Multi-view Gender Classification using hybrid Transformed Features

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Abstract

In this paper, a two step efficient pose based gender classification technique has been presented. In first step, the proposed technique uses different type of features for pose classification which classifies the input image as frontal or side pose image. Based on pose classification result, gender classification is performed in the second step. Two different types of gender classifiers have been proposed for both side pose and frontal images which use the image and pose classification result as input and classifies the image as male or female. The proposed technique is tested over standard datasets using well known quantitative measures. Results show that the proposed technique gives superior performance than the existing techniques.

Keywords: *Pose based Gender classification, Hybrid Feature extraction*

1. Introduction

Classification has been viewed as major area of research in various disciplines. Classification is being applied in various environments quite effectively to yield impressive results. Among several problems tackled by classification, gender classification is considered to be a challenging task. Use of facial images has been an interesting area of study in the domain of computer vision apart from gender classification. Feature extraction and pattern classification are two fundamental concepts involved in gender classification process. Literature review points out the fact that significant volume of extensive work exists in the area of gender classification using facial images by well known researchers. Chiraz BenAbdelkader et. al. [0] has come up with a technique which uses local region for effective gender classification. Another technique for gender classification developed by the Majid et. al. [8], calculated the DCT and then used normalization to compute the significant DCT coefficient in a zig-zag manner starting from top left corner.

Shan et al. 2011 [0] investigated gender recognition on real-life faces using the recently built database, the Labeled Faces in the Wild (LFW). Local Binary Patterns (LBP) was employed to extract features from face, and Adaboost technique was applied to select final set of features from Local Binary Patterns Histogram (LBPH) bins at different scales. For gender classification Support vector machine (SVM) was adopted and for this purpose boosted LBP features were given to SVM. They obtained the performance of 94.81% by applying Support Vector Machine (SVM) with the boosted

LBP features. Feature selection using PCA and SVM for classification of margin maximization was presented by N.P.Costen, et.al [0]. Their work has shown significant improvement against other existing methods. A. Majid et.al [0] used genetic programming (GP) based optimized SVM classifiers for gender classification. Their work performed better than individual SVM classifiers.

In this paper, we have proposed an efficient pose based feature extraction and classification technique. The novelty of proposed scheme actually lies in applying pose based classification as intermediate step. An ensemble of classifiers is used to achieve results with higher degree of accuracy and precision while maintaining the efficiency of the system intact. Pose based classification can be used in the earlier stages of classification such as recognition process. In this case the technique is used in real time environment, when there will be several situations, in which frontal image may not be available. In such circumstances, use of pose based classification is very vital.

2. Proposed Method

The architecture of this proposed method is shown in figure 1. The proposed method consists of two main modules including pose classification and gender classification. Preprocessing module consists of face detection, block based feature selection, feature extraction and classification as in [0]. The proposed technique starts by extracting features using well known feature extraction techniques. Features are further processed and classification takes place accordingly. The enhanced efficiency of the proposed methodology is due to the fact that instead of presenting whole image as input to classifier, we have used only facial part of the image. This facial part is then used to extract significant features using DCT and Discrete Wavelet Transform (DWT) based reduced features selected through PCA.

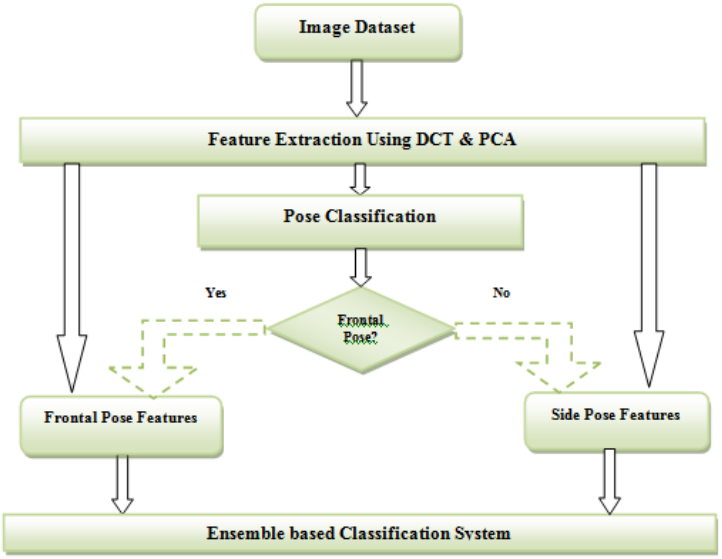

Figure1. Proposed System Architecture

It reduces the total number of computations thereby yielding classification in a more robust and efficient manner. Features having significant impact on classification are

then used for pose classification. In order to achieve better pose classification, different classification algorithms have been applied.

After getting the pose information from the pose classifier, gender classification is performed using two different gender classifiers. One gender classifier is trained on frontal faces whereas the other one is trained on side poses. The main steps of the proposed methodology are given below:

The datasets of images used in the proposed technique includes FERET [0], CVL database [0] and Indian database [0]. Images passed to the system are first converted into gray scale and resized to size 100x100. This process is essential in order to transform the images in a standard format and size. DCT is applied on selected images to extract features. Optimal feature selection is performed over extracted features by selecting the features at top left corner in a zigzag manner [0]. Furthermore, DWT features are also extracted and reduced by PCA have also been used to achieve better accuracy. The new feature vector comprising of most significant features is given to ensemble of heterogeneous classifiers which includes SVM, KNN, LDA, NMC, NMSC and FLDA. The second module utilizes features extracted through DCT and PCA of both frontal and side pose images and generates the binary output which determines whether the image is of a male or a female.

