

Face Detection and Recognition Using Skin Color Segmentation and PCA

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ABSTRACT

Face detection and Face Recognition is one of the challenging problems in Computer Applications. The main part is to detect the face portion from the entire image. Problems includes sensitivity to the illumination conditions of input image. Here we propose method to detect human faces in color images based upon the edge and skin tone information of the input color image by setting appropriate thresholds. First, image enhancement is performed, especially if the image is acquired from an unconstrained illumination condition. Next, skin segmentation in srgb and lab space is conducted. The edges of the input image are combined with the skin tone image to separate all non-face regions. So, for face detection Skin color detection methods are used and for face recognition Eigen face method is used. Eigen face method is also known as PCA method. This process is stimulated in MATLAB environment and it is tested for various samples of face images and successfully giving desired results. Because of the increasing instances of identity theft and terrorism incidences in past years,. Face detection and recognition can identify uniqueness of one human face to other human face. To detect a face from an online surveillance system or an offline image, the main component that should be detected is the skin areas. Skin color has proven to be a useful and robust cue for face detection, localization and tracking. The face detection simply means to determine the given input is a face image or not regardless of the size, position and background etc. The current evolution of computer technologies has boosted in this era.

Keyword : - Skin segmentation, principal component analysis, face detection ,face recognition

1. INTRODUCTION

1.1 Face Detection and Face Recognition:

Face detection and recognition plays a wide variety of application benefits to the real time problems but to detect facial image and giving results in less time is been area of research since long time. Computational models of face recognition are interesting because they can contribute not only to theoretical knowledge but also to practical applications. Computers that detect and recognize faces could be applied to a wide variety of tasks including criminal identification, security system, image and film processing, identity verification, tagging purposes and human-computer interaction. The problem is to detect faces in the given, colored photograph. In this paper, 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 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

For example: Computer vision contributes in face recognition and video coding techniques. Face detection in computer vision involves segmentation, extraction, and verification of faces. Face detection is considered as primary steps towards face recognition. In recent years with the development of artificial intelligence, Internet of Things, ecommerce and other computer applications, face recognition gains much more importance[1].

Application includes[1]:

- Surveillance
- General identity verification
- Criminal justice systems
- Image database investigations
- Multi-media environments

Face detection techniques are classify as follows: [2]

(A) **Feature based techniques:** The feature based approaches use the facial features to their detection process. Hjemal and Low further divide this technique into three categories: low level analysis, feature analysis and active shape model. Low level analysis detects with the segmentation of visual features. Feature analysis removes ambiguity Active shape models define the actual physical and higher-level appearance of features.

(B) **Image based techniques:** Explicit modeling approach is used to overcome environmental condition and accurate detection. Example: neural networks, example based learning, support vector machine. Face detection techniques can be roughly classified into four categories , namely, skin color model-based approaches, template matching-based approaches, feature-based approaches, and statistical model-based approaches.

The face detection simply means to determine the given input is a face image or not, regardless of the size, position, background etc. Face detection is considered as primary steps towards face recognition .Here we have studied and implemented a pretty simple but very effective face detection technique which takes human skin color into account. Focus is to develop fast, robust, reasonably simple techniques to search.

1.2 Face Recognition : Eigen face method:

At this stage the faces can be detected and generalized. To be able to recognize a face, the mathematical process Principal Component Analysis (PCA) is implemented in a method called Eigen face method. PCA is a statistical method that decreases the dimensionality of the data, but at the same time maintains the variation. Eigen face method is a holistic matching method based on the fact that information regarding a face is stored in so-called eigen faces. These are then compared with other eigen faces to find a matching face.

In this approach, first the eigen vector of the covariance matrix of the set of face images is found out and then they are sorted according to their corresponding eigenvalues. Then a threshold eigenvalue is taken into account and eigenvectors with eigenvalues less than that threshold values are discarded and then obtain a set called eigen faces. The best M eigen faces from a M dimensional subspace is called “face space”. Now the weights of the test image are compared to the set of weights of the training images and the best possible match is found out. The comparison is done using the “**Euclidean distance**” measurement. Minimum the distance is the maximum is the match.

1 BACKGROUND STUDY

There are various face detection methods as follows:

(1) AdaBoost Method[3] is abbreviated for "Adaptive boosting". It is a machine learning meta-algorithm by Yoav Freund and Robert.

(2) Principal component analysis: Principal component analysis (PCA) [4] is a statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components that results in dimensional reduction.

(3) Hidden Markov Model: A hidden Markov model (HMM) is a statistical Markov model in which the system being modeled is assumed to be a Markov process with unobserved (hidden) states.

(4) Support Vector Machine (SVM): SVM are learning models in machine learning that are used for analysis of data and can perform non linear classifications

(5) Skin color segmentation [5] :As name indicates this method uses skin color detection and segmentation methods for fast retrieval for image detection.

(6) Local binary pattern: Local Binary pattern (LBP) is a feature used for classification in computer vision especially for texture classification. Image texture features extraction used in fields of image retrieval, texture examination, face recognition, image segmentation etc.

