FACE RECOGNITION FROM A GROUP PHOTOGRAPH USING SKIN COLOR MODELS WITH PCA

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Abstract: Face recognition can be realized as identification of a person from his facial features that can be accomplished by the application of various computational algorithms. Face recognition system is one of the most cost-effective methods for the use of computing resources in comparison to the authentication and identification. This work is done in two parts that is training and testing phase. In this paper, group image as taken as input image and face segmentation is done on the basis of skin color models and then preprocessed to remove the additional noise. The face detection is improved by using maximum likelihood function and features are extracted by using Principle Component Analysis method. This method also reduced the dimensionality and provides effective result. After this process testing phase is started in which captured image saved in the database and compared for detection. In this work the comparisons of different models like HSV +PCA, Binarized RGB +PCA and YCbCr +PCA is done and for validation of proposed method with ORL and Yale database. The accuracy and Hit rate of the proposed method represents the effectiveness and efficiency of the model.

Index Terms **- Face Detection, Skin Color Models, PCA, ORL, Yale, Face Recognition**

I. INTRODUCTION

Face detection engage in recreation for face recognition functions such as video supervision, security system, attendance monitoring, human computer interaction, biometric identification and others [1]. Face recognition is one of the best and least invasive biometrics as compared to iris and fingerprints recognition techniques [2]. Biometric system consist two types of characteristics i.e. behavioral and physiological to confirm person's identity. Voice, handwriting etc are the parts of behavioral characteristics and iris, fingerprint, retina, palms of hand and face recognition are the parts of physiological characteristics. Face recognition is an appropriate method among all others biometric techniques for person's identification and authentication. Human face explains maximum information about person's identity. Face feature gives the unique identification to the human being. For verification and identification in image processing, face plays a vital role.

Among all identification techniques face recognition is the economical method. In human appearance the main interruptions are aging effect, beards, eye glasses, hair styles that becomes the drawback in face recognition system. Face detection, characteristic removal and categorization/pattern recognition are three main steps in face recognition system. For efficient recognition, face detection has highest dependable and most important part in recognition system. Fig.1 shows face detection process using color space models.

Fig.1 Face Detection Process using Color Models

Face detection is the primary pace of recognition process that improves the accuracy or high detection rate for all recognition applications. In detection process the face part is extracted as of the given image [3]. There are lots of face detection algorithms but in this work skin color models are used for detection process. On the basis of skin segmentation face part is detected from given input image. Skin segmentation is based upon the color space models. There are different kinds of color models i.e. HSV, YCbCr, RGB, YIQ, YUV etc. In this work, Binarized RGB, HSV and YCbCr space color models are used.

In recent years, skin color detection becomes the challenging task for the researchers. It is so, because there are various methods, but it is quite difficult to find out the efficient algorithm which would have greater accuracy in various conditions. Various facial expression, pose variation, variant lighting condition, are the main pitfall in recognition process [4].

II. SKIN COLOR MODELS

In recent years, skin color models have been considered as the most powerful methods for the skin segmentation. To avoid the inclusive search skin color models are used for detection process. In this work Binarized RGB, HSV and YCbCr have been used [4] and there explanations are as follows:

(i) Binarized RGB Color Model

RGB contains RED, Green and Blue prime color. By combination of all these primary components of RGB color models all others color can be obtained. Red, Green and Blue constituent are powerfully interconnected so that it is not preferred for various image detection algorithms. It shows non uniform characteristics because the mixing of chrominance and luminance information [5]. Fig.2 shows RGB color model.

