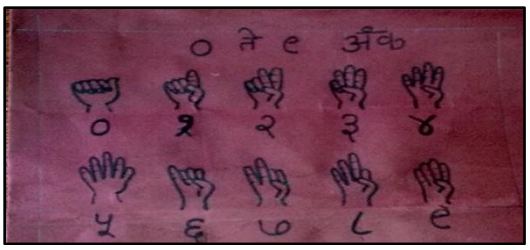

Fig 3: Devanagari Number System

Here in Fig 3 we have a sheet for Devanagari Sign Language Number system symbols for hand gesture.

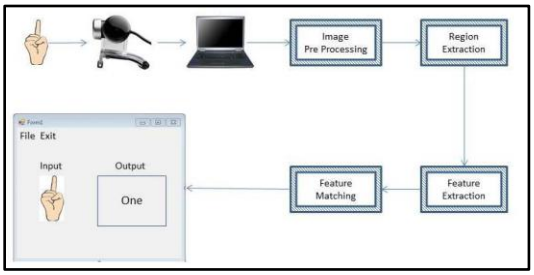

Fig 4: System Architecture

Figure 4 shows the architecture of the Static Hand Gesture Recognition System.

III. PROPOSED HAND GESTURE SYSTEM

The hand gesture is found using the number of active fingers. System Architecture shown in Figure 4 consists of five stages of Hand gesture recognition system.

A. Image Acquisition or Image Capturing:

The RGB image of size 160*120 is captured using a 16mp web-camera. Web-cam with higher configuration can be used for more accurate results.

Fig 5: Captured Image

B. Image Pre-processing:

Background image is subtracted from captured image. Background subtracted image is further converted to greyscale image. [10] Median Filter is applied on the grey scale image for salt and pepper noise reduction. This image is then converted to binary image.

Fig 6: Image after Pre-processing

C. Region of Interest Extraction:
Biggest continuous part of image (also known as BLOB-'Binary linked object') of size 80*60 is extracted from binary image. [9] Here we get the ROI. On this ROI image we applied canny edge detection algorithm to detect smooth edges. Again Gaussian filter is applied to this output image. Database of HGRS consist of these output images.

Fig 7: ROI extracted Image

D. Feature Extraction:
Feature extraction from extracted region reduces computation and works efficiently while matching feature vectors of real-time hand gesture images with feature vectors of training dataset.

Discrete Cosine Transform (DCT)
This is the formula to calculate Discrete Cosine Transform of 2-D image. The definition of the two-dimensional DCT for an input image A and output image B is:

$$B_{pq} = \alpha_p \alpha_q \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} A_{mn} \cos\frac{\pi(2m+1)p}{2M} \cos\frac{\pi(2n+1)q}{2N}, \quad \begin{matrix} 0 \le p \le M-1 \\ 0 \le q \le N-1 \end{matrix}$$

Where

$$\alpha_p = \begin{cases} \frac{1}{\sqrt{M}}, p = 0 \\ \sqrt{\frac{2}{M}}, 1 \le p \le M-1 \end{cases}$$

And

$$\alpha_q = \begin{cases} \frac{1}{\sqrt{N}}, q = 0 \\ \sqrt{\frac{2}{N}}, 1 \le q \le N-1 \end{cases} \quad (1)$$

M and N are the row and column size of A, respectively. [8]

Edge Oriented Histogram (EOH)
In this method, it counts the number of values in vector x that fall between theElements in the edges vector (which must contain monotonically non decreasing values).

D. Feature Matching:
Feature vectors of training images are stored in .mat files of MATLAB and feature vector of input hand gesture image are calculated at run time.
In this step feature vector of training image is compared with the database which is created earlier, using Euclidian Distance Formula.
[11] Euclidian Distance Formula for 2D image. In the Euclidean plane, if p = (p1, p2) and q = (q1, q2) then the distance is given by:

$$d(p,q) = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2} \quad (2)$$

Least Euclidian distance is used for recognition of perfect matching hand gesture. If the image matched with the database it will produce desired output.

IV. EXPERIMENTAL RESULT

The proposed hand gesture recognition system is tested with 20 test images. Images are acquired using 16mp web cam and system is developed using MATLAB 7.11. The result for different gestures can be calculated using average accuracy of the gesture results. Based on the proposed algorithm the recognition results are reported in Table 1.

Table 1: Comparative Study

Gestures	DCT	EOH
0	2	0
1	2	2
2	2	2
3	2	2
4	2	2
5	2	2
6	1	2
7	2	0
8	2	2
9	1	1
total	18	15

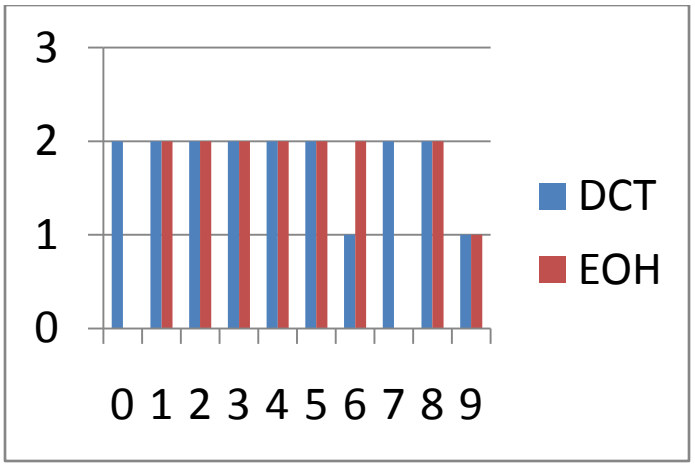

Fig 8: Graphical representation of results

V. CONCLUSION

This system works suitably in simple background for number system of the DSL. From the table no.1 we have concluded that DCT is a better technique of feature extraction as compared to Edge Oriented Histogram. The system gives better results with higher resolution web cameras. The segmentation of image gives better results if the light conditions are good.

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