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Real-Time Static Devnagri Sign Language Translation using Histogram

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***Abstract*— Sign language is nowadays widely used in hearing impaired people as communication media. It has different applications in many domains like HCI (Human Computer Interaction), Robot Control, Security, Gaming, Computer Vision, etc. Devnagri Sign Language Translation System using histogram matching algorithm is proposed in this paper; for recognizing Devnagri Sign Language (DSL) alphabets, the steps of algorithm are Image capturing, Image Pre-processing, Hand region extraction, Feature extraction and histogram matching. Image is captured in RGB color space using 8 Mega Pixel I-ball web camera mounted on top of the laptop. In image pre-processing morphological operation like blurring, noise removing is done. In region extraction stage, hand region is extracted and then edge detection is done using canny edge operator. The third stage is feature extraction; in this the histogram of cropped image is taken. The histogram obtained in this stage is compared with the histogram of image in the training dataset and similarity factor is calculated. Perfect match is obtained for highest similarity factor. In this paper hand gestures for Devnagri Sign Language (DSL) which includes 13 vowels ("swars") and 33 consonants ("Vyanjan") are taken. The result mainly depends upon illumination conditions and background texture and by considering all these possibilities our hand gesture recognition system gives up to 87.82% accuracy.**

***Index Terms*— DSL, Edge oriented histogram, Region extraction, Swars, Vyanjan .**

I. INTRODUCTION

Hand gestures are mainly of two types static and dynamic. Dynamic hand gesture recognition requires video processing whereas static requires image processing. Since complex background, illumination and changing lighting condition are the challenges in visual hand gesture recognition system so we have static hand gesture recognition as the main area of focus in this paper. Hand gesture has many applications like control of consumer electronics, interaction with visualization systems, control of mechanical systems, computer games, converting sign language into text for hearing impaired people. Sign language recognition is done in three different categories: 1) Glove based analysis 2) Device based analysis 3) Vision based analysis. Different countries are having different sign language which is used by hearing impaired people for communication. In India Devnagri Sign Language is used as an interactive language but a very little work has been done on it so far. This paper stresses upon translating Devnagri gesture into Devnagri script.

J.R.Pansare and S.H.Gawande proposed the hand gesture recognition system in complex background for American Sign Language. In this paper, combination of algorithm is used and it has highly helped us in our work. Here if the images are stored in database then they give more accuracy [1]. Lars Bretzner ,Ivan Laptev and Tony Lindeberg in their work demonstrated how a real-time system for hand tracking and hand posture recognition can be constructed combining shape and color cues by (i) Color feature detection in combination with qualitative hierarchical models for representing the hand and (ii) particle filtering with hierarchical sampling for simultaneous tracking and posture recognition[2].

P.V.V.Kishore, P.Rajesh Kumar, E.Kiran Kumar & S.R.C.Kishore proposed a system where gesture features are recognized by using Sobel edge operator, DCT (Discrete Cosine Transform) is used for feature extraction and neural network is used for classification [4]. Miss Sulochana M. Nadgeri, Dr. S. D. Sawarkar and Mr. A.D. Gawande proposed more effective method for Hand Tracking in their approach. It overcomes the drawback of mean shift algorithm by making it continuously adaptive mean shift (CAMSHIFT). The technique used here is color distribution for hand tracking but it failed to elaborate on lighting variation [5]. In the Work of Enrico Gutzeit, Matthias Vahl, Zhiliang Zhou and Uwe von Lukas, contextual information is used for extracting and calculating possible skin cluster. All skin clusters are tracked and verified over time. After verification best cluster is used for hand segmentation [6]. Nasser H. Dardas and Nicolas D. Georganas proposed a method where detection of hand tracking is performed in clustered background. Recognition of gesture is done by using bag of features and Support Vector Machine Algorithm without using any marker and gloves[7].