After converting color image to standard grayscale, we have applied the technique proposed by viola and Jones [0] for face extraction. For the purpose of classification of images of different pose, we need some key parameters (features) of the image to discriminate pose and gender. DCT has been used for feature extraction. Consider $f(x, y)$ is a gray scale image of size $N \times N$, then DCT coefficients can be calculated using the following equation. After performing the DCT, the coefficients are selected from the top left corner of the transformed image in a ziz-zag manner as used in [0]. In the proposed technique PCA has been applied on the approximation component of the discrete wavelet transform. Continuous wavelet transform (CWT) was extended to DWT. CWT composed of scaled and shifted version of mother wavelet transform; therefore, it can be defined in the form of mother wavelet transform. The one dimensional transforms of wavelet functions can easily extended to two dimensional functions like images. $\varphi(x,y)$ is a two dimensional scaling function and there are three 2D wavelets $\psi^H(x,y)$ $\psi^V(x,y)$ and $\psi^D(x,y)$ The discrete wavelet transform of image $f(x,y)$ as described in [0] is calculated as

$$F(u,v) = \alpha(u)\alpha(v)\sum_{x=1}^{N}\sum_{y=1}^{N} f(x,y) \ldots \times \cos\left[\frac{(2x+1)u\pi}{2N}\right]\cos\left[\frac{(2y+1)v\pi}{2N}\right] \quad (1)$$

Where

$$\alpha(u), \alpha(v) = \begin{cases} \sqrt{\frac{1}{N}} & u, v = 1 \\ \sqrt{\frac{2}{N}} & Otherwise \end{cases}$$

DWT transforms given image into its frequency components. These components are called detailed and approximation components. High pass and low pass filter are applied to separate detailed and approximation components respectively. Following equations define scaled and wavelet functions:

$$\varphi_{j,m,n}(x,y) = 2^{j/2}\varphi(2^j x - m, 2^j y - n) \quad (2)$$

$$\psi^i_{j,m,n}(x,y) = 2^{j/2}\psi^i(2^j x - m, 2^j y - n), i = \{H, V, D\} \quad (3)$$

Input data in the form of features is passed to the classifier for classification. The features of frontal and side pose are fed into the second classification module which determines the gender. For this purpose, four different classifiers have been used to train and test on facial images dataset. We have used 10-fold cross validation to remove bias. Classifiers used in this paper include BPNN, SVM, NMS, NMC and LDA.

3. Experimental Results & Discussion

In order to perform experiments and performance evaluation of different classifiers, FERET (Gray scale), CVL and Indian colored image databases has been used. The dataset was equally divided into two sets. Each set contain male and female images. Images are of different races and facial expressions. We have performed experiments on DCT and DWT coefficients by using different number of features ranging from (2, 3 . . . 20) from each image respectively. In case of DWT, Daubecchies (db2) wavelet has been used for feature extraction and then these features have been further reduced through PCA. The normalized DCT and DWT coefficients are selected and passed to classifier for classification. Classifiers with train to test ratios 1:3 and 3:1 have been used with 10-fold cross validation. Averaged results of the classifiers are calculated. In the case of KNN, we have used different value of K ranging from 2 to 6 but best results were found at k=3 features extracted. The range of features is from 4 to 20. The best accuracy is achieved when we use six features. However, among different classifiers, the best performance is shown by using classifier ensemble. Training to test ratio was maintained at 1:3. The technique suggested by [0] uses 50 features while our proposed method uses 20 features only. Experimental results indicate that proposed method performs well on LDA and Mahalanobis classifiers as compared to [0] whereas the performance of proposed model is marginally lower on KNN classifier. Results presented in [0], the accuracy of SVM is 94.81%. The results of pose classification on FERET database are 95.35%. Though the results presented in [0] are performed on real world face images.

Table 1. Comparison of KNN, LDA, NMC and ensemble for gender classification and Pose based gender classification

Technique	Dataset	KNN	LDA	NMC	Classifier Ensemble
Gender Classification using DCT Features	*CVL Database*	***0.9746***	*0.6962*	***0.9746***	***0.9867***
	FERET	***0.9785***	*0.7745*	***0.9650***	***0.9757***
	Indian	***0.9578***	*0.7865*	***0.9878***	***0.9878***
Gender Classification Using DWT Features	*CVL Database*	*0.8350*	*0.9350*	*0.8530*	*0.9830*
	FERET	*0.8940*	***0.9535***	*0.8830*	*0.9630*
	Indian	*0.9035*	*0.9450*	*0.9135*	*0.9725*

The comparison of our proposed pose based gender classification technique has promising results with DCT gender Classification and pose based in table 1 using KNN, NMC and LDA classifier. It can be seen that in case of frontal face based gender classification where [0] has used KNN, the technique proposed performs slightly better than our proposed technique. However, the results are quite comparable. When it comes to the case of pose based gender classification, the performance of our proposed technique shows double the size of improvement over the one proposed in [0] as

compared to the improvement achieved in the case of frontal face based gender classification.

4. Conclusion

Gender classification is one of the active areas of research in pattern recognition and image processing. Currently most of acclaimed work in this domain revolves around frontal facial image based classification. Instead, we have proposed the use of feature extraction to perform gender classification. In feature extraction, a subset of features is obtained by choosing a subset of the original predictive variables thereby eliminating redundant and uninformative ones. This gives us the advantage of obtaining as much information as possible from a given data set while using the smallest number of features. In this paper, an efficient feature extraction module has been used for pose based gender classification which makes classification process fast and accurate. The results of the proposed technique, when compared with other techniques, shows that the proposed method gives superior performance in terms of various quantitative measures especially in the case of pose based images.

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