Reconstruction method of low resolution image by using few DCT coefficients and Face detection in low resolution image (AdaBoost method) is carried out and fewer DCT coefficients are adopted to reconstruct low-resolution image. And then faces are detected in low-resolution image but reconstruction of images are compulsory which results in delayed result.[6].Face geometry method, Principal component analysis and Color space transformation and decompress images are used for Face Detection based on Viola and Jones algorithm and principal component analysis but computation cost is high [7].

Morphological operations and filtering. Rule based search for eyes. Using the location of the eyes and the distance between them face region in an image is determined. No training is required but Performance of the system degrades with eyes occlusion and extreme lighting conditions[8].For template matching, Skin color feature, the hole feature and the template feature are used to produce Two-dimensional Gaussian model to realize skin color modeling and Facial template matching[9]

Principal Component Analysis (PCA) or Discrete Cosine Transform (DCT) are used to describes a prototype system for carrying out human face recognition based on a combination of correlation with PCA or DCT technique used for the purpose of deciding a facial match. But Recognition of a person from a 2D projected image of the 3D face is a challenging task[10].

Among all these method we have implemented skin color segmentation method are able to successfully produce the desired results. For Face recognition PCA(principle component analysis) commonly known as eigen face method is used .

2 WORKFLOW OF THE SYSTEM

Following fig 1 shows face detection and recognition system workflow. Fig 2 shows face detection flow fig.3.shows face recognition flow.

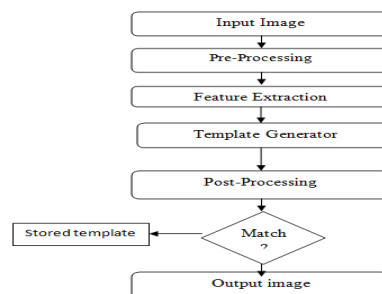


Fig -1: Face Detection and Recognition System

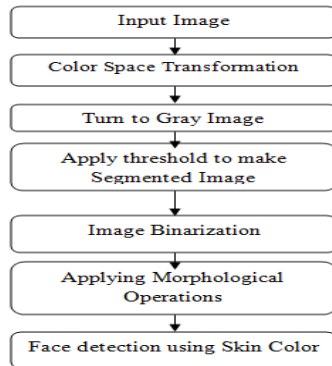


Fig -2: Face Detection System Flow

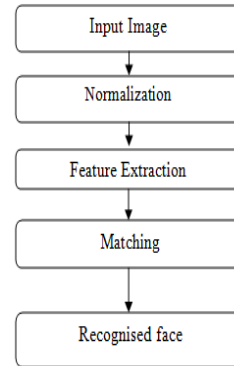


Fig 3 Face Recognition System Flow

3 IMPLEMENTATION

3.1 FACE DETECTION USING SKIN COLOR DETECTION

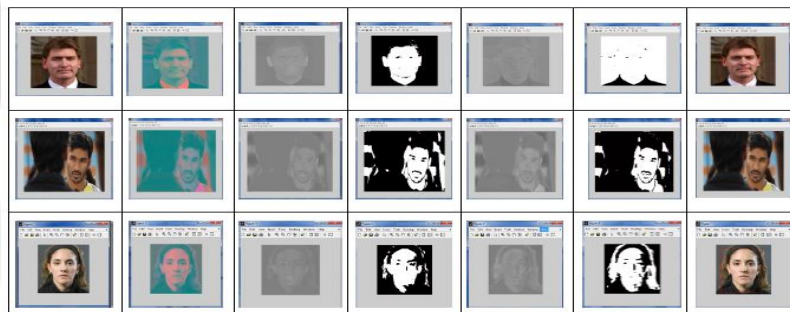


Fig 5. Sample mages used for face detection

(1)Input image, (2) Applying c form (Converting srgb to lab color), (3) 2-D Matrix transformation, (4) Convert intensity image into binary (2D),(5) Applying morphological operation,(6) Submission of binary images , (7) Bounding box selection (skin region)

3.2 FACE RECOGNITION USING PCA

PCA (Principle Component Analysis) is used to determine the most distinguishing features between facial images. Face recognition are carried out using PCA is followed by three important steps i.e. Creating Databases, Eigenface Core creation and recognizing the images. For experimental purpose test database is created having 10 images and trained. database is having 20 images. The output contains equivalent face images.

Step1: Creating Databases First step is to create 2D matrix of training images. For database creation we train database and reshapes all 2D images of training databases into 1D column vectors then using these column vectors again 2D matrix is constructed in a row matrix. Therefore, construction of 2D matrix is done from 1D image vectors for creating database. Creating database includes these images :



Fig 6.Trained database

Step2: Eigenface core method Second step includes production of basis of facespaces. Eigenface method is used for determining most significant features between the face images. It uses 2D matrix, containing trained images and returns mean of trained database, eigen vectors of covariance matrix and matrix of centered image vectors. Mean image calculation is followed by calculating the deviation of each image from mean image.

