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Color Face Recognition using Texture Features and Fractional Fourier Transforms

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Abstract— This paper proposes color local binary pattern and fractional Fourier Transform features for face recognition. The YCbCr Color space model is used in this approach. Fractional Fourier Transform features and local binary pattern features are used for face recognition. kNN classifier is applied to face recognition phase.

Index Terms— Face Detection, Face Recognition, Feature Extraction, Local Binary Patterns, Fractional Fourier Transforms,Color space conversion,Classification

1 INTRODUCTION

Face recognition has recently received significant attention because of its wide range of applications. There has been increasing amount of work on colour aspects of image analysis. The colour information can be used to enhance classification and recognition performance.

Face detection is the first step of any face processing systems. Face detection algorithms are classified into four categories. 1) Knowledge Based methods. These are rule based methods which consider the relationships between facial features. 2)Feature Invariant Approaches. These algorithms find structural features like texture, colour, grouping of edges or a mix of them. These structural features work even when the pose, viewpoint, or lighting conditions vary. 3) Template matching methods. In these methods, several standard patterns of the face are stored and the existence of a face is determined based on correlations between an input image and the stored patterns.4) Appearance based methods. These methods are based on learning algorithms.

Pre processing is done for two purposes.1) To reduce noise. 2) To transform the image into a different space where classification may prove easier by exploitation of certain features.

The main issues in face recognition are features representing the face and the classification method used. Feature extraction is an important task in face recognition process. In Signal processing applications, FRFT is used for filtering, image recovery, restoration, enhancement and pattern recognition. Local texture features are powerful face descriptors. Local Binary Pattern (LBP) texture features are highly discriminative for Face Recognition due to different levels of locality.

The techniques of Pattern Recognition can be classified into four categories: Template Matching, Statistical approaches, Syntactic approach, and Neural networks. In template matching, several templates are built for each label class and these templates are compared with the test pattern to get a suitable solution. The statistical approaches extract knowledge from training data and use different kinds of machine learning tools for dimension reduction and recognition. The Syntactic approach is rule-based pattern recognition in which the recognition system use rules to perform certain actions. A neural network is a framework based on the recognition unit called perceptron.

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2. PROPOSED METHOD

The proposed FR method consists of the following steps: Face detection, Color space conversion, Feature extraction and Classification.

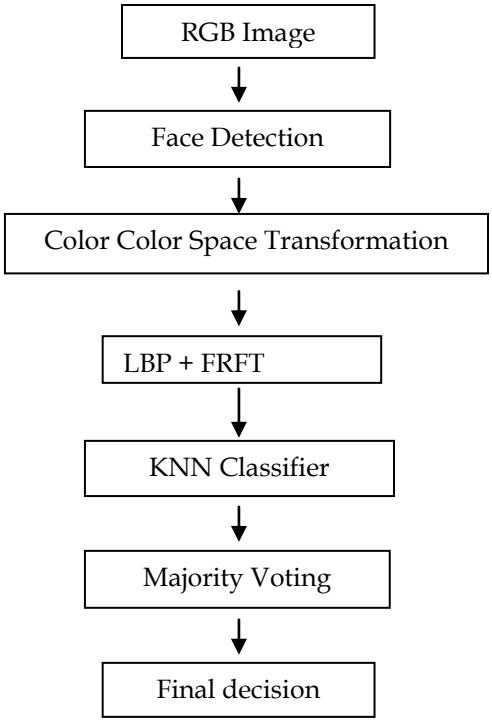

Fig 1. Proposed Method

A face image in RGB color space is first converted to L*a*b* so that luminosity can be increased. Feature based system operates much faster than a pixel-based system. Because of this reason, face detection based on Haar basis functions are used. Rectangle features of the image are constructed using Integral Image which is an intermediate representation of the image. Using the integral image, any rectangular sum can be computed in four array references.

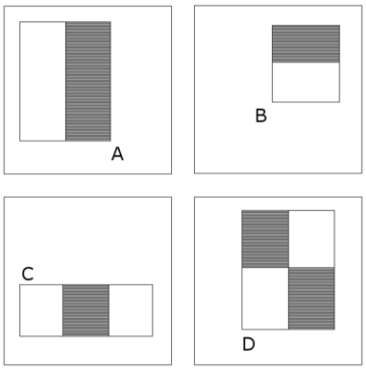

Fig 2. Feature types used by Viola Jones

The features that Viola and Jones used are based on Haar Wavelets which are single wavelength square waves. In two dimensions, a square wave is a pair of adjacent rectangles, one light and one dark. The actual rectangle combinations used contain rectangle combinations suited to visual recognition tasks.