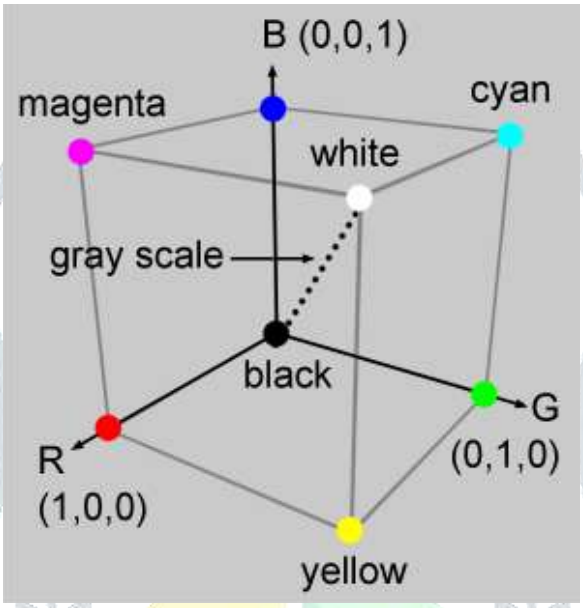

Fig.2 RGB Color Model

So image binarization technique improves the performance of image processing. Image binarization converts the images into two levels of image pixels i.e. black and white. Segmentation of image into foreground and background text, image binarization is very essential. Thresholding is the best way for binarization of image. If the thresholding is not correctly assigned then it degrades the performance and accuracy of recognition applications [6].

(ii) HSV Color Model

Hue, Saturation and Value are the abbreviated form of HSV. The most apparent feature of this color space is Hue. “Hue” shows the property of unadulterated color representation, “Saturation” explains how by white light is diluted with hue and “Value” gives an achromatic conception of color strength. Fig.3 shows HSV color model.

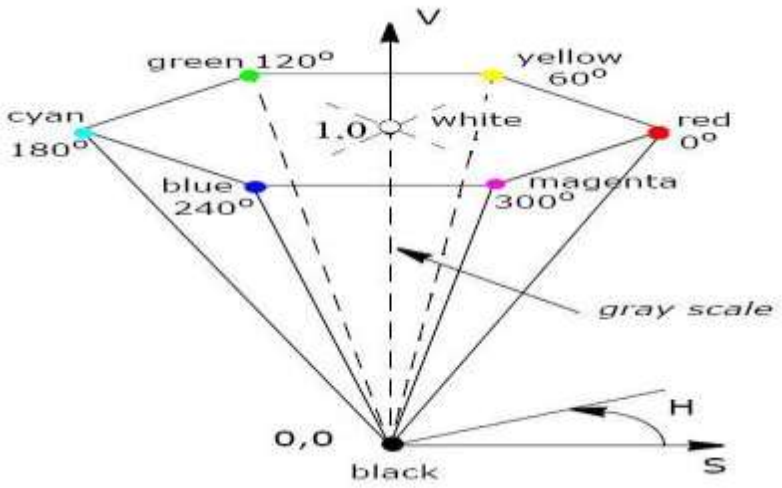

Fig.3 HSV Color Model

Saturation represents the range from 0 to 1. Color represent its rich look if it's more saturated and less saturated explain the more grayish of its looks. Value, also known as luminosity or brightness, represents how light or how dark a color is. When V = 0, black color appears and when V = 1, white color appears. So, color shows its lighter phase when the value of V is maximum and color shows its darker phase when the value of V is minimum. Hue model has three components to represent a color, as like the RGB model [7].

(iii) YCbCr HSV Color Space

The YCbCr represents the color by luminance, Y, and chrominance as the difference between two colors, Cr and Cb using the following set of equations [7].

$$Y = 0.299 + 0.587 + 0.114 \quad (1)$$

$$Cb = B - Y \quad (2)$$

$$Cr = R - Y \quad (3)$$

Removal of non skin area from the given images that consist (skin + non skin) pixels YCbCr color space is more efficient tool as compare to other color space models . The YCbCr space is perceptually uniform, and explains the solidity of the skin sharing cluster by separating the luminance and chrominance. There are different events to be considered but human skin outlines a quite tight clustering color space. Hence chromaticity information of YCbCr space might be helpful for learning the likelihood of skin color [8]. Fig.4 shows YCbCr color model.

