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DYNAMIC HAND GESTURES RECOGNIZATION BY USING MULTI LEVEL CLASSIFIER (KNN SVM)

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Abstract: This paper mainly focus on detecting and tracking bare hand in cluttered background using and hand postures contours comparison algorithm after face subtraction skin detection, and recognizing hand gestures using Principle Components Analysis (PCA).a set of hand postures images with different scales, lighting and rotation conditions are trained. the most eigenvectors of training images are calculated, then the training weights are determined by projecting each training image onto the most eigenvectors. In the testing stage, for every frame encapsulated from a webcam, the hand gesture is detected based on proposed algorithm, then the small image that contains the detected hand gesture is projected onto the most eigenvectors of training images to form its test weights. Finally to recognize the hand gesture. the minimum Euclidean distance is determined between the test weights and the training weights of each training image.The system is tested with the controlled and uncontrolled database and shows 90% accuracy with controlled database and 84.83% with low brightness images.

1. INTRODUCTION:

Gestures of any body part used to convey the meaningful information based particular part movement. Communication based on gestures has been widely used by humans to express their thoughts and feelings.. Gestures have been classified in two categories static and dynamic. Gestures recognition refers to the process of identifying gestures performed by human so that machine can perform the corresponding action . Static gestures refer to still body posture and dynamic refers to movement of body part. Gestures can be performed with any body part like head , face, arms, hands, etc. but most predominately we use hand to perform gesture like we wave hand to say 'good bye'. Hand gestures have been widely used for many applications like human – computer interaction (HCI), robotics, sign language, human machine interaction, TV interaction etc. With the advancement of technology, human robot interaction (HRI) has become an emerging field in recent years. Hand gestures can be used to give commands to the robot for large number of applications.Now-a-days, in medical sciences human robot interaction using hand gestures has widely been used.. But still challenges regarding robustness and efficiency are to be considered. Hand Gestures Recognition techniques have been divided into two categories- Sensor based and Vision Based recognition. Sensor based recognition collects the gesture data by using one or more different types of sensors. The data is collected by the sensors which are attached to hand and collected data is analyzed for gesture recognition. Data glove is an example of sensor based gesture recognition.Vision based techniques uses one or cameras to capture the hand images. cameras used for capturing image can be classified as stereo cameras, monocular cameras, fish eye cameras, time- of –flight cameras,. infrared cameras, etc. There are various image processing algorithms to get hand posture and movement of hand for Vision based techniques. Some vision based techniques uses colored markers to get the position of hand. But the vision based recognition also has some limitations that it is affected by illumination changes and cluttered backgrounds. Vision based techniques are further divided into two categories – 3D model based and Appearance base recognition. The 3D hand image and input frame are get compare with 2D projection to search kinematics parameters of Model based approaches uses 3D hand model.3D model are further divided into volumetric 3D recognition and skeleton 3D recognition. Because of the complexity of 3D model it is not preferred.Appearance based techniques are used to extracting features from the visual appearance of the image and compare it with already defined templates.

The features extracted from the image are shape based features that can be geometric or non geometric. Geometric features include- position of fingertips, location of palm, centroid, orientation, direction,etc. Non-geometric features include color, silhouette and textures, contour, `edges, image moments, Fourier descriptors, Eigen vectors, etc. Some techniques uses skin color model [14] to extract skin colored pixels. Other techniques HOG features, SIFT features, etc. Appearance based technique is preferred over model based technique because of the complexity of the model based techniques. The basic step of hand gesture recognition is to localize and segment the hand from the image. Various techniques are available for hand segmentation. The simple and popular technique is skin color model, it is used to get the skin pixels in the image but it has some limitations that skin color of different person can vary and background image can also contain the skin pixels Other techniques are thresholding which divides the image into two regions foreground and background based on color, depth etc. Some researcher uses background subtraction for segmenting the hand.In our approach keeping in view the limitation and simplicity of skin color model we will combine it with thresholding for hand segmentation. Skin color segmentation can be applied on any color space-RGB, HSV, YCbCr, YUV, etc. Every color space has its own benefits. We will use YCbCr color space for skin color segmentation. For gesture recognition HMM, SVM, Nearest Neighbor classifier, neural network, PCA, finite state machine (FSM) etc .In our approach vision based hand gesture recognition technique is proposed using a database-driven approach based upon skin color model and thresholding along with an effective template matching using PCA which will used for controlling robotics hand in surgical applications and many other similar applications.

