Dense Pixel Correspondence based Gender Recognition of Facial Images

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Abstract - Human gender recognition is a basic task in computer vision systems based potential applications. The complexity increases due to substantial variations in unconstrained scenarios. Though there are many handy approaches proposed, as the complexity increases due to substantial variations in unconstrained scenarios effected by noisy back grounds and poor illuminations exploiting information becomes a challenging task. This paper present about multi-stage gender recognition technique; identifying the face using Haar features and cascade classifier with help of Adaboost technology, and computing dense pixel correspondence for facial gender recognition for de-noise preprocessed images using deformable spatial pyramid (DSP) matching. Simulations are carried out using Open-CV libraries. Based on the results, higher efficacy has been demonstrated on FDDB (Face detection dataset and benchmark).

Keywords: Adaboost technology, deformable pyramid matching, face, gender classification, gender recognition

1 Introduction

Humans adept in gender recognition through complex visual perceptions, but computer vision based systems like biometric authentication, security, criminology etc., still lacks in matching the ability of classification due to unconstrained scenarios enhanced with noises and low level of illuminations hampering the demographic attributes. In addition, the system need to be robust to detection of gender even if the facial hair changes [1, 2]. As the demand for machine dependent based security, reliability and convenience increases urge to address the limitations that foreclose the recognition systems being applied on real time applications increases.

The face demographic attributes vary a lot due to variations in pose and the initial works which extracted features based on the measurement of distance between eyes and mouth, and other facial measurements [2] alone were not able to discriminate the face in the image. Golomb et al [3] to discriminate the faces gender used a two stage network (SEXNET), compression network and the sex network where former network encodes the normalized images in to hidden nodes and these nodes are fed in the sex nodes to determine the gender. A Cottrell style back propagation is used to activate the network but no efforts are made to optimize the network. Tamura et al [4] introduced enhanced network training that utilize orbit and cheek bone shape via possible shadings of face shape. Jain et al [5] utilized independent component analysis (ICA) for feature vectors of image in a low dimensional sub-space. Caifeng et al [6] and Mostafijur et al [1] utilized local binary pattern (LBP) for feature extraction. These authors utilized support vector machines (SVM) based classification for gender identification. In addition histogram equalization techniques [1] are utilized for removing unwanted noises.

In general, the gender recognition techniques can be divided into multi-stage process which include object detection, preprocessing, feature extraction and classification. In our study for a given image the presence of face is identified used Haar features and cascade classification. Preprocessing is done for denoising and enhancement of the image through the combination of the wavelet denoising and anisotropic filtering. Finally, the feature extraction and classification for gender discrimination is replaced by deformable spatial pyramid (DSP) matching.

The rest of the paper is organized as follows: Section 2 provides the detailed description of the step by step procedure of the algorithm. Section 3 provides the results and discussion. Section 4 concludes the study.

2 Proposed algorithm

Features from the facial images are extracted to discriminate the gender as the persons face demonstrate many variations. The proposed algorithm can be shown in Fig.1.
2.1 Face detection

Face detection as a first step is an important task in this study. Viola and Jones [7] methods are utilized for identifying the presence of face in the image which is built on three stages process: representation of image as integral image for high speed feature computations which are set of Haar basis function, optimal feature selection utilizing Adaboost as the feature set of Haar-like features is exclusively huge in number, and a complex classifier cascade structure. To train the cascading function, the pattern identifier requires a combination of positive and negative images where certain patterns are matched through extracting all highlighted features from image. Instead of performing computations on overall 160000+ features in a single window, the image integral values which sums up pixels in a given rectangle are utilized to reduce the number of features and countenancing for real time detection. With the help of Adaboost technology relevant and irrelevant features are distinguished which in turn helps in finding out the best features among the 160000+ features. A weighted combination at the end is used to finally determine the presence of face structure.

2.2 RGB to grey level conversion

Once the images with faces are identified, the color images are mapped into grey scale images upholding the contrast, sharpness, shadow and structure addressing the disparity of chrominance and luminance and through RGB approximations [8]. The resultant high quality mapped grey scale images are prone to noise due to conversions and preservations.

2.3 Noise reduction and image enhancement

Wavelet coefficients can filter the presence of noise in an image which degrade the image information. A two level decomposition of discrete wavelet transform fetch four filtered coefficients. A reconstructed image from these filter coefficients is free from noises [9]. Fig. 2 describes the reconstruction of the image from filter coefficients.

2.4 Gender detection using deformable spatial pyramid matching algorithm

The de-noised imaged is resized and fed into pyramid model for detecting the gender where the detection is done through corresponding matching from the given knowledge base [11]. The image is converted in to the pyramid model by dividing the image in to four rectangular grids, further each of the rectangular grid is again divided in to four grids of same shape. This process is repeated for three levels to form the pyramid structure. A pixel layer is appended at the end or bottom of the pyramid. Spatial nodes which are varied in size are defined with edges spatially distributed over all levels of the pyramid. Edges spans through every level as the pixels that are associated to parent grid cell are not among them. Shift invariant descriptors compute the matching cost. Once the energy minimization problem is computed through matching algorithm, a loopy belief propagation minimizes the computed energy[12]. The equation can be formulated as.
\[
E(t, s) = \sum_i M_i(t, s) + \alpha \sum_j V_j(t, s) + \beta \sum_{i,j \in N} W_{ij}(s, s_j)
\]

where \( M \) is matching cost, \( V \) is smoothness to regulate solution, \( W \) scaled smoothness, \( t \) is translation node, \( s \) is scale variable, \( i \) and \( j \) are nodes. \( \alpha \) and \( \beta \) are two constant weights.

3 Experimental Results

For the proposed model, FDDB: face detection dataset and benchmark [13] a widely used dataset for face detection have been utilized. The dataset comprises of 2845 images containing 5171 faces in total images which are collected from popular Yahoo website news articles. For detecting the gender, a DSP matching algorithm is utilized after the noise reduction and image enhancement. Fig. 3 illustrates the noise reduced and enhanced images of the proposed model for a sample image considered from the dataset. After detecting the face, the resultant image is mapped from RGB to Grey. Later wavelet de-noising is applied to get rid of the noise while the information is preserved. Finally, when an anisotropic diffusion filter is applied, the image is enhanced.

![Fig. 3. Noise reduction and image enhancement process.](image)

DSP techniques are utilized for the matching purpose where Open CV libraries are used for processing. The classification results are illustrated in Fig. 4. The results demonstrate that using a pre-processing image the DSP algorithm is able to discriminate the gender.

The recognition accuracy of the male and female faces is 83.53% and 85.71% without any preprocessing. While the performance increased drastically when a preprocessing is applied with accuracies increased significantly to 96.47% and 92.21% for male and female respectively.

![Fig. 4. DSP matching output and detected gender for resultant images from sample images from Dataset.](image)

From Fig. 5 it is evident that pre-processing images provide better accuracy by approximately 13% for male and approximately 7% for female gender identification. DSP matching is giving us the better result as the images information is enhanced eliminating the effects uncontrolled scenarios.

4 Conclusions

This study proposed a multi stage gender identification procedure where de-noising and enhancements through wavelet decomposition and anisotropic diffusion serve as preprocessing for DSP matching algorithm. The problems of uncontrolled scenarios like the poor illumination levels, noisy back grounds, variations in facial geometry are addressed. The combination provided higher classification accuracy to implement on real time scenarios. This algorithm is tested on
classification of adults alone and need to be tested and optimized further on kids gender classification.

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5 References