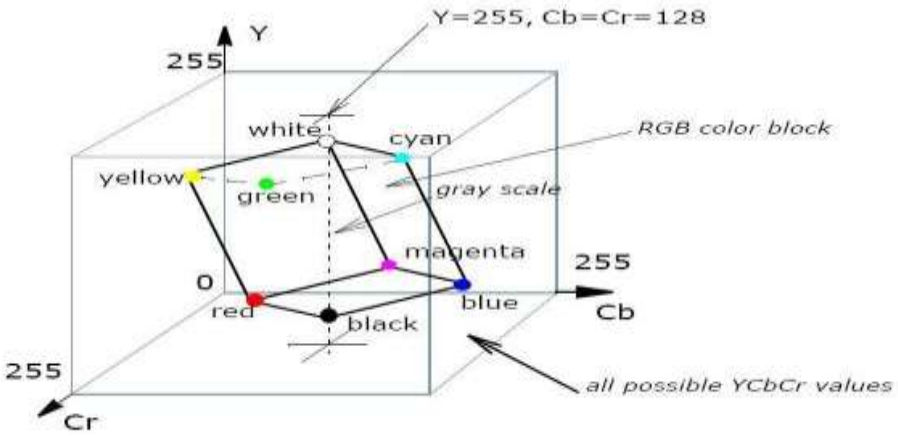

Fig.4 YCbCr Color Model

III. PROPOSED WORK

In this paper, group image is taken as an input image and after that the image is segmented using YCbCr, HSV and BRGB skin color models. The face detection is improved by using maximum likelihood function. Intensity thresholding helps to find skin likelihood function that further improves the recognition rate. The proposed work is to enhance the accuracy of the recognition system for images using the three different color models followed by Principal Component Analysis [9]. The comparison is done on the basis of accuracy and hit.

In proposed methodology given input image is segmented on the basis of three color models i.e. BRGB, HSV and YCbCr models. The next step is to remove the "salt and pepper" noise is reduced by performing the image aperture operations and for holes filling in the faces closing operations are used. Fig.5 shows the projected face recognition system.