II. LITERATURE SURVEY:

2.1. Fahn, C.S,Sun, H, "Development of a fingertip glove equipped with magnetic tracking sensors", *Sensors 2010*,vol. 10, pp. 1119–1140, 2010

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The part of detecting the face of user while logging into the system, is performed by using haar features and adaboost. And the use of component analysis and Eigen face is done for recognizing the face i.e., authenticating the user. For detecting the hand of user, the technique of skin color detection is used by implementing the YCbCr color spaces. For tracking the hand, steady adaptive mean shift-Cam shift is used. And finally PCA (principal component analysis) method is used to recognize and track the hand gesture particularly. The proposed system here is used mainly in a home environment, in which initially few faces of the members are stored as data. That is why better results are achieved on small scale recognition of faces. According to, many other techniques and methods are there that can be used for such a system. Some of them are neural networks, support vector machine, etc. Among all of these, PCA is supposed to be faster in analyzing and recognizing the users. a scheme is Proposed for recognition of hand gestures based on a model which was dependent on a skin color model approach along with the scheme of threshold approach. It included an effective template matching. This could be used on a large scale in robotics effectively and also in same other applications. It inculcated the same method as. But there are some differences in the phase of tracking of hands. Initially in, segmentation of hand region is done by using the YCbCr color model, and then the Otsu threshold is applied. This application of Otsu threshold is to separate the background from the foreground. And initially PCA is applied for template matching. This system shows 90% accuracy with controlled database and 84.83% accuracy under low brightness images.We have developed an efficient mechanism for real-time hand gesture recognition based on the trajectory of hand motion and the hidden Markov models classifier. In the system, we divide our movement into single or both hands, one hand have been defined four basic types of directive gesture such as moving upward, downward, leftward, rightward. Then, two hands have twenty-four kinds of combination gesture. the most natural and simple way are applied to define eight kinds gestures in our developed human-machine interaction control system so that the users can easily operate the robot. Experimental results reveal that the face tracking rate is more than 87% in general situations and over 74% when the face suffers from temporal occlusion. The efficiency of system execution is very satisfactory, and we are encouraged to commercialize the robot in the near future.

2.3. FPGA Based Real Time Human Hand Gesture Recognition System:

In our society we have people with disabilities. Even if the technology is developing day by day no significant developments are undertaken for the betterment of these people. We have thus planned to create a product as a part of our project. In future it may become a widely used technology for helping the handicapped people. We aim for developing an FPGA based hand gesture recognition system for establishing communication between the deaf and the dumb people.The main platform in the project is FPGA which is Field Programmable Gate Array. It helps to generate a real time system which can decode the gestures. It

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makes the system fast and efficient. Image acquisition is done with a digital camera. The acquired image is then processed using efficient algorithms. Edge detection and feature extraction is done to correctly identify the gestures. The images of the required gestures are all stored and then it is compared with features extracted from the acquired image. Accordingly audio and visual output is generated. This will help in establishing an efficient communication between the deaf and the dumb. We have almost achieved our aim in this project. We have successfully implemented image processing algorithms in FPGA. We have realized UART module through FPGA.

III. EXISTING SYSTEM:

In this section we will discuss our proposed methodology step by step

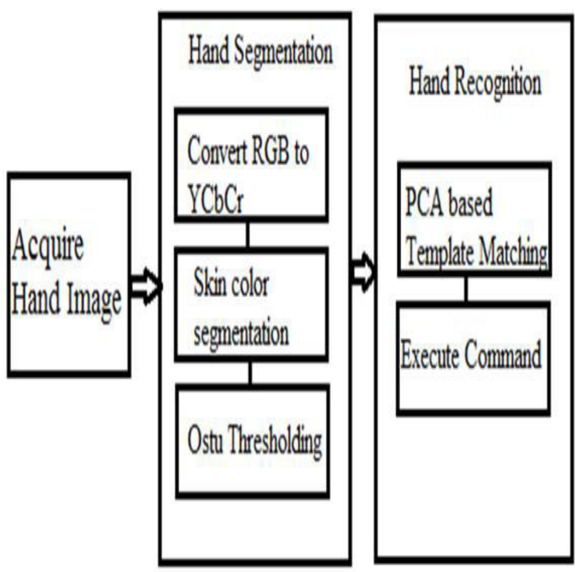

Fig.1FlowDiagram of proposed method

3.1 IMAGE ACQUISITION:

Images are acquired using the 13 megapixel real-aperture camera in controlled background as well as by varying the lightning conditions.

