Gender Identification from Facial Images: Survey of the State-of-the-art

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Abstract—Face recognition is one of the most flourishing applications of image analysis and understanding, which has gained significant attention, especially in the past several decades. In field of image processing face is one of the most important biometric traits and is becoming more popular for many application purposes in now days. During past several years classification of gender from facial images has gained enormous significance and has becoming a popular area of research. Recently it is applied in many areas such as security, monitoring, surveillance, commercial profiling and human-computer interaction. In this paper we will discuss different gender classification methods and uses of different facial features such as eyes, nose, mouth etc. for gender classification using machine learning techniques.

Keywords—Gender identification, Face detection, Feature extraction, Classification

I. INTRODUCTION

Image processes and machine learning techniques are used in various types of applications, such as gender classification, face gesture and facial expression recognition system [1]. In the recent decades computer has become popular and gaining attention immensely in identifying of ethnicity of human faces, gender and age [2], so image processing have a big role in computer science fields such as, surveillance,bio-metrics applications, Security, image tagging and General Identity Verification system [3]. When identifying gender there are some distinguishable features that exist between male and female which are used by computerized methods to classify gender [4]. Gender classification is a binary classification technique to classify male and female, this technique has become one of the most important task due to its many applications [5]. When using the gender classification convergence with face recognition that makes the face recognition task fast as twice, by eliminating the search for a particular gender [6].

In this paper, we survey the methods of human gender recognition in facial images. We are focusing on the face of the human with application of some facial analysis.Also we concentrate on approaches using (2-Dimensions) image. Generally, all pattern recognition problems, when tackled with a supervised learning technique, could be dividing into fallowing steps (1) object detection and preprocessing (2) feature extraction (3) classification. In step 1, subject of human or face region is detected and cropped. This is followed by some preprocessing, for example histogram equalization, geometric alignment or resizing. In step 2, a feature vector was extracted from the image using different textural, structural and geometric feature extraction techniques in order to obtain the most accurate facial feature. Finally, the classification involves taking the feature vectors extracted from the image and using them to automatically classify an images gender. This is done by using different algorithms. As the subject is to be classified as either male or female, a binary classifier is used, for example, K-Nearest Neighbors (KNN), support vector machine (SVM), Adobos', neural networks and Bayesian classifier [7].

II. LITERATURE REVIEW

Many researchers have developed techniques for facial gender classification. Most of these techniques focus on the extraction and fusion of different types of facial features,such as:
Tolba and Shan Sung et al [8],[9] used neural network to handle the problem of gender identification via radial basis function (RBF) and learning vector quantization (LVQ) networks. The results show that the identification of gender with accuracy rate of 100% in the case of a LVQ network when hair information excluded with small number of facial images and 95.1% when hair information included. In the case of an RBF network the accuracy is 98.04% when hair information is excluded. Although LVQ obtained high accuracy but in terms of generalization RBF is better and smoother, because the study adjustthe spread constant as parameter to ensure that the overlapping of active regions of the radial basis neurons enough.

In [9] an approach using a convolutional neural network (CNN) for real-time gender classification based on facial images is proposed. This study used SUMS and T&T databases. The proposed CNN architecture reduced to only four layers. The network is trained using a second-order back propagation learning algorithm with annealed global learning rates. The accuracies obtained are 98.75% and 99.38% for the SUMS and T&T respectively. This result is considered to be a superior classification performance and it verifies that the

proposed CNN is an effective real-time solution for gender recognition. The CNN work can be extended for face detection and alignment tasks. However, the problem with any neural network method is that they are computationally expensive. There are many researches used the frontal facial images to classify the gender [10, 11, 12, 13, 14], some them used local feature and other used global feature. Supervised learning, unsupervised learning and deep learning used for classification. In [10] amit et al., introduce method to classify the gender with superior performance. They used a feature vector to represent each image by using (ICA) and working on linear expansion of the vector to make it independent as possible. The accuracy rate when they use (SVM) is 96% that relies to use of most discriminating features (MDF), which works to decrease irrelevant feature (like the lighting direction) for the classifier.

In [11] ErnoMakinen and RoopeRaisamoconducted a study to identify the similarly of the state of the art gender classification methods in order to figure out their actual reliability by using FERETS and WWW data bases. The study has an inclusive and analogous classification result for gender classification methods merge with spontaneous real-time face detection and manual face normalization. The study decided that, the use of hair in face images has no guarantee of better classification rate when it compared with use of face location normalization, which improved recognition and classification rates.

