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A Hybrid Approach to Detect and Recognise Faces in Complex Background

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***Abstract**: Face recognition from image or video is a popular topic in biometrics research. In this research work, a new hybrid approach to detecting and recognize faces is proposed and implemented. The proposed algorithm uses Viola-Jones method to detect a face area from a complex background and then uses the same image to create a database of images. In the recognition part, it again detects the face area and computes the Euclidean Distance of the current face with that of the face images in the training database. The minimum Euclidean distance parameter is used to recognize the correct face if it is available in the database. The algorithm shows good results in terms of recognition rate as compared to some previous research work in the similar field.*

Keywords: Face Recognition, Face Detection, Euclidean Distance, Recognition Rate, Viola Jones.

I. INTRODUCTION

Detection and Recognition of the human face is a simple visual task for human vision, however, this undertaking isn't simple and is thought to be a test for any human-computer communication approach in view of computer vision since it has a high degree of fluctuation in its appearance. In what capacity would computers be able to identify numerous human faces introduce in a picture or a video with complex foundation? That is the issue. The answer for this issue includes division, extraction, and confirmation of countenances and perhaps facial highlights from the complex foundation. Face recognition from picture or video is a well-known theme in biometrics research. Numerous open places ordinarily have cameras for video catch and these cameras have their huge incentive for security reason. The real points of interest of face-based identification system over different biometrics are uniqueness and acceptability. As human face is a dynamic dataset having a high level of changeability in its appearance, that makes confront location a troublesome issue in computer vision.

Computer vision area has different applications, for example, Face Recognition, Face Localization, Face Tracking, Facial Expression Recognition, Passport Control, Visa Control, Personal Identification Control, Video Surveillance, Content-Based Image and Video Retrieval, Video Conferencing, Intelligent Human-Computer Interfaces and Smart Home Applications. Face detection techniques have been researched for years and much progress has been proposed in the literature. The most five known algorithms for face detection are Principle Component Analysis (PCA), Linear Discriminator Analysis (LDA), Skin Color, Wavelet and Artificial Neural Networks .Most of the face detection techniques focus on detecting frontal faces with good lighting conditions in images or videos.

The goal of this research work is to evaluate various face detection and recognition methods, provide solutions for image-based face detection and recognition with higher accuracy, a better response rate as an initial step for video surveillance. The solution is proposed based on performed tests on various face rich databases in terms of subjects, pose, emotions, race, and light. The Viola-Jones method has been used for detecting a face region in a complex background to detect the human presence in a random image. This detected face is then compared with the existing faces in the database to recognise the subject in question.

II. LITERATURE SURVEY

Faizan Ahmad et.al [1] have discussed the various challenges in the area of image-based face detection and recognition. In this paper, the authors have evaluated a number of face detection and recognition methods existing and developed a system for the proposed method's evaluation as the first milestone for video-based face detection and recognition for surveillance.