3.2 HAND SEGMENTATION:

The main and basic step in hand gesture recognition is to segment the hand from the whole image so that it can be utilized for recognition. In our proposed color skin color segmentation is applied to segment the hand. As skin color of different person can vary and background image can also contain the skin pixels so after skin color model Otsu Thresholding is applied to remove the background

3.3 Conversion from RGB to ycbcr:

The proposed skin color segmentation in applied to YCbCr color space. So first of all RGB color space is converted to YCbCr color space. Y represents the luminance and Cb and Cr represents chrominance. The RGB color space is converted to YCbCr color space using the following equation:

$$Y = 0.299R + 0.587G + 0.114B$$
$$Cb = (B - Y) * 0.564 + 128$$
$$Cr = (R - Y) * 0.713 + 128$$

3.4 SKIN COLOR SEGMENTATION:

The skin color segmentation is used to classify the pixel as skin pixel or non-skin pixel. As or hand is connected component made of skin pixels we will get the hand after

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skin color segmentation. Steps for skin color segmentation:

1. The first step in skin color segmentation to specify the range for the skin pixels in YCbCr color space.

$$[R_{Cb}, R_{Cb}'] = [77, 127] \quad \& \quad [R_{Cr}, R_{Cr}'] = [133, 173]$$

2. Find the pixels (p) that are in the range defined above :is lower and upper bound for Cb component.

$$R_{Cb} \leq Pixel\ value(Cb(i,j)) \leq R_{Cb}'$$
$$R_{Cr} \leq Pixel\ value(Cr(i,j)) \leq R_{Cr}'$$

3. Summation of all the pixels in the above step belongs to Region of interest i.e hand.

$$ROI = \sum p(i,j)$$

After Skin color segmentation we will the hand but may be some other pixels in the background also. To remove that background pixels we will use Otsu Thresholding.

3.5 OTSU THRESHOLDING:

Thresholding is used to separate the object from its background by assigning pixel to either background or foreground based on threshold value. In our proposed system hand is in foreground. Otsu threshold is a global thresholding method which chooses threshold that minimizes within class variance.1. Calculating threshold value: In MATLAB there is a function Gray threshes (I) which calculate global threshold value using Otsu Threshold. TH = gray thresh (I)

2. Convert Image pixel values into binary value according to THR. Then

$$g(i,j) = \begin{Bmatrix} 1 \ \ if\ p(i,j) \geq T \\ 0, \ \ otherwise \end{Bmatrix}$$

3.6 GESTURE RECOGNITION:

One of the important technique of recognition is template matching in which a template to recognize is available and is compared with already stored template. In our approach PCA method for feature extraction and matching is used. Principal Component Analysis: PCA is used to reduce the dimensionality of the image while preserving much of the information. It is the powerful tool for analyzing the data by identifying patterns in the dataset and reduces the dimensions of the dataset such that maximum variance in the original data is visible in reduced data. PCA was invented by Karl Pearson in 1901. It works by converting set of correlated variables to linearly uncorrelated variable called principal components. Principal components are calculated by computing Eigen vectors of covariance matrix obtained from the group of hand images. The highest M eigenvectors contains the maximum variance in the original data. These principal components are orthogonal to each other and the first component is in the direction of greatest variance.

3.7 Mathematical Model for PCA: The PCA approach has 2 stages: Training and Testing

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stage. In the training stage the Eigen space in established using training images of hand gestures and these images are mapped to the Eigen space. In the testing stage the image to be tested is mapped to same Eigen space and is classified using distance classifier.