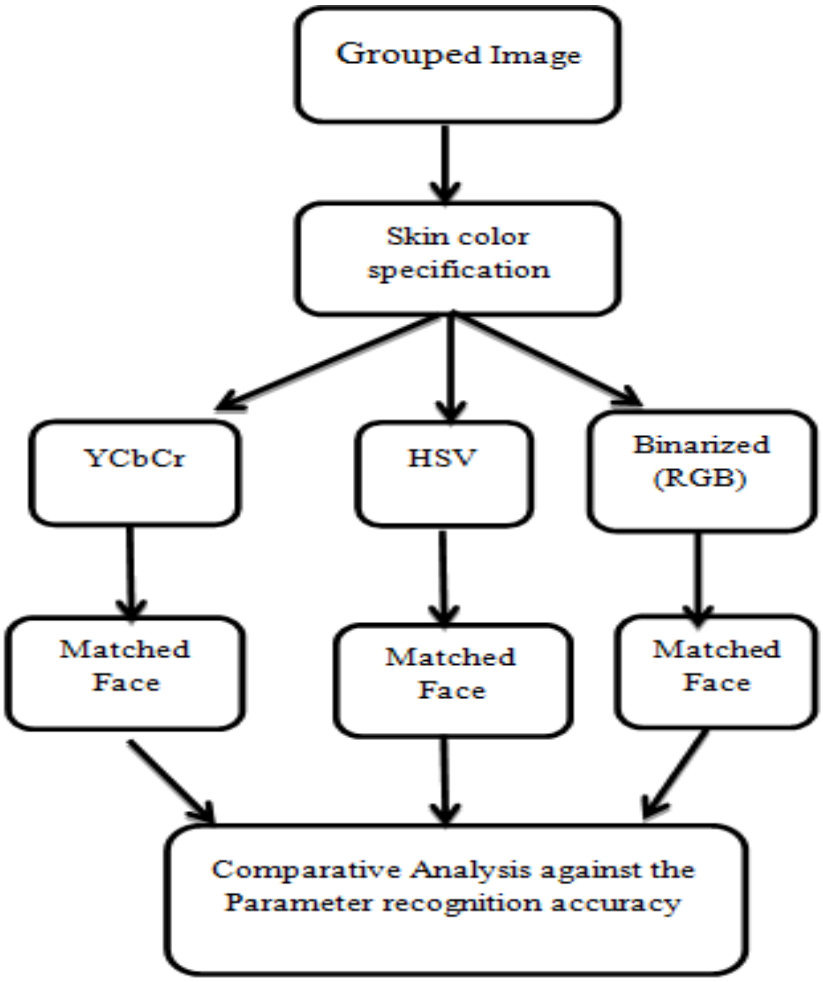

Fig.5 Projected Face Recognition System

For intensity, the dynamic threshold is set, which find maximum skin likelihood through Expectation Maximization algorithm. In image, binarization technique improves the performance of image processing. Thresholding is the best way for binarization of image. If the thresholding is not correctly assigned then it degrades the performance and accuracy of recognition applications [10]. For further morphological processing, the cleaner mask image is generated which is having goal to pinpoint face centroids. Finding regions by the face template matching, which templates are similar to image. Hence, template generating is important because it will look like a face. The in the image, the non-face regions is rejected should be such in the template. The 50x50 pixels is the actual template size. For smaller faces, the low correlation is yielded by the larger templates for smaller faces, while for both the small and large faces the high correlation is yielded by the smaller template. At last the template image is recognized by the eigenfaces [11]. The recognition process has been implemented in matched face block diagram and illustrate in Fig.6.