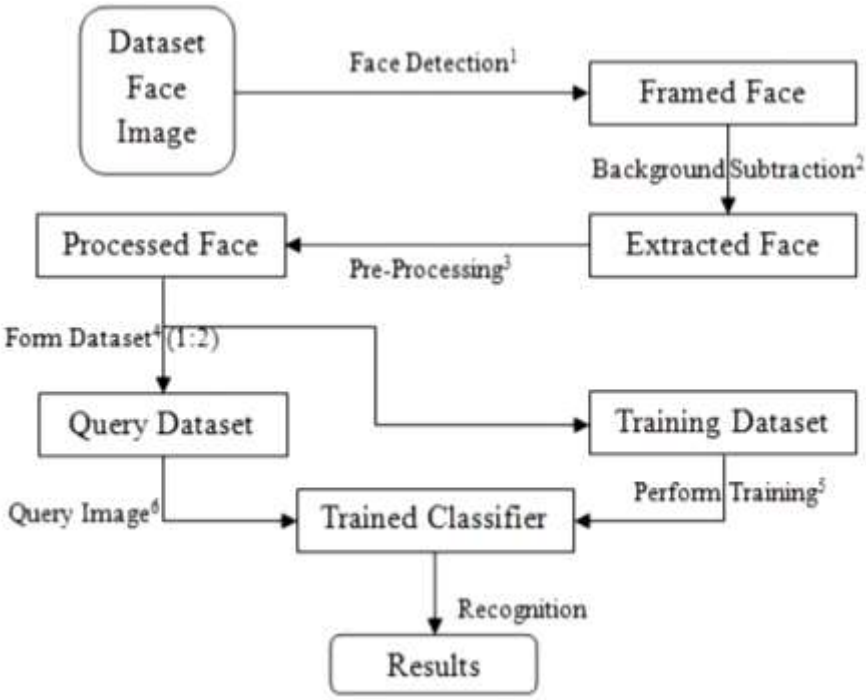

Figure 1: Face Detection and Recognition Conceptual Model

Some methods performed consistently over different datasets whereas other methods behave very randomly however based on average experimental results performance is evaluated [1], five datasets been used for this purpose. As shown in the paper, Haar-like features reported relatively well but it has much false detection than LBP which could be considered being a future work in surveillance to reduce false detection in Haar-like features and for the recognition part Gabor is reported well as it's qualities overcomes datasets complexity.

Amr El Maghraby et.al [2] in their paper have discussed a hybrid face detection method using Viola-Jones method and skin color detection. In this paper, a fast, reliable automatic human face and facial feature detection is one of the initial and most important steps of face analysis and face recognition systems for the purpose of localizing and extracting the face region from the background. This paper presents a Crossed Face Detection Method that instantly detects low resolution faces in still images or video frames. Experimental results evaluated various face detection methods, providing a complete solution for image-based face detection with higher accuracy, showing that the present method efficiently decreased the false positive rate and subsequently increased the accuracy of face detection system in still images or video frames especially in complex backgrounds. The proposed method can process different kinds of images and under different lighting conditions. The experimental results showed that our new approach was able to achieve a higher detection rate than any of the 2 methods mentioned prior, and clearly improved Viola-Jones face detection accuracy and decreasing false negative rates.

K. M Poornima and Ajit Danti [3] have proposed human face recognition of still images using face detection by AdaBoost face detector, region of interest (ROI) extraction, feature extraction using discrete wavelet transform (DWT), dimensionality reduction by employing independent component analysis (ICA) and classification using k-Nearest Neighbourhood (k-NN) classifier. The proposed system is evaluated by conducting the experiments on Faces 94 database. For experimenting the proposed system, 40 classes from "Faces94" database are chosen. For training and testing, 40 class each and each class containing 10 images are considered. Out of 10 images, 5 images from each class are used for training and remaining are used for testing. Out of 40 classes, 13 classes are taken from the female dataset, 21 classes are from the male dataset and 6 classes are from the male-staff dataset. Therefore, total 400 images are considered, out of which 200 images are used for training and remaining 200 images are used for testing. The proposed system achieved about 83.5% of recognition rate when k value is 1.Recognition rate decreases ask value increases.

Zahra Sadri Tabatabaie, [4] present a hybrid face detection system using a combination of appearance-based and feature-based methods. They have combined Viola and Jones face detection method with a color-based method to propose an improved face detection method. They discuss a pixel-based skin detection methods, that classify each pixel as skin or non-skin individually, independently from its neighbours and combine it with Viola and Jones based face detection to improve the performance of face detection systems in terms of increasing the face detection speed and decreasing false positive rate. The results as shown that the proposed method efficiently increases face detection speed as well as decreases false positive rate.