Baoyun Zhang, Ruwei Yun proposed an approach; it uses distance distribution feature to recognize the hand gestures which help overcome the intensity factor of hand gesture recognition caused by changing distance and direction of

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user's hand. So this method improves recognition rate and maintains a high detection rate with lower error rate. Methods used are 1) Skin Color Segmentation 2) Distance Distribution features 3) Color marker to grid the images [8]. To obtain a rotation invariant gesture image, a novel technique is proposed by Dipak Kumar Ghosh and Samit Ari. The first principal component of the segmented hand gestures is coincided with vertical axes. A localized contour sequence (LCS) based feature is used here to classify the hand gestures and a k-mean based radial basis function neural network (RBFNN) is used for classification of hand gestures from LCS based feature set [9].

Ravikiran J, Kavi Mahesh, Suhas Mahishi, Dheeraj R, Sudheender S, Nitin V Pujari proposed a method to recognize the number of fingers open in a gesture. There are three main phases 1) Edge detection done using canny algorithm, 2) Clipping is done to cut the unnecessary portion after edge detection, 3) Boundary tracing gives the final traced image and the detected fingertips are highlighted in red [10]. Archana S. Ghotkar, Rucha Khatal proposed a method for recognition of Indian sign language. In this paper the algorithm is divided into four modules as Real time hand tracking, Hand segmentation, Feature extraction, Gesture recognition. The Hand tracking and segmentation uses Camshaft method and Hue Saturation (HSV) color model while for gesture recognition, Genetic Algorithm is used [11].

The focus of our paper is to design a gesture recognition system that will automatically capture, recognize and translate the alphabets of Devnagri Sign Language into the corresponding text. The single handed gestures of Devnagri Language are to be recognized with highest accuracy in least possible time is our aim. The modules used are Image Capturing; Image pre-processing, Region Extraction, Feature Extraction, Feature Matching, and Pattern Recognition.

II. FLOW OF HAND GESTURE RECOGNITION

In this section, the flow of hand gesture recognition system algorithm is presented as shown in Fig 1. Flow contains different stages like capture image, process image, extract image, generate feature vector and histogram matching. After the image is captured then the further processing includes filtering of binary image. The extracted features obtained after binary filtration and feature matching are compared for both the input and training set images. An image is captured in RGB color space with resolution of 160 × 120 using an 8 megapixel webcam. The blob (binary linked object) image is stored at the size of 80 x 60.

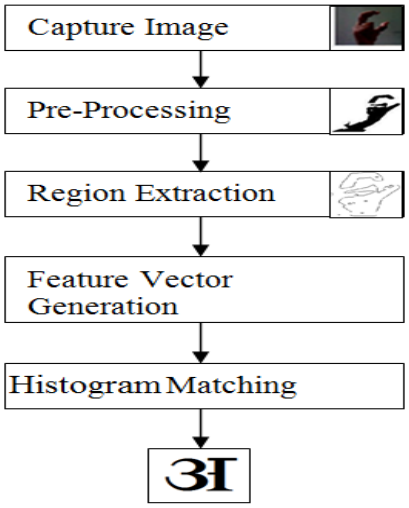

Fig. 1 Algorithm Flow

Fig. 2 DSL Alphabets

III. SYSTEM ARCHITECTURE

The Histogram matching method shows the following System Architecture.

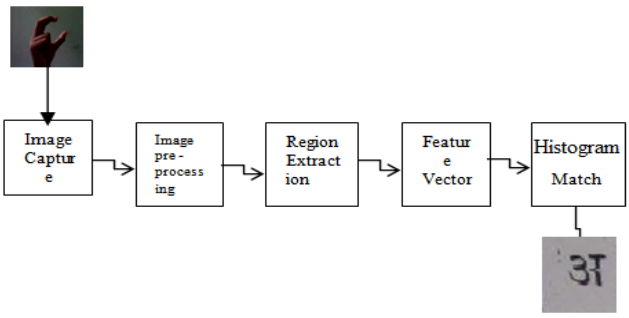

Fig. 3 System Architecture

1. Image capturing
2. Image pre-processing
   -Skin detection
   -Noise removal using filters
   -Morphological Operations
3. Region and Feature Extraction
4. Histogram Matching