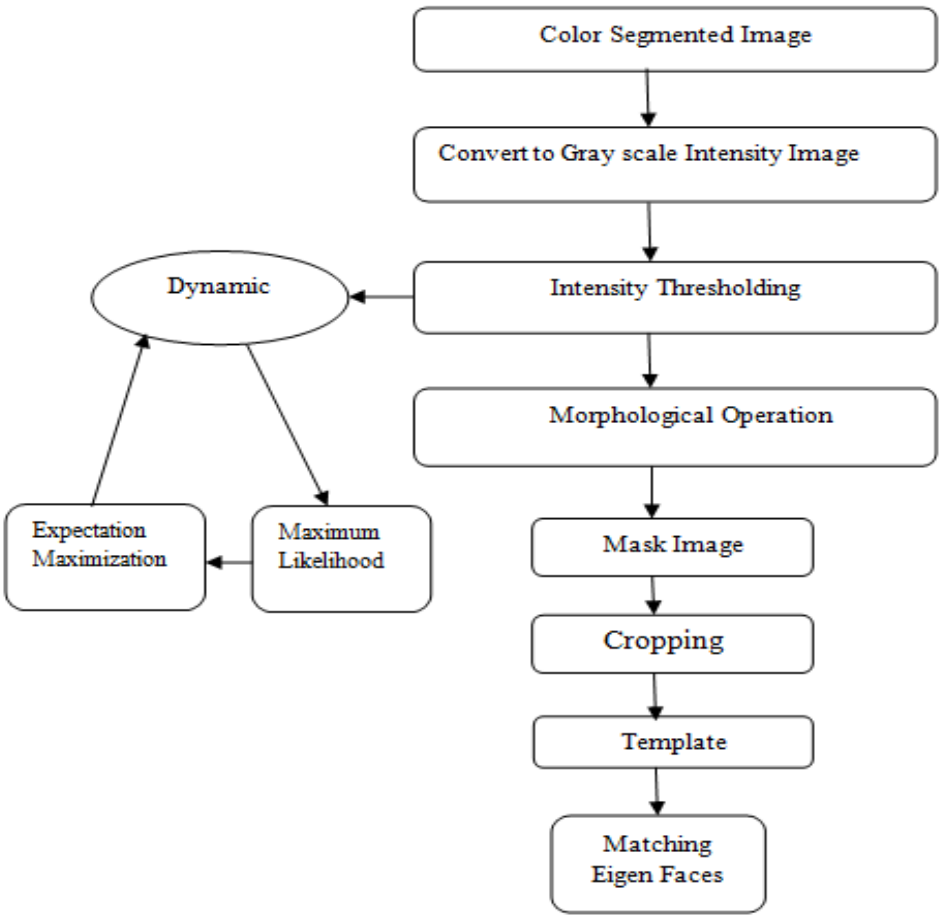

Fig.6 Block Diagram of Matched Face

There are various kinds of face recognition techniques. These techniques are classified into two group namely appearance based (holistic) and texture based (local) techniques. Linear Discriminate Analysis (LDA), Principal Component Analysis (PCA) [12] and Independent Component Analysis (ICA) [13] are commonly used holistic techniques and Local Binary Patterns (LBP) and Local Derivative Pattern (LDP) [14] texture based techniques. Principal Component Analysis (PCA) one of the most well-liked techniques used for image identification with dimensionality reduction, which is recognized as Karhunen-Loeve Transform or Hotelling Transform [15]. It was developed by Turk and Pentland [16] in 1991 using eigenspace projection. The objective of PCA is to lower down the dimensionality of data into reduced dimensional feature space that describe the data efficiently.For testing of the various face detection and recognition methods, we created our own face data base which comprises of 3 persons in frames with different postures and expressions. Fig.7 shows the group images with different postures and expressions.

Fig. 7 Group Images with Different Postures

The range of each image is 512x512, with 256 grey levels for every pixels stored in jpeg format. These images are captured with different postures such as: left, right, up, down etc. The preview of the sample images is illustrated in Fig.8.

Fig.8 Sample Images of our own Created Data Base

Various skin detection techniques based on color spaces: HSV, YCbCr and Binarized RGB are used to obtain the specified skin region of the faces from above mentioned images. The sample images of these models are illustrated in Fig.9.

Fig.9 Sample Images of BRGB, HSV and YCbCr Color Models

For testing of different face detection cum recognition approaches, 50% images are measured as training images and remaining images taken for testing of the methods. We have implemented and tested three different skin detection techniques associated with Principal Component Analysis algorithm for face recognition such as: YCbCr + PCA, HSV +PCA and Binarized RGB +PCA on own created face database and accuracy is obtained for each approach. Comparison of accuracy for each implemented approach has been illustrated in table 1.

Table 1 Result of Various Face Detection and Recognition Approaches

Approaches	Total Images	Hit	Accuracy
YCbCr	30	29	**95%**
HSV	30	21	**70%**
BRGB	30	14	**45%**

The graphical representation of comparative analysis presented in table 1 of our own created database has been demonstrated in Fig.10 which clearly shows that the maximum accuracy is obtain by the YCbCr + PCA detection and recognition system.

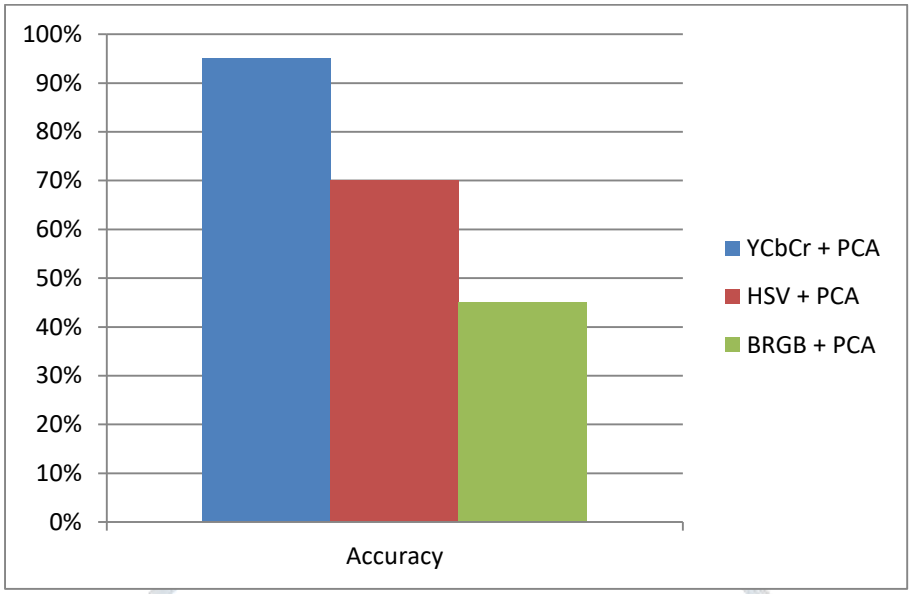

Fig.10 Comparison of Accuracy for Various Face Detection and Recognition Approaches