Abhishek Maity et.al [5] have suggested a novel approach to face detection using image parsing and morphological analysis. The main objective of the paper as mentioned by the authors is to propose an algorithm for extraction of some fundamental information of an image efficiently and then finally use that to detect the human face on the image. The method which they propose is based on assumption that the image contains the frontal face. They describe a method which widely-used edge-based features. Firstly, the skin region is detected using a colour based algorithm and Brightness preserving histogram equalization techniques operated on RGB to determine the presence of human and the head region is calculated. Lastly, probably calculated head region is extracted using Sobel Edge-Detection and matched with our trained database files for further classification of the segmented image.

Sayantan Thakur et. Al [6] have proposed a face detection method using skin tone segmentation. They have proposed an algorithm which ingeniously uses a novel skin color model, RGB-HS-CbCr for the detection of human faces. Skin regions are extracted using a set of bounding rules based on the skin color distribution obtained from a training set. The segmented face regions are further classified using a parallel combination of simple morphological operations. Experimental results on a large photo dataset have demonstrated that the proposed model is able to achieve good detection success rates for near-frontal faces of varying orientations, skin color and background environment. The model proposed by the authors utilizes the additional hue and chrominance information of the image on top of standard RGB properties to improve the discrimination between skin pixels and non-skin pixels. Skin regions are classified using the RGB boundary rules and also add new rules for the HS and CbCr subspaces. These rules are constructed based on the skin color distribution obtained from the training images. The classification of the extracted regions is further refined using a parallel combination of morphological operations.

III.PROPOSED WORK

The proposed method in this research work is based on the Eigenfaces technique in which the Principal Component Analysis (PCA) is used. PCA is a statistical method which is used to reduce the high dimensional data space to the low dimensional characterized space. This method is best suited for data compression and removal of redundancy. It is the most successful technique that is prevalent in image recognition and compression.

The foundation of using Eigenfaces in face recognition is based on the fact that each image can be represented as a matrix. A matrix has a set of eigenvectors that represents the principal components of the matrix. Eigenfaces are the eigenvectors of the covariance matrix of all faces. Similar faces can be described in a space with lower dimensionality. In mathematical terms, Eigenfaces are the principal components that divide the face into feature vectors (or we can say that basic approach of using PCA in a face recognition is to put across the large 1-D vector of pixels built from the 2-D facial image into its discrete components of the feature space. This can be said to be as an Eigen Face projection. A covariance matrix gives us the information about these feature vectors. These eigenvectors are the basis for measurement of variation among several faces. The faces are described by a linear combination of highest Eigenvalues.

The basic principle of the Viola-Jones algorithm is to scan a sub-window capable of detecting faces in a given input image. The standard image processing approach would be to rescale the input image to different sizes and then run the fixed size detector through these images. This approach turns out to be rather time-consuming due to the calculation of the different size images.

