International Journal of Advanced Computer Research (ISSN (print):2249-7277 ISSN (online):2277-7970)
Volume-3 Number-2 Issue-10 June-2013

Personal Identification with Face Biometrics using Color Local Texture Features

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Abstract

Face recognition (FR) has received a significant interest in pattern recognition and computer vision due to the wide range of applications including video surveillance, biometric identification, and face indexing in multimedia contents. Recently, local texture features have gained reputation as powerful face descriptors because they are believed to be more robust to variations of facial pose, expression, occlusion, etc. In particular, local binary pattern (LBP) texture feature has proven to be highly discriminative for FR due to different levels of locality. Hence, it is proposed to employ these features along with color local texture feature for efficient FR system. The personal identification accuracy with face modality using color local texture features is around 97% is achieved.

Keywords

Color local texture features, Local binary pattern, Color space conversion, Viola and Jones algorithm, Match score level, Distance based classifier.

1. Introduction

The biometrics is a powerful tool to authenticate a person for multiple applications. The face recognition is better biometrics compared to other biometric traits as the image can be captured without the knowledge and cooperation of a person.Face recognition is a biometric identification process by scanning human face and matching it against a library of known faces. In recent years many research works have given new denotation to face recognition because ofits budding approaches with new perception, nevertheless still remained very challenging-one.

This work was supported in part by the Department of Computer Science and Engineering Basaveshwar Engineering College, Bagalkot, Karnataka State India.

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To meet such face recognition challenges number of typical algorithms [1] are presented in the literature andcategorized into appearance based, model-based schemes, template matching schemes and neural network schemes. In appearance-based methods, if object is represented in terms of several views, then human face model is constructed to capture facial variations using prior knowledge of human face in model scheme, whereas template matching method uses the co-relation between input images and stored standard patterns of faces or features and, in neural network model used as artificial intelligence tool in pattern recognition and classification.

Variation in illumination, pose and expression are the major issues addressed in the recognition process of face, especially when face images are takes under gray-scale and same lead to worst face recognition rate. To alleviate such limitations to certain extent this work focused on considering color information of face being identified, by implying color face database. Along with color information a new local texture feature, i.e., color local binary pattern (CLBP) [2] isincorporated for color face recognition. The local texture features are able to exploit the discriminative information derived from spatio-chromatic texture patterns of different spectral channels within a certain local face region.In addition, for effective utilization of combined information of color and texture, the opponent color texture features which are captured by the texture patterns of spatial interactions between spectral bands are combined during the generation of CLBP.

It is planned to explore the new approach for color face recognition using color local texture features like color local binary pattern and conduct the evaluation of efficiency using color face database.However with database images, faces are already aligned and background information isminimalistic to certain extent. Therefore recognition accuracy expectation is quite high.

The rest of this paper is structured as follows: Section II details the related work of FR. In Section III the proposed color FR framework using color local texture features is outlined. Section V includes Figures and Table. Section VI describes the

experimentation with results and finally conclusions constitute in Section VI.