In [12] M. Nazir et al.presented an efficient gender classification technique, using Stanford University Medical Student (SUMS) database. Viola and Jones face detection technique used for segmentation the face part of the image.Itknown as cascade face detection[13]. This technique searches the face portion to extract face from the image.It starting by top left corner to the bottom right corner down ward and it normalize the illumination effect by performing the histogram equalization. Viola and Jones techniquefollowed by DCT and KNN for feature extraction and classification respectively. Experimentally their approach achieves 99.3% as accuracy. However the method proposed is not affected by the training and testing set size and the classification accuracy is not affected even if were selected a very few of the total DCT features.

In [14] Li et al., came out for gender identification from occluded faces of six of facial element such as hair, forehead, eyes, mouth, nose and clothing. They carried out these experiments on FERET and BCMI (self-collected) face database. The general using a fivefold validation crossing method for non –occluded face was higher than for occluded face with 95%, 90% respectively.

In [15] came up with a method which utilizes Local Block Difference Pattern (LBDP) with the assistant of Support Vector Machine (SVM) to identify the gender from the face images using FERET database. The experimental result provided to illustrate and clarify the suggested approach is an effectual method, than other similar methods.

Also in another side in [16] Zhejiang et al., proposed study on spontaneous face gender classification that concentrated on the various character normalization methods. It includes Delaney triangulation warping and two kinds of offline mapping to perform gender classification using Linear Discriminant Analysis (LDA), SVM and real Adabbost. The study results concluded the suitability of Delaney triangulation for global features approach based and haar like feature based method such as SVM or Fisher Linear Discriminant (FLD).

In [17] suggested learning discriminative Histogram (LBPH) in gender classification bins. It selected to a compact and consolidated facial representation and 94.8% accuracy was achieved on LFW database.

In [18] Priteeet al. conducted a robust gender classification to occlusion by using Gabor features based. Later (2D) and PCA techniques is used to calculate features for every sub-image, one each illumination steady real Gabor space generated using both Support Vector Machine (SVM) and Gabor fitter for classification .The experiment results indicate that above 90% accuracies can be yielded for the system. Besides it can with stands in laugher occlusion condition by producing a minimum of 86.8% accuracy, however the accuracy of the system is essentially to be improved at the same time of size of the features vector is to be kept at small size.

In [19] Gour and Roy determined age and gender from fingerprint. For their work they were used Discrete Cosine Transforms (DCT) and Discrete Wavelet Transforms (DWT) coefficients to extract fingerprint image feature, and KNN as classifier. The data-set contain 100 number of fingerprint image of different age which include both male and female fingerprint. The result shows an accuracy of 90% for age and gender.

III. THE GENERAL SYSTEM

General steps of solution of the problem in computerized method in facial images is illustrate below: Figure 1 shows that.

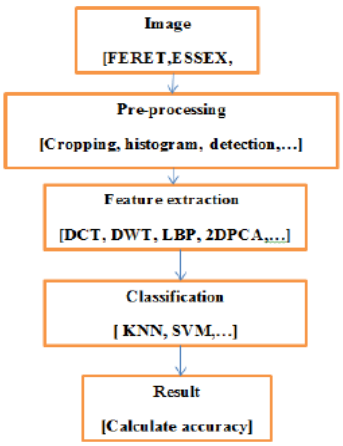

Fig1: The General System OfGender Classification

A. Preprocessing

Some variation such as illumination is Sensitive to classifiers or the result of the system, it poses or inaccuracies. So, some preprocessing steps have to be performing in order to reduce this sensitivity.These processing steps include [1]:

- Brightness normalization by using Histogram equalization function.
- Remove the background from the images and take just the region of face. Then resizing images by reducing it.

B. Face Recognition

A computer technology application that is used in human faces in digital image is called face detection [20]. It also refers to the psychological process where human can locate and attend to face in a visual scene [21]. To detect a face in a scene there are numerous ways some of them easier and other are harder. The following are the list of the most familiar approaches (methods) in face detection [22]. Single image detection methods are classified into four categories.

1) Knowledge-based methods:

Theprocedures of these method isencoding information of humanin constitutes a distinctive face and working exactly forface localization. The rule learns about the relation of features. It can doing by top-downand bottom-up methods [22].

2) Feature invariant approaches:

The procedure here is to find the structural features that live with deferent situations then use it to find the faces. It used mainly for face localization [22].

3) Template matching methods:

The standard patterns of facial features are stored separately. The procedure here is to compare between an input pattern and the stored one to carry out the detection. It applied for both facedetection