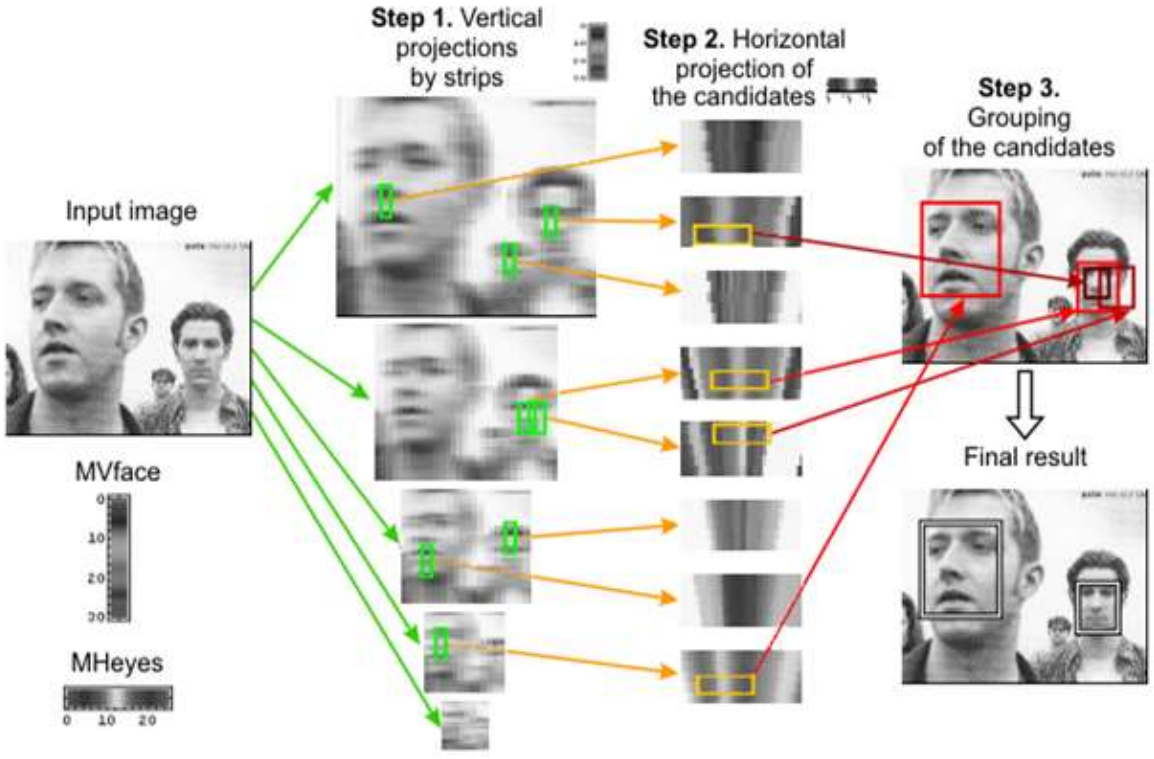

Figure 2: Viola Jones Algorithm

.Figure 2 shows a representation of Viola Jones method where each figure object is divided into vertical projects and horizontal projections. An image representation called the integral image evaluates rectangular features in constant time. Because each feature's rectangular area is always adjacent to at least one other rectangle, it follows that any two-rectangle feature can be computed in six array references, any three-rectangle feature in eight, and any four-rectangle feature in nine.

Face Detection Phase

- Step 1: Read the input image
- Step2: Read Frontal Face Object
- Step 3: Obtain face co-ordinates
- Step 4: Use coordinates to locate face on complex background using Viola Jones
- Step5: Detect face

Training phase

- Step 1: Crop face for detection
- Step 2: Make bounding box of 240 x 320 pixels
- Grayscale conversion reduces the dataset.
- Apply Image Enhancement to enhance the quality of obtained Image by adjusting intensity value of pixels.
- Step 3: Create Eigen faces from this image
- Computing the average face
- image m = (1/P)*sum(Tj's)
- for i= 1 to Number of rows
- Computing the difference image for each image in the training set

Recognition Phase

- Step 1: Get the image to be recognized i.e. test image
- Step 2: Apply Eigenfaces algorithm on the test image
- Step 3: Calculate Euclidean Distance from all Eigenfaces in database
- Step 4: Minimum Euclidean Distance data set is recognized.
- Post-Recognition Steps:
- Step 1: Calculate the MSE and PSNR values of the input image and training image.
- Step 2: Tabulate the results.

IV. SIMULATION AND RESULTS

The algorithm has been implemented using MATLAB 2010b software tool. It contains various ready to use functions in the image processing domain. Real-time images using laptop built-in webcam has been used. One thing taken into consideration is sufficient lighting.