These Stages are explained below:

A. *Image Capturing*

First image capturing is the main step in the system architecture of the DHGRS. The image is captured using 8 Megapixel webcam. Image capturing can be done by different colour space methods such as RGB, Gray and HSV; our system uses the RGB colour space model to capture the image and the image size is restricted to 160x120.

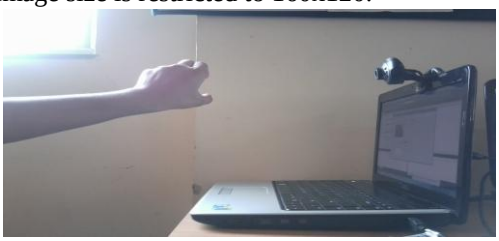

Fig 4 Image Capturing

An 8 megapixel i-ball webcam is used. Fig 5 shows the camera model used in the system.

Fig 5 8 megapixel i-ball Web Camera

B. *Image Pre-processing*

In the image pre-processing, RGB Image captured by Webcam is converted into HSV (Hue Saturation Value) image. Actual processing in the image pre-processing is as follows:

Skin Detection:

To identify and isolate the user's hand from a picture containing only his/her hand and maybe some other parts of his/her body. We used a color characterization method which is based on both RGB and HSV color models.

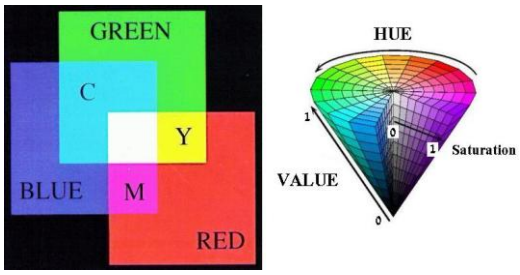

Fig 6 HSV Color Model

Noise removing:

Filtering of Gray image is done using Gaussian Filter for preserving edges and image smoothening.

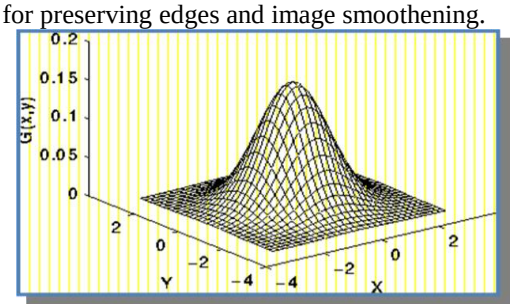

Fig 7Gaussian Filter

Morphological Operations:

Converted Bit-Map image is blurred so that this blurred image gets the exact edges of the image.

C. *Region and Feature Extraction*

In this stage, Region of Interest (ROI) is calculated. Using this step the actual part of image can be extracted by cropping or by using blob (binary linked object) function in MATLAB. The Gray image of size 160x120 is converted into 80x60 sizes and then stored in the database. Feature vector is formed using coefficients of the image histogram. The input to this module is a blob image and the output generated is an edge. Feature vectors of training images are stored in mat files of Matlab simulation software. The feature vector of input hand gestures is calculated at runtime.

$$(C_x, C_y) = \frac{1}{n}\left(\sum_{t=1}^{n} x_t, \sum_{t=1}^{n} y_t\right)$$

D. *Histogram Matching:*

Given a gray scale image, the histogram consists of its gray levels i.e. a graph indicating the number of times each gray level occurs in the image. By calculating maximum similarity values between histograms of training and the testing image the correct hand gesture can be recognized.

System will implement all the pre-processing steps mentioned above in system implementation design and will generate the output as shown below in Fig 8.