IV. PROPOSED SYSTEM:

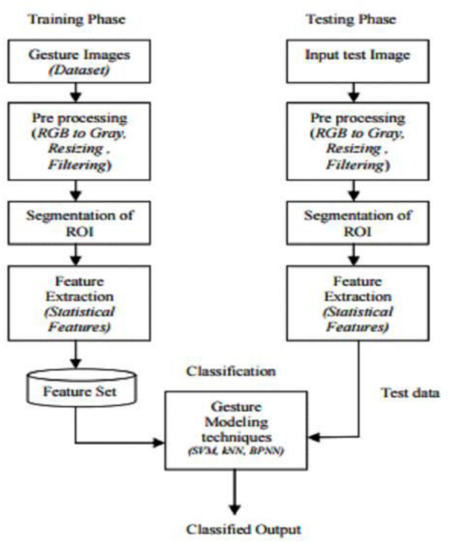

Fig2: proposed Block Diagram

4.1. KNN METHOD: KNN algorithm is used for classification in this research because it is the simplest machine learning algorithm and it is very easy to implement. It is a technique based on the closest training samples in the feature space. When the test sample is given, the distance between the test sample and all the training samples are first calculated using Euclidean distance. Then, the 'k' nearest neighbours which have minimum distance are determined. Once the nearest neighbours are found, the test sample is classified according to the majority votes of the nearest neighbours. k-NN Training involves storing the input feature vectors and their corresponding labels. In the testing phase, the unlabelled query image is simply assigned to the label of its k nearest neighbours. The k-NN classification process is shown in Fig. 4. for different values of k.

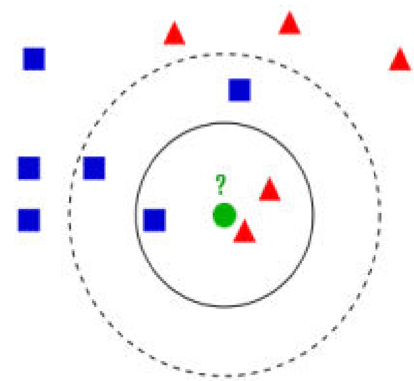

Fig 4 knn Classifier

Typically, the test data is classified based on the majority labels of its k nearest neighbours. For k=1, the class label of test image is assigned as the class of its nearest object If there are only two classes, k must be an odd integer. For multiclass classification, ties occur even though k is an odd integer. The Euclidean distance 'd' between the training feature vector X=(x1,x2, ……xn) and the test feature vector Y= (y1,y2,…..yn) of fixed length is calculated using the following equation.

$$d = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2 \dots . (x_n - y_n)^2}$$

The accuracy of k-NN classifier is found by choosing different values of k. We obtained the better classification accuracy of 96% at k=5. If the value of k is increased further, there is no significant improvement in the performance.

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4.2. SVM The classification: SVM The classification of hand gesture images is performed using the SVM classifier by employing one-against-all (OAA) approach. Support Vector Machine is a powerful machine learning technique for classification and regression. It is a supervised learning machine where its support vectors and kernels are employed for many learning tasks. By choosing the appropriate kernel functions, different tasks could be performed in various domains. A support vector machine constructs a separating hyper plane in a high dimensional space. SVM is used to classify the group of test data as one of the ten gestures, depending upon the feature values. In this research, classification is done for ten categories of gesture images. Therefore, ten binary SVM models are created where each SVM model is trained to distinguish one class of images from the remaining nine classes. For example, the SVM classifier for class one data (number zero) is assigned +1 and the remaining nine classes (numbers one, two, three, four, five, six, seven, eight, nine) are assigned as -1. Other SVM classifiers are constructed on the same way. Ten SVMs are trained independently for classifying ten classes of hand gestures. When the test or query image is given, it is classified based on the trained SVM models

Hard-margin

If the training data are linearly separable, we can select two parallel hyper planes that separate the two classes of data, so that the distance between them is as large as possible. The region bounded by these two hyper planes is called the "margin", and the maximum-margin hyper plane is the hyper plane that lies halfway between them. These hyper planes can be described by the equations

$$\vec{w} \cdot \vec{x} + b = 1$$

and

$$\vec{w} \cdot \vec{x} + b = -1.$$

Geometrically, the distance between these two hyper planes is so to maximize the distance between the planes we want to minimize. As we also have to prevent data points from falling into the margin, we add the following constraint: for each either these constraints state that each data point must lie on the correct side of the margin. This can be rewritten as: We can put this together to get the optimization problem:"Minimize subject

$$\vec{w} \cdot \vec{x}_i + b \geq 1, \text{ if } y_i = 1$$

or

$$\vec{w} \cdot \vec{x}_i + b \leq -1, \text{ if } y_i = -1.$$

To for "The and that solve this problem determine our classifier, An easy-to-see but important consequence of this geometric description is that max-margin hyper plane is completely determined by those which lie nearest to it. These are called support vectors.