The graphical representation in Fig.11 clearly shows that there is maximum number of miss hit in BRGB + PCA system and maximum hit is on the YCbCr + PCA system.

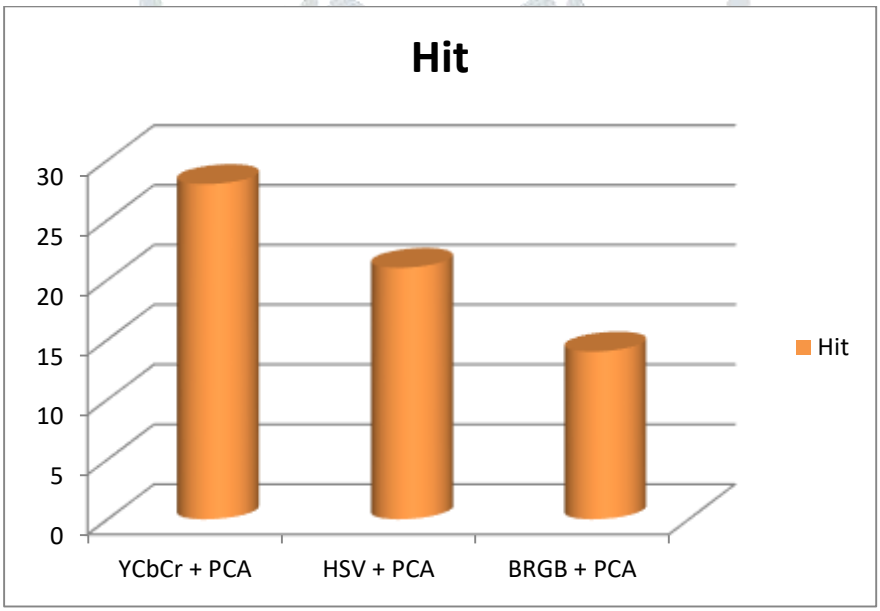

Fig. 11 Comparison of Hit for Various Face Detection and Recognition Approaches

IV. RESULT AND DISCUSSION

The evaluation of implemented face recognition approaches will focus on their performance of recognition under various conditions for different data sets. A series of tests will be performed to compare the accuracy of the methods on ORL and YALE database. In this work the testing of various face detection cum recognition approaches, 50% images are considered as training images and remaining images taken for testing of the methods.

Accurate identification is obtained if the correct individual is returned as the best match for each approach. If multiple faces per subject are used, in this case it will be sufficient for any one of the face images to appear as the best match. The accuracy is calculated by the formulae:

$$accuracy = \frac{\text{Number of correct hits}}{\text{Number of total attempts}} x\ 100 \qquad (4)$$

In this paper two databases are considered for the testing of proposed face recognition algorithm. These two data bases are ORL and Yale database and explanation of both database are as follows:

***ORL Face Database*: -** ORL face database formerly known as AT&T face database [17]. It comprises of total 400 images of 40 discrete persons with 10 different images of each. For few of the persons, the images are captured at different times, varying the illumination, facial appearances like with closed and open eyes, with smile and without smile, and features details i.e. with spectacles / without spectacles. The pixels size of every image is 92x112, of 256 grey levels per pixel stored in PGM format. The sample images are displayed in Fig.12.

Fig.12 Sample Images from ORL Face Database

***Yale Face Database:* -** This database comprises of tota165 images of with 11 images per subject of 15 different individuals. The pixels size of every image is 320x243, of 256 grey of 256 grey levels per pixel stored in GIF format. These images are captured with unlike facial appearance such as: center-illumination, with spectacles, cheerful, left-light, without spectacles, normal, right-light, sad, sleepy, surprised, and wink [18]. Fig. 13 shows sample images of Yale database.