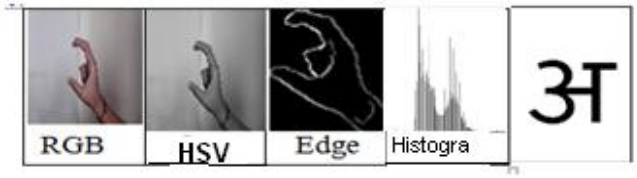

Fig 8 System Implementation

IV. Experimental Setup

The database contains the maximum of training samples. The webcam of 8 Megapixel is mounted on top of the monitor. Now the camera or monitor is adjusted such that it will make 90 degree angle with horizontal plane. The gesture should be taken in plane background only and the lighting condition should be such that there will be sufficient light on the input hand gesture and it is captured properly. The performed gesture has to be a static one since we are not considering the dynamic gesture; it will not be recognized. The distance of hand gesture from camera should be 30cms and in the same plane as that of the camera.

Fig 9 Experimental Setup

V. Experimental Result

The performance of project Real Time Static Hand Gesture Recognition System for Devnagri Script using Histogram is evaluated for 46 hand gestures (13 *Swar* and 33 *Vyanjan*). For this experiment about 10 samples of each alphabet are stored in the database. The captured sample is matched with stored sample and when the match is found it is converted into text (Devnagri letter) by using a predefined pattern of alphabet. According to the experimental results the obtained accuracy for various alphabets on an average is about 87.82%

अ	90.12%	ण	82.89%
आ	82.36%	त	87.31%
इ	89.65%	थ	88.85%
ई	86.87%	द	89.95%
उ	89.25%	ध	99.36%
ऊ	87.01%	न	81.64%
ए	91.58%	प	80.93%
ऐ	87.56%	फ	88.63%
ओ	98.26%	ब	88.95%
औ	88.84%	भ	96.38%
क	99.50%	म	82.57%
ख	87.59%	य	86.89%
ग	87.25%	र	80.45%
घ	88.98%	ल	80.95%
च	89.36%	व	87.68%
छ	96.68%	श	85.37%
ज	88.60%	ष	80.74%
झ	90.35%	स	84.31%
ट	90.78%	ह	80.99%
ठ	81.57%	ळ	87.45%
ड	90.36%	क्ष	80.98%
ढ	89.67%	ज्ञ	88.76%

Fig 10 Experimental Result of each alphabet

The graph below shows the percentage result of each gesture

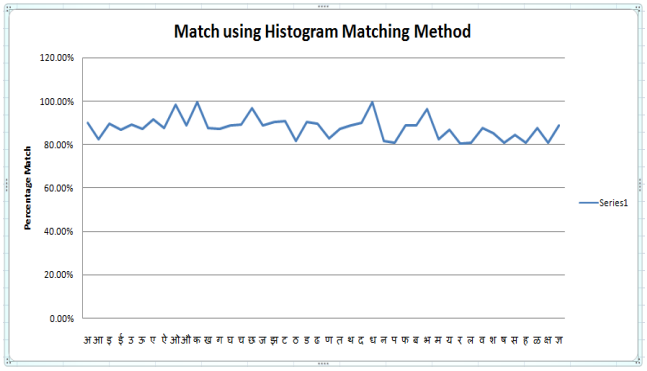

Fig 11 Graphical Result

From above experimentation it is observed that the results are more accurate with 8 mega pixel iball web cam as compared to 1.3 megapixel USB web camera and 1.3 megapixel LifeCam. The Web camera fixed at one position is mounted on top of monitor shows good results for RGB color space images captured from 30 cm distance. Total 460 samples of hand gestures are collected having 10 samples per gestures for 46 alphabets in different lightning conditions with different hand shapes and sizes. The experiment shows that the least Euclidian distance identifies perfect matching of hand gesture and system achieves 87.82% accuracy. Hand gesture recognition rate is suitable for DSL alphabets with meaningful words and sentences.

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