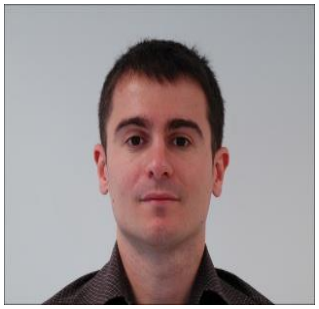

Fig 3a. Input Image

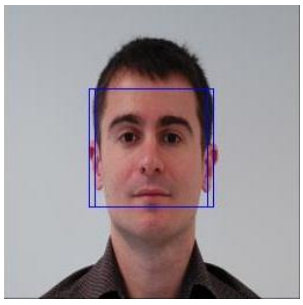

Fig 3b. Image with detected face

Color space transformations reduce the interference between skin and non-skin pixels. This interference can happen by eliminating the components of light. Skin detection can be performed using color models named RGB, YCbCr, HSV, YUV etc. RGB color space is the most common color space, but R, G and B are dependent on illumination conditions. Because of this reason, skin detection with RGB color space can be unsuccessful when the illumination conditions change. YCbCr color model belongs to the family of television transmission color models. In this model, Y is considered as lighting component and Cb and Cr are related to the blue and red chrominance components, respectively. Chrominance component of the skin-tone are independent of the luminance component. YCbCr color space helps in handling intensity variations.

The cropped image is divided block wise, so that FRFT can be applied. FRFT is the generalization of the classical Fourier Transform. It depends on a parameter $\propto (= a\,\pi/2)$. FRFT is the rotation of a signal for an arbitrary angle α in the time-frequency plain or decomposition of the signal in terms of chirps. A Discrete Fractional Fourier transform of a vector

$f = [f(0), \ldots, f(N-1)]^T$ is defined as a vector

$fa = F^a f$, i.e., the vector with components

$$f_a(k) = F^a f = \sum_{n=0}^{N=1} F^a(k,n) f(n), k = 0, \ldots\ldots, N-1 \quad ,$$

where $F^a = E\Lambda^a E^T$, *with* $F^a = E\Lambda E^T$, an eigenvalue decomposition of the DFT matrix.

Local Binary pattern features are extracted from the detected face region. The LBP operator assigns a label to every pixel of an image by threshholding the 3 x 3 neighbourhood of each pixel with the centre pixel value and considering the result as a binary number. The histogram of the labels can be used as a texture descriptor. The LBP method for face description consists of using the texture descriptor to build several local descriptions of the face and combining them into a global description. The facial image is divided into rectangular regions. Next step is to extract texture descriptors independently from each rectangular region. A histogram is computed with each of the rectangular regions. The resulting histograms are combined which give the spatially enhanced histogram. The spatially enhanced histogram gives a description of the face. Both the LBP features and FRFT features are used for face recognition.

Classification is done using *k*NN classifier. Given a set of training examples, upon receiving a new instance to predict, the *k*NN classifier will identify *k* nearest neighbouring training examples of the new instance and then assign the class label holding by the most number of neighbours to the new instance. For pattern recognition techniques, the patterns are represented as a vector of feature values. The selection and quality of the features representing each pattern have a considerable bearing on the success of subsequent pattern classification. In *k*NN classification, each training pattern is represented in a *d*-dimensional space according to the value of each of its *d* features. The test pattern is then represented in the same space and its k nearest neighbours, for some constant k, are selected.

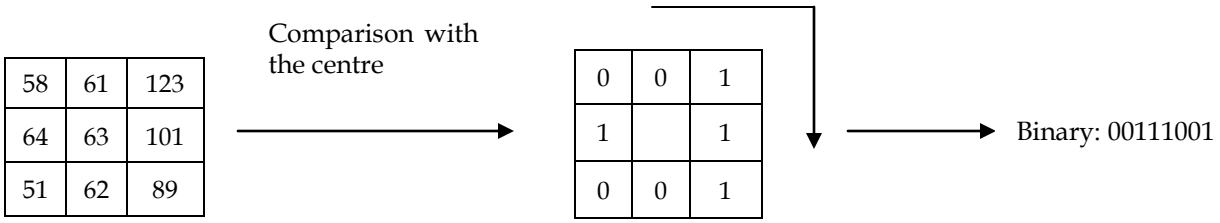

Fig 4. LBP Operator

Neighbours are calculated according to Euclidean distance. The class of each of these k neighbours is then tallied, and the class with the most "votes" is selected as the classification of the test pattern. *k*NN gave a good classification performance on a wide range of input sets. The color images from GTAV Face Database were used.

3 Conclusion

In this paper, a face recognition method that used Local Binary Patterns and Fractional Fourier Transform for feature extraction is proposed. The *k*NN classification used gave a good performance with 80% accuracy.

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