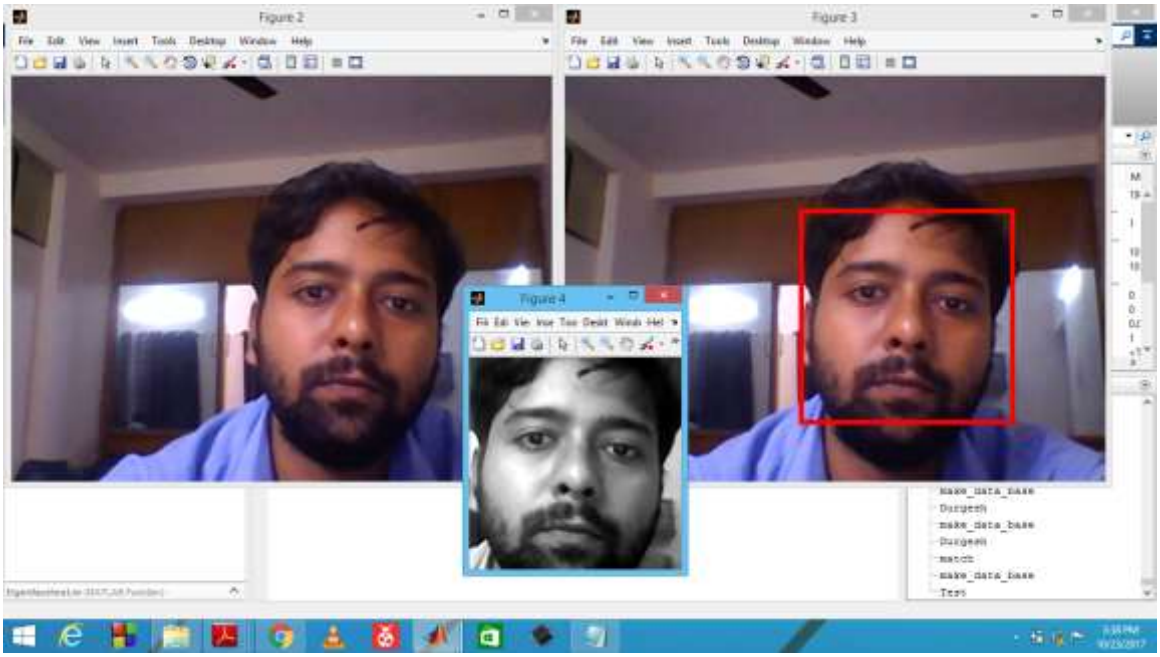

Figure 3: Detection Phase

As shown in Figure 3, the system detects the face area from the complex background using Viola Jones algorithm and makes a bounding box of dimension 640x480.