According to linear algebra theory, $P * Q$ matrix has maximum no. of non-zero eigenvalues i.e. $\min(P-1, Q-1)$. So, training images will less than no. of pixels thus dimensionally size will decreased. Diagonal eigen values are considered for reduction of size of image. After calculating eigen values sorting is performed and eigenvalue which are less than threshold values are eliminated successfully. Lastly, eigen vectors of covariance matrix are calculated.

Step3: Recognition the image Third step is recognition step in which equivalent featured image is extracted from the trained database. It compares two faces by projecting the images into facespace and then measuring Euclidean distance between the images. Matrix of centered image vecors are found and equivalent recognized image is extracted from the trained database.Centered image vecors are projected into facespace by multiplying with eigenface basis. After that extraction of PCA features are carried out from input image and finally , calculation of Euclidean distance between projected test image and centered training image is done and we get recognized image from database.Below showing result of face recognition using eigen method:

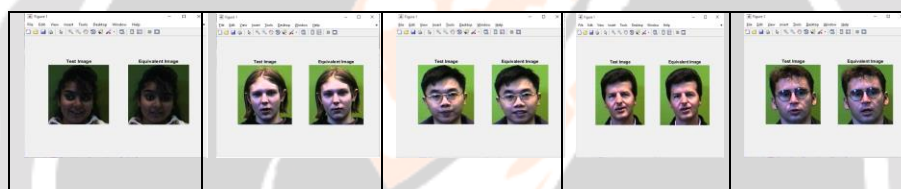


Fig 6 OUTPUTS

Hence ,we are able to produced desired results by using skin color detection technique for face detection and principle component analysis for face recognition. There are 5 test images and desired output is achieved. Further, If skin color is detection for hands then ratio is taken to do morphological operation. Here,we have frontal images in databases.

Analysis of system.

Test Images	Number of Classes	DCT	DWT	Our Method (PCA)
5	10	46%	90%	100%

- DCT = Discrete Cosine Transform
- DWT = Discrete Wavelength Transform
- accuracies for DCT and DWT and PCA

TABLE 1: ANALYSIS OF PCA METHOD

4 CONCLUSION

We propose method to detect human faces in color images based upon the edge and skin tone information of the input color image by setting appropriate thresholds. First, image enhancement is performed, especially if the image is acquired from an unconstrained illumination condition. Next, skin segmentation in srgb and lab space is conducted. The edges of the input image are combined with the skin tone image to separate all non-face regions. So, for face detection skin color detection methods are used and for face recognition Eigen face method

is used. This process is stimulated in MATLAB environment and it is tested for different samples of face images and successfully giving desired results.

Future work would be concentrated on improving light compensation, morphological operations and optimizing the threshold for the Eigen face method. Thus, a greater precision in both detection and recognition of faces would be obtained. The approach would be to combine our holistic method with a feature based method to achieve higher performance.

5 REFERENCES

- [1] Ms. Varsha Gupta, Mr. Dipesh Sharma ,”A Study of Various Face Detection Methods”, Vol. 3, Issue 5, May 2014 IJARCE.
- [2] Urvashi Bakshi, Rohit Singhal ,”A SURVEY ON FACE DETECTION METHODS AND FEATURE EXTRACTION TECHNIQUES OF FACE RECOGNITION”, International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 3, Issue 3, May-June 2014
- [3] WAN Li, CHEN Pu-chun,” Face Detection Method Based on Skin Color and AdaBoost Algorithm” 2010 International Conference on Computational and Information Sciences, 2010 IEEE.
- [4] Mohammed A. M. Abdullah, F. H. A. Al-Dulaimi, Waleed Al-Nuaimy, Ali Al-Ataby, ”One-Sample Face Recognition Using HMM Model of Fiducial Areas.
- [5] Qieshi Zhang, Sei-ichiro Kamata, and Jun Zhang,” Face Detection and Tracking in Color images Using Color Centroids Segmentation”, Proceedings of the 2008 IEEE International Conference on Robotics and Biomimetics, Bangkok, Thailand, February 2009
- [6] Tian Qing, Zhao Shiwei,” A Fast Face Detection Method for JPEG Image”,2012,IEEE.
- [7] Samiksha Agrawal, Pallavi Khatri,” Facial Expression Detection Techniques: Based on Viola and Jones algorithm and Principal Component Analysis”, 2015 Fifth International Conference on Advanced Computing & Communication Technologies.
- [8] Devadethan, Geevarghese Titus, Purushothaman,” Face Detection and Facial Feature Extraction Based on a Fusion of Knowledge Based Method and Morphological Image Processing”, International Conference on Magnetics, Machines & Drives (AICERA-2014 iCMMD), 2014
- [9] Zhu Youlian, Huang Cheng, Zhai Kun, Pan Lingjiao,” Face Detection Method Using Template Feature and Skin Color Feature in rgb Color Space”,IEEE 2015
- [10] Soumitra Kar, Swati Hiremath, Dilip G. Joshi, Vinod.K.Chadda, Apurva Bajpai,” A Multi-Algorithmic Face Recognition System”, *EISD, BARC,2006*.