2. Literature Survey

The face recognition is important in security related applications. Recognizing the genuine user is a crucial task in such applications. In last decade's most of the researchers proposed different methods for face recognition. Some of the related work are summarized in the following; In 2012, Jae Young Choi, Yong Man Ro and Konstantinos N. (Kostas) Plataniotis [3] proposed two effective color local texture features, i.e., Color Local Gabor Wavelets (CLGWs) and Color LBP (CLBP), to encode the discriminative features derived from spatio-chromatic texture patterns of different spectral channels (or bands) within a certain local region. To perform color FR, multiple color local texture features have been combined at the feature level with uniform weights. In 2012, Anjali jain, Pankaj Chawla [4] proposed a Novel techniques like, skin likely-hood model to segment human skin regions from non-skin regions based on color, and morphological operation to simplify image data by preserving their essential shape characteristics and eliminating irrelevancies.In 2011 Son Lam Phung, Douglas K. Chai, Abdesselam Bouzerdoum [5] proposed a color input image that processed using neural-networks to detect skin regions from the face image. Each neural network separates skin and non-skin pixels on the basis of chrominance information. The skin color classifier achieves a classification rate of 84%compared to MLP classifier. In 2011, Aysegul Ucar [6] proposed a new color feature extraction algorithm and a new hybrid color space are proposed in order to further enhance the color face recognition performance.In 2011, Smt. M.P.Satone, Dr. G.K.Kharate [7] proposed that skin region is segmented from non skin region based on skin color classification by converting image in skin likelihood and adopting adaptive thresholding process to achieve the optimal threshold value. In 2011, Smita Tripathi, Varsha Sharma, Sanjeev Sharma [8] proposed the combination of the skin color detector and the template matching method to detect the human face.In 2009 Jae Young Choi, Yong Man Ro and Konstantinos N. (Kostas) Plataniotis[9] proposeda new metric called "Variation Ratio Gain" (VRG) to prove theoretically the significance of color effect on low-resolution faces. VRG quantitatively characterizes how color features affect the recognition performance with respect to changes in face resolution. In 2005, Saman Cooray and Noel O'Connor [10] proposed combined methodology of skin detection, automatic eye localization, and appearance-based face/nonface classification analysis models. In 2003, Scott Tan Yeh Ping, Chun HuiWeng, Boonping Lau [11] proposed processes like multi-resolution, template matching, region clustering and color segmentation for face detection. In 2001, K. Sandeep and A.N. Rajagopalan [12] proposed a method where each pixel in the given image is classified as a skin pixel or a non-skin pixel, using connectivity analysis different skin regions are identified in the skin detected image, finally decision is made, whether each of the skin regions identified is a face or not. In 2000,Yanjiang Wang, Baozong Yuan [13] proposed an Evolutionary computation technique to detect and locate the face-like regions in color images in presence of varying lighting conditions as well as complex backgrounds. In 1999 Rein-Lien HSU and Mohammad Abdel, Anil K [14] proposed detection of skin region over the entire image, based on a lighting compensation technique and a color space transformation (i.e. YC_bC_rcolor space).

Although previous works in color-based FR have successfully demonstrated the importance of color information in order to obtain improved FR performance, the complementary effect taken by combining color and local texture information on the FR problem (e.g., illumination or pose constraints) has not been systematically explored in the current color FR works. In this paper it is aimed to fill this blank by presenting the effective FR framework based on integrating color and local texture information in an effective way.

By performing the literature survey many applications of FR are observed, various issues and challenges areidentified in face recognition.

The following applications of face recognition are identified:

1. Security: Access control to buildings, airports/seaports, ATM machines and border checkpoints computer/network security, email authentication on multimedia workstations.
2. Surveillance: a large number of CCTVs can be monitored to look for known criminals; drug offenders etc. and authorities can be notified when one is located.
3. General identity verification: Electoral registration, banking, electronic commerce,

identifying newborns, national IDs, passports, driver's licenses, employee IDs.

4. Criminal justice systems: Mug-shot/booking systems, post-event analysis, forensics.
5. Image database investigations: Searching image databases of licensed drivers benefit recipients, missing children, immigrants and police bookings.
6. Smart Card –Applications: In lieu of maintaining a database of facial images, the face-print can be stored in a smart card, bar code or magnetic stripe, authentication of which is performed by matching the live image and the stored template.
7. Multi-media environments with adaptive human computer interfaces: Part of ubiquitous or context aware systems, behavior monitoring at childcare or old people's centers, recognizing a customer and assessing his needs.
8. Video indexing: Labeling faces in video.
9. Witness faces reconstruction.

Some of the Issues and challenges are identified and are listed below**;**

1. Illumination: The color that we perceive from a given surface depends not only on the surface's nature, but also on the light illumination on it. There can be relevant illumination variations on images taken under uncontrolled environment. Two faces of same subject with illumination variations may show more differences between them compared to another subject. Hence, the chromaticity is an essential factor in face recognition. The intensity of the color in a pixel can vary greatly depending on the lighting conditions.

2. Pose variation: It is uncontrolled problem because in security domains it is difficult to predict or restrict the pose of candidate. Many approaches are presented to align the pose variation.

- Multi-image based: Many pictures are taken of same object at a different angle.
- Single model based: The user face is aligned from different sources and merged to produce a single face image to reduce the effect of pose variation.

3. Occlusion: I.e., state of being obstructed, it means some part of the face cannot be obtained. There are also objects that can occlude facial features such as – glasses, hats, beats.

4. Expression: Facial features will change as per expressions and they will be considering as great change in discriminative information.

5. Distance of the camera: Quality of face image changes based on the distance between acquisition camera and face.

By the literature survey it is been found that though many research work is carrying out in the direction of increasing accuracy rate of face recognition, still it remains challenging in one another way which makes it evolving with new ray day by day.

3. Scaffold of FR using Color Local Texture Features

The proposed color FR framework using color local texture features consists offive steps as shown in Fig. 1, such as color face databasecreation, face detection, color space conversion, feature extraction and classification/combination and are detailed below;

A. Database Description

1. Indian Color Face Database

Indian face database [15] contains human face images captured in February, 2002 in the campus of Indian Institute of Technology Kanpur. This database contains images of 40 distinct subjects with eleven different poses for each individual. All the images have a bright homogeneous background and the subjects are in an upright, frontal position. For each individual, the following pose for the face is included: looking front, looking left, looking right, looking up, looking up towards left, looking up towards right, looking down. In addition to the variation in pose, images with four emotions -neutral, smile, laughter, sad/disgust are also included for every individual. As an example, images corresponding to one individual are shown in Fig.2. The files are in JPEG format. The size of each image is 640x480 pixels, with 256 grey levels per pixel. The images are organized in two main directories - males and females.

2. Own Database Creation

Using web camera i.e. Hp-101 with a maximum resolution of 2 mega pixels, the color face database, in RGB color space is constructed by capturing faces from 20 users of 640x480 pixel resolution of size, sample shown in Fig.3. In order to build the color face database of users in the age between 10 years to 60 years, 10 face images of every user is acquired with the variation in the light illumination, pose and, expression. Color database of 200 color faces is constructed from 20 users, of 10 instances per user.

B. Face image Detection and Alignment

To detect the region of interest (ROI) i.e. face, Viola and Jones algorithmis used, where-in a system object is created to detect the face by combining skin region and rejecting non skin regions with additional property i.e., like bounding box and centroid to detect face. Further in alignment phase, face bounded by bounding box is cropped to the 240x240 of pixel resolution from the whole image in order to remove complex background from the captured user face image.

C. Color space conversion

The main focus of this work concentrated on extracting discriminative information. It is quite natural to use color spaces which yield high discriminative information. However, every color space has different discriminating power, to enhance discriminating power of color space for better face recognition it is needed to convert weaker color spaces into powerful ones.The color space normalization technique (CSN) has significantly and consistently improved the discriminating power of RGB color space. Hence, in the proposed work RGB color space is used. The RGB color image is converted into R, G, and B channels to retain color information and Y channel of YC_bC_rcolor space to get the gray scale information for LBP which is used for skin region detection. The Y channel conversion can be expressed in equation (1),

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

D. Extraction of Color Local Texture Features

The color local texture feature extraction from a color image (RGB color space) i.e. LBP is described in this section. The grayscale texture feature is extended to the multispectral texture features using color information. Specifically, given a color image, the texture operator is applied on each separate color channel. In addition, it can be further extending the texture operator to make use of opponent colors.

The N numbers of spectral images are generated from an RGB color face image via color space conversions methods. Then, each spectral image is divided into L local face regions (as described in Fig. 1), and then on each of the local regionsLBP operation is performed for feature extraction.

Due to discriminative power the local binary pattern (LBP) texture operator has become a popular unifying approach to the traditionally divergent statistical and structural models of texture analysisand, is a powerful feature for texture classification. Its most important property is itsrobustness to monotonic grayscale changes caused (i.e., by illumination variations), and its computational simplicity which makes it possible to analyze images in challenging real-time scenarios.

The LBP feature vector, in its simplest form, is created in the following manner:
Step 1.Divide the Y, R, G and B color component face images into 256 cells i.e., 8x8 pixel resolution for each cell.
Step 2.Compare center pixel of a cell with its 8 neighboring pixels along a circular manner in clockwise direction.
Step 3.If the center pixel's value is greater than its surrounding neighbor, then label with "1" otherwise, label with "0". i.e. 8-digit binary number (converted to decimal for convenience).
Step 4.Compute the histogram, over the cell, of the frequency of each "number" occurring.
Step 5.Normalize the histogram.
Step 6.Concatenate normalized histograms of all cells to generate the feature vector.

The Fig.4.Illustrates three circularly symmetric neighbor sets for different values of P and R [16]. Bilinear interpolation method is adopted to estimate the values of neighbors that do not fall exactly on pixels. Since correlation between pixels decreases with distance, much of the textural information in an image can be obtained from local neighborhoods.

The flow of the work with LBP operation performed on each color component image from the YRGB color space is illustrated in Fig.5.

The opponent color[17] texture features are also extracted by capturing the texture patterns of spatial interactions between spectral channels. All pairs of color channels i.e., opponent colors are perceived as opposing pairs by humans: red-green and yellow-blue. In the opponent color LBP, the LBP operator is applied on each color channel separately. In addition, each pair of color channels is used in collecting opponent color patterns so that the center pixel for a neighborhood and the neighborhood itself are taken from different color channels. In OCLBP, the center pixel is considered from the red channel. Hence collectively three inter-channel LBP histograms and six intra-channel histograms are extracted. Hence, nine opponent color texture features are extracted.

Fig.6. illustrates the three situations in which the center pixel is taken from the respective channel. In total, three inter-channel LBP histograms and six intra-channel histograms are extracted and concatenated into a single distribution. Since opposing pairs, like R–G and G–R, are highly redundant, either will suffice for analysis. Consequently, three of the six inter-channel histograms can be discarded. Even then, the resulting texture descriptor is six times longer than the gray-scale version.

E. Combining Color Local Texture Features For Face Recognition

This section suggests the way of combining (i.e. fusion) color local texture features for achieving the best FR performance.Generally, in biometric systems the fusion is performed either at sensor level, feature level, matching score level. The matching score level fusion method is used, as the most common approach due to the ease in accessing and combining the scores generated by different matchers. The matching module compares the extracted feature set with the stored templates using a classifier or matching algorithm in order to generate matching scores; in the decision module the matching scores are used either to identify an enrolled user or verify a user's identity using Manhattan distance-based classifier. The Manhattan distance is computed using following equation,

$$d = \sum_{i=1}^{n} |xi - yi| \qquad (2)$$

where n=256 is the dimension of the feature vector, x_i is the i^{th} component of the sample feature vector, and y_i is the i^{th} component of the template feature vector.

4. Experimentation

The proposed work is carried out by constructing the feature vector of six face images of every user from the color face database, captured in various constraints like variations in illumination, change in the facial expression and pose. During the testing, of each user four instances of face are used with various constraints. In this experiment, the R, G, B channels from RGB color space were adopted for extractingtexture features.

The developed method is tested for Indian face database by considering four face images of each user with severe variation in illumination, pose and expressions; using CLBP the Genuine Acceptance Rate (GAR) of around 97% is achieved. Further, for our database it has yielded 95% GAR. The performance of the proposed model is measured using GAR and False Acceptance Rate (FAR) [18]. GAR is the ratio of total number of correctly identified users by the system to the total number of users attempted for identification. It is stated as follows:

$$\text{GAR} = \frac{\text{Number of Correctly identified users}}{\text{Total number of attempts}} X\ 100\% \qquad (3)$$

FAR is the ratio of number of wrongly identified users to the total number of users attempted for identification.

$$\text{FAR} = \frac{\text{Number of Wrongly identified users}}{\text{Total number of attempts}} X\ 100\% \qquad (4)$$

Hence, by using the color information with local texture features the identification accuracy of around 92 % is achieved and false acceptance rate of 8 % is obtained for the own created color face database of 25 users. And about 94%GAR and 6% FAR obtained for Indian color face database.The performance of the proposed system is tabulated in Table 1.

5. Figures and Table

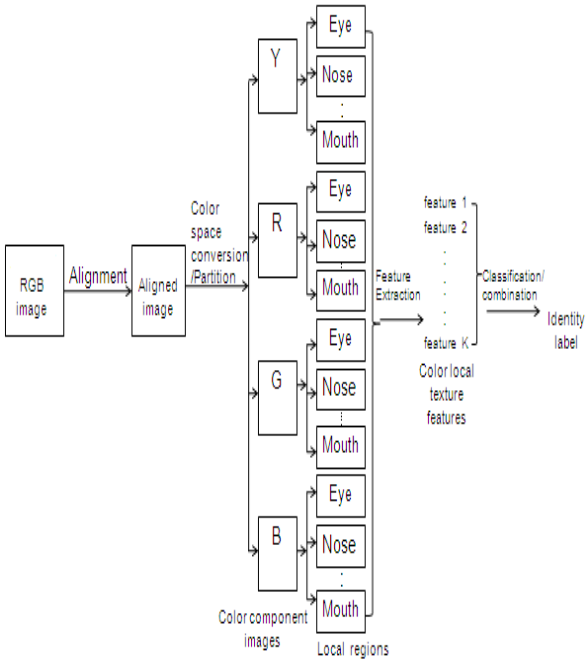

Fig.1: Proposed color FR framework based on color local texture features.