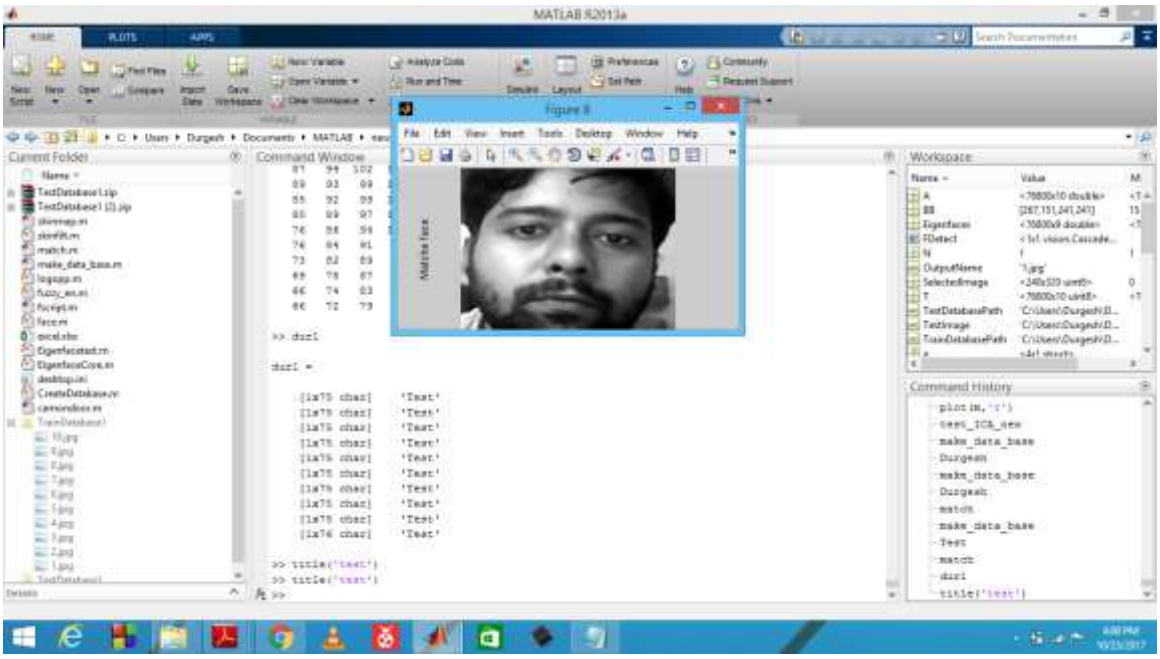

Figure 4: Cropped and Grayscale Converted

The face area detected in the above phase is then converted to a grayscale form to reduce the computational complexity and cropped to show only the face area. The result for this step is shown in figure 4.

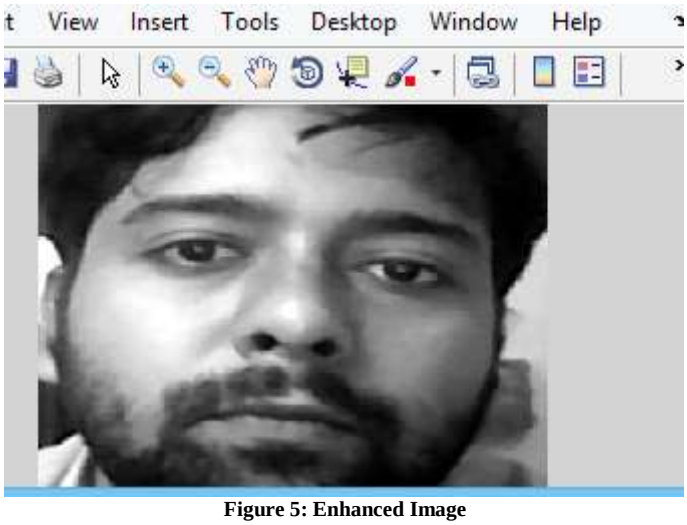

Figure 5: Enhanced Image

The image obtained after cropping and grayscale are then enhanced using histogram equalization method to sharpen the image features.

Figure 6: Training Database

For making the training database 10 images of each subject has been taken of the frontal face in different moods. The system is trained by evaluating the classifiers for the training database. This is shown in figure 6.
During recognition phase, the system performs matching by calculating the Euclidean Distance with each entry in the database. The subject with minimum Euclidean distance is determined has the recognized face. A comparison chart with previous algorithms has been shown in the below table 1.

Table 1: Comparison of other Algorithms

	Technique	**Inferences**
Proposed Work	**Viola Jones and Eigenfaces**	**85% appx.**
Ms. Turk and Kavita, Ms.Manjeet Kaur	**Face feature selection using LBP**	**Recognition rate 73%**
Abhishek Maity, Sayan Dasgupta, Debjit Paul	**Edge detection using morphological analysis**	**Recognition rate 62%**
Faizan Ahmad, Aaima Najam and Zehan Ahmedes	**PCA, LBP,LDA**	**Recognition rate 61%**

CONCLUSION

Face Detection and Recognition from a complex background is always an interesting area of research. In this paper, we have presented an algorithm to facilitate the detection of the human faces based on Viola-Jones face detection algorithm and then recognition of the faces by comparing the features with the trained faces database. The system shows good recognition rate close to approximately 85 percent on a limited number of subjects and a constrained environment. The work can be further extended to add suitable hardware and scaling in terms of software to provide an efficient system of surveillance and security in a number of application areas.

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