Fig.13 Sample Images from Yale Database

***Comparative Analysis:* -** This part illustrates the comparative study of proposed face recognition approach with existing approaches for two different sets of face databases. Experiments have been executed on ORL and Yale databases with unlike number of training and test images. Comparative analysis of the proposed algorithm with existing algorithms has been presented in Table 2.

Table 2 Comparative Analysis of Present State-of-Art

Database	**50% Training Samples**	

	PCA [3]	Proposed (YCbCr+PCA)
ORL	90.56%	**94%**
Yale	87.80%	**89%**

Table 2 clearly shows that the higher accuracy of proposed face detection and recognition approach, which is the combination of YCbCr followed by PCA as compared to existing PCA technique [3].

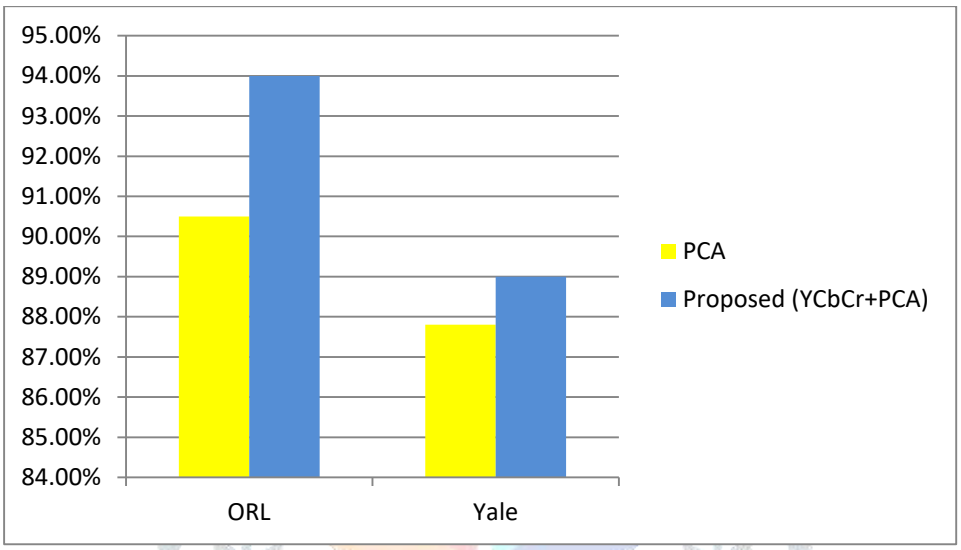

Fig. 14 Comparative analysis of Present State-of-Art

Graphical comparison of recognition rates for these approaches for different sets of ORL and Yale face databases has been depicted in Fig.14.

V. CONCLUSION AND FUTURE SCOPE

Face detection has been considered as one of the main rigorous problems in the pasture of pattern identification and computer visualization, because of the large change and variations in facial expressions, illumination and different gestures. The detection of face is important because it checks the faces in an image or videos frame, if it is, then to return their respective positions. In this work image is given as input then the skin color specification is done as per as the color model of the image. After this process image face is matched and the comparative analysis is formed which shows that the accuracy of YCbCr + PCA is 95%, HSV + PCA 70% and Binarized RGB + PCA is 45%. ORL and Yale database are used for validation purpose.

We created training/test sets for each database selecting 50% training images and remaining images in test sets. The proposed efficient method YCbCr + PCA is executed on ORL database and attain 94% while Yale database attain 89% accuracy in terms of recognition rate. The objective of this work was to improve the recognition accuracy by using the best face detection method. The proposed face recognition approach comprising of YCbCr color model followed by Principal Component Analysis (PCA) attain higher accuracy as comparing with existing Principal Component Analysis. This research can be further enhanced in future by using the concept optimization based on the biological term with more parameters like precision and recall.

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BIOGRAPHY

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