Face Recognition system using Local Object Appearance and Spatial Colour Layout

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Abstract: Importance of Face biometric identification system, one of the easily accessible biometric systems has increased in the last few years. When comparing to other biometrics like fingerprint, iris, signature, etc, applicability of face recognition is easier and working range is larger. This paper proposes a system to extract the texture and colour features of face images for face recognition system. This is implemented by incorporating Local Object Appearance and Spatial Colour Layout (LOA & SCL). The proposed work gives better result than many of the previous works.

Keywords: Face Recognition, Spatial Colour layout, Local Object Appearance

I. INTRODUCTION

Biometrics, which are the metrics used to refer the human characteristics can be used to authenticate human. It may be used as a measure for authentication, authorisation or identification of a person in surveillance. The biometric used for this purpose should be unique and measurable and it may be behavioural or physiological. Physiological identifiers are like face, fingerprint, palm veins, iris etc. The behavioural patterns like gait, voice etc also can be used. Easy and non-contact accessibility make the face biometric more viable among other biometrics. The face recognition [1, 5,6] can be done by using image or video from which the needed features from face are compared. The eyebrows are used as an effective feature in many of the works. Colour, texture and shape are the features used for face recognition [2].

Fig.1: Face Recognition System

Fig.1 gives the working of face recognition system. The training images are used for learning the features. The same feature of acquired image is also extracted and matched with the features of training data set. The closest match is given as the matched image and the person will be authenticated [7, 8]. If the system could not able to
find the match, then that message will be displayed. Here the challenge is identifying the match irrespective of differences in scale, pose, facial expressions etc [3, 4, 9].

II. RELATED WORK

Many researchers worked on authentication and authorization of human based on face. Many reviews [5, 6, 8] were also done in this work. In [20], the facial features are extracted by using different algorithms region-wise. In this work, for skin region, YCbCr colour space is used, for eyes, Principal Component Analysis is used and for mouth, geometrical information is used. In another work [21], the facial features are extracted using colour snakes. Another approach [22] used YCbCr colour space for feature extraction and Linear Support Vector Machine (SVM) is used for verification. Another work used statistical model for segmenting regions, Cb and Cr channel in YCbCr colour space for feature extraction, verification is done with eye and mouth map [23] and final verification is done by Feed Forward Neural Network [24]. Bebar et al. [25] used YCbCr color space for identifying eyes and mouth and final verification is done by verifying the position of the eyes and mouth. Many other algorithms were also proposed based on skin colour [26-31, 49,50]. Some of the other commonly used algorithms for face recognition are Eigen Face [32-34], AdaBoost [35], Support Vector Machines [36 - 39] and Neural Networks [40-45]. The Local Binary Pattern (LBP) [47], Local Tetra Pattern (LTrP) [51] are the texture measures used for face recognition. Shechtman et al. [48] used another descriptor named self similarity based on binned log polar representation for feature extraction.

For feature extraction, researches show better results in combining more than one feature in parallel than applying a single feature. In this work, a spatial and spectral layout of the images is provided with CPAM [11-13] and a descriptor for characterizing local object appearance and edge is provided by using HOG [14].

To incorporate human colour vision [15], the interpretation through synthesis approach has received considerable attention over the past few years [16, 17]. Ning et al [12] and Kin et al [18] used CPAM to characterise the visual appearance of small image patterns. Using CPAM, the visual appearance of a small image block is modelled by three components: the stimulus strength (S), the spatial pattern (P) and the coloured pattern (C).

Navneet and Triggs, researchers for the French National Institute for Research in Computer Science and Control, first described HOG descriptors [14]. In this work, they focused their algorithm on the problem of pedestrian detection in static images, although since then they expanded their tests to include human detection in film and video as well as to a variety of common animals and vehicles in static imagery. In Deniz et al [19], the authors were successful in applying the HOG for face recognition.

This can be applied for the images of varied image databases since this descriptor characterizes local object appearance and edge of the images well. The first step of calculation is the computation of the gradient values. In order to account for changes in illumination and contrast, the gradient strengths must be locally normalized, which requires grouping the cells together into larger and spatially connected blocks. The HOG descriptor is then the vector of normalised cell histogram components from all block regions. These blocks typically overlap, meaning that each cell contributes more than once to the final descriptor.