Soft-margin

To extend SVM to cases in which the data are not linearly separable, we introduce the hinge loss function, This function is zero if the constraint in (1) is satisfied, in other Images, if lies on the correct side of the margin. For data on the wrong side of the margin, the function's value is proportional to the distance from the margin. We then wish to minimize where the parameter determines the tradeoff

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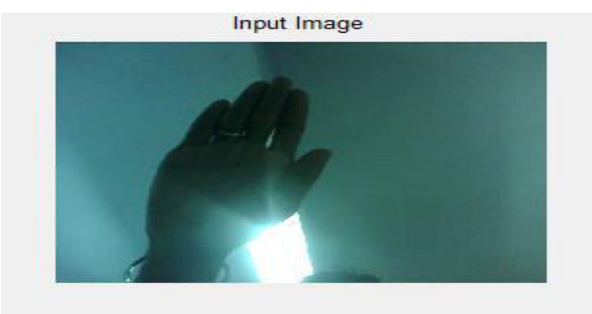
between increasing the margin-size and ensuring that the i.e. on the correct side of the margin. Thus, for sufficiently small values of , the soft-margin SVM will behave identically to the hard-margin SVM if the input data are linearly classifiable, but will still learn a viable classification rule if not.

Feature Extraction Stage

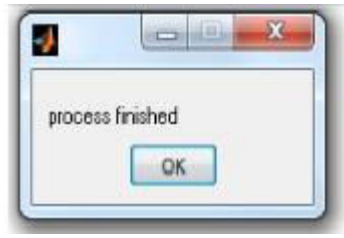
Feature extraction is the process of getting useful information from the Image/character image. The information will be used to generate modules to train the classifier and to be used for classification purposes. In general there are two categories of features extracted, structural and statistical features. Choosing the right feature extraction method might be the most important step for achieving a high recognition rate . However, in some cases the combination of several features extraction types could be a wise decision to enhance the overall recognition performance.

V.SIMULATION RESULTS:

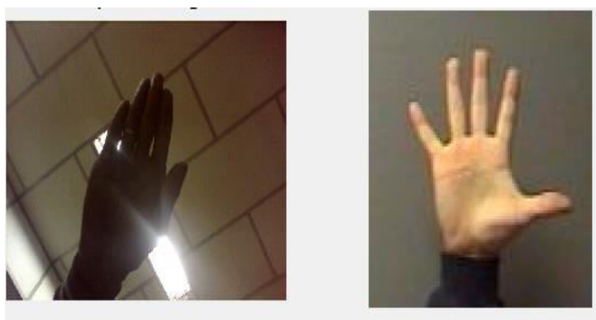
Image acquisition:



Preprocessing image:



Output



CONCLUSIONS: In this paper the hand gesture recognition system is developed using skin color model, Otsu thresholding and PCA. The SVM system is tested in controlled background and indifferent lightning conditions. The database collected in the ideal conditions has proved to be the most efficient database in terms of accuracy and gives 68% accuracy and when the lightning conditions are changed the accuracy decreases as compare to the previous one. The system shows 74.43%

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with low brightness images.The hand images have been obtained for the purpose of human computer interactions for the operation theatre robots, which must understand the hand language in order to take the actions. Our research empowers the medical experts to pass the instruction to the robotic hands remotely to add the accuracy in the operations. But the proposed model is not capable of working with the images containing hands of other than skin color. The proposed model does not evaluate the images clicked in other light colors where the hand gestures has been clicked and the model work only with static gesture .In future the system can be upgraded to support dynamic gestures and an application for controlling medical operations can be developed using the system.

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