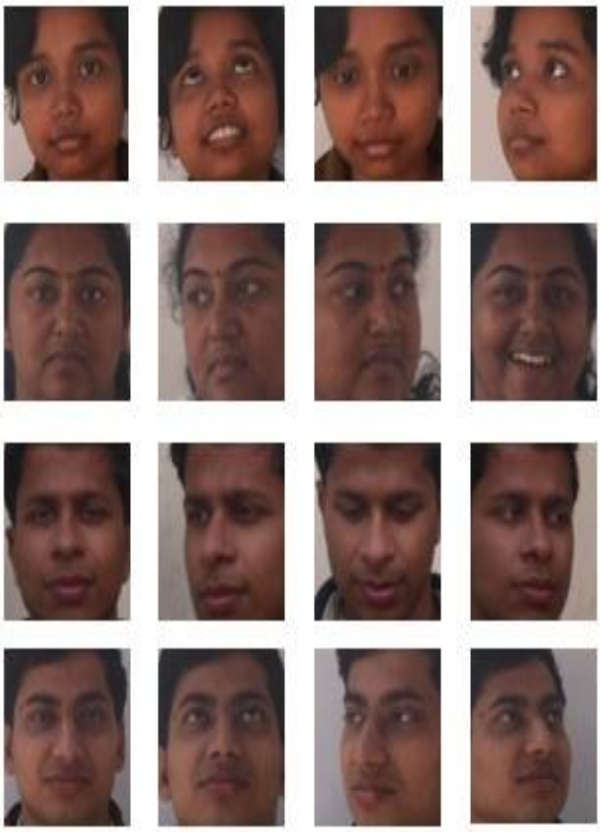

Fig.2: Indian Color face database

Fig.3: Color face database constructed by capturing mage through web camera

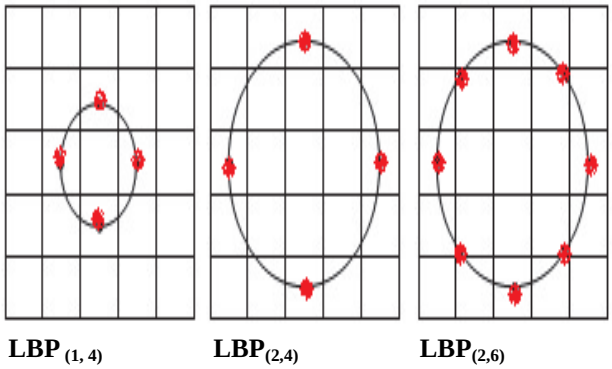

Fig.4: Circularly symmetric neighbor sets

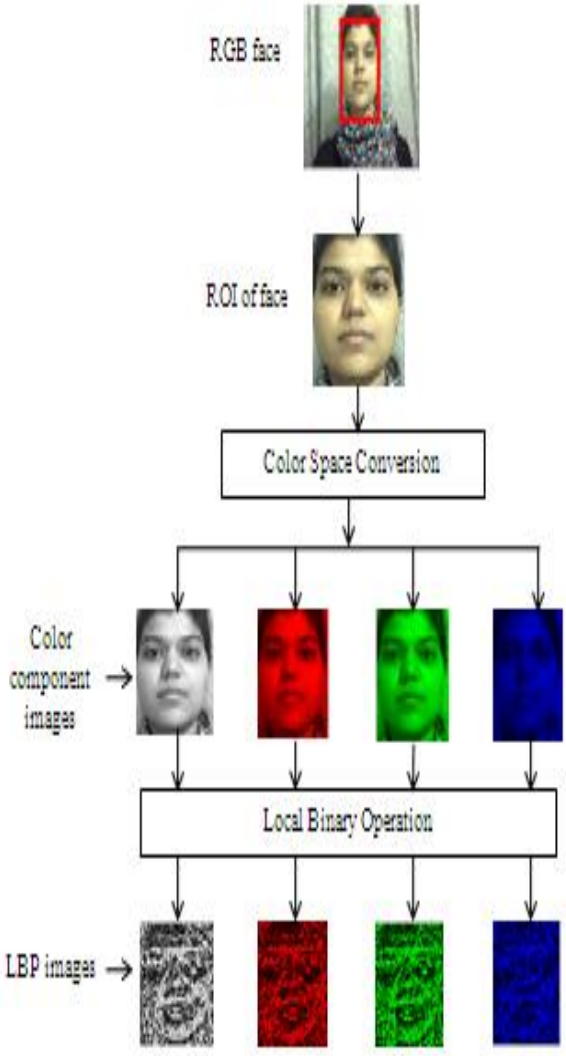

Fig.5: LBP operation process performed on each color-component image corresponding to respective channel in the YRGB color space

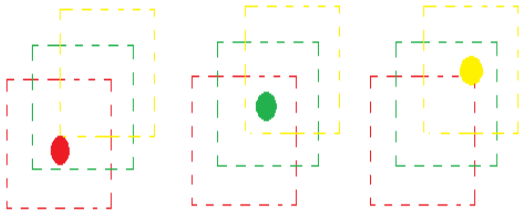

Fig.6: Opponent color LBP codes

Table 1: Face Recognition Performance

Sl. No	Number of Users	Number of instances taken for testing	Number of Correctly Identified faces	Number of Wrongly identified faces	FAR%	GAR%
Indian Face Database						
1	10	40	39	1	2.5%	97.5%
2	15	60	58	2	3.3%	96.6%
3	20	80	76	4	5%	95%
4	25	100	94	6	6%	94%
Own Color Face Database						
5	10	40	38	2	5%	95%
6	15	60	56	4	6.6%	95%
7	20	80	73	7	8.7%	93.7%
8	25	100	92	8	8%	92%

6. Conclusion

Face recognition is becoming favored biometric modalities due to its non-contact process, which is the main facet in security domain. In the proposed method experiments are carried out to exploit the discriminative information by combining color and texture information, as well as using Viola and Jones method for face detection and matching score level fusion approach with distance-based classifier to achieve better recognition rate as compared to grayscale. This experiment shows that combining color and texture information and using only CLBP significantly improves the FR performancein various FR challenges like severe variations in illumination, pose and expressions around 97%. However as this work carried out on database images, faces are already aligned and background information is minimalistic to certain extent. Therefore recognition accuracy expectation is quite high. In future, the scope for other challenges like occlusion and age factor are to be addressed.

Acknowledgement

I would like to thank all the researchers for contributing valuable suggestions and motivating to carry out the work with face recognition mainly with color local texture features. I extend my gratitude to all the authors of reference papers, to my parents and beloved teachers.

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