III. PROPOSED WORK

This work combines HOG and CPAM. In this, colour and texture features are considered. By using HOG, local object appearance and edge within an image can be described by the distribution of intensity gradients or edge directions, and by using CPAM, the human colour vision is imparted to the system.

Figure 2 shows the CBIR architecture of the proposed system. The image is divided into various blocks. HOG is applied separately for each block in the image. Likewise, CPAM is also applied to the image. The HOG features are combined to form the spatial information, and the CPAM features are combined to form...
the spectral information. This information is combined to form the feature for each image. The database images are trained in the same way, and the feature vectors are stored in a separate file. While the query image is given, the extracted feature vector is matched with the feature vector database which is being stored. The most similar images are retrieved from the database.

1.1. Descriptor Extraction Using HOG

The variation of the spatial position to scaling and rotation can be achieved by extracting descriptors in the scale space of the image following rotation normalization. The steps involved are (1) Scale-space extrema detection, (2) Orientation assignment and (3) Descriptor extraction. Figure 3 shows a patch with their corresponding gradient directions.

![Fig. 3: Patch in HOG with their corresponding gradient directions](image)

The testing on the gradients is computed using Gaussian smoothing with several discrete derivative masks. Several smoothing scales were tested. Simple 1-dimensional \([-1, 0, 1]\) masks work best. While the larger masks are used, it decreases the performance, and if the smoothing is done in images, the performance decreases significantly.

The strengths of gradient vectors can be varied for various local variations and contrast change. So the local contrast normalization is very essential to get a proper descriptor block.

1.2. Descriptor Extraction Using CPAM

RGB image is converted into YCbCr space. CPAM code is found out for this YCbCr image. The three visual pathways, pattern, colour and strength for a small block of image are modelled in CPAM as S, P and C. For a small image area, the stimulus strength S is approximated by the local mean of the Y component.

The pixels in Y is normalised by S form the spatial pattern. Because Cb and Cr have lower bandwidth, they are sub-sampled by a factor of 2 in both dimensions. The sub-sampled pixels of Cb and Cr are normalised by S, to form the colour (C) component of the appearance model. By separating achromatic and chromatic signals, the work can be done on two low-dimensional vectors rather than one very high dimensional vector.

1.3. Feature Level Fusion of HOG and CPAM

The HOG and CPAM descriptors of the given image are found out separately. The feature vector of the image is the parallel combination of HOG and CPAM descriptors. By doing this, the spatial and spectral orientation of the image and the local object appearance can be found out.

IV. PERFORMANCE ANALYSIS

Indian Face database [46] is used for implementation. Indian Face database, which is published by IIT Kanpur in India, is widely used for research purposes. In this database, images of 50 persons with 10 sample images with different orientations and views are available. There are 25 female subjects and 25 male subjects available in Indian Face database. The resolutions of this database images are changed into 128 x 128 for computational purpose and one normal face of each subject is used for training. This experiment uses 240 expressions variant and 357 pose variant faces up to 180° for testing. Figure 4 gives sample images of one person with different face orientations from Indian Face database.
Although remarkably robust, many face image retrieval techniques are not perfectly invariant to pose and viewpoint changes. The pose variation is one of the key challenges in the case of face recognition especially in single sample per class. The Indian Face database consists of samples of poses up to 180° rotation angle. Figure 5 illustrates the comparison between the proposed work and the existing works in terms of average precision. From this, the following points are observed.

1. The average precision of LOA & SCL is 82.93%, HOG is 81.7%, LTrP is 78.2%, LBP is 82.1% and Self similarity is 23.93%.
2. The E-LOA & SCL gives better result compared to other existing works.

Figure 6 gives the comparison of average retrieval rate of methods.
Figure 7 gives the comparison of average recall of methods. From this, the following points are observed.

1. The average recall of LOA & SCL is 75.04%, HOG is 73.48%, LTrP is 73.76%, LBP is 73.48% and Self similarity is 23.4%.
2. The E-LOA & SCL gives better result compared to other existing works.

Figure 8 shows the precision of top number of images retrieved for Indian Face Image Database.
V. CONCLUSION

Face image recognition system is used in many application areas such as person verification, video surveillance, crime prevention, and similar security activities. It’s challenging to authenticate a person when the picture is not having needed clarity. Different researches were done for improving the accuracy of face recognition system. This proposed work gives combines the HOG and CPAM methods, which will help to extract texture and colour information of the face image. The proposed work gives better result than many of the previous works.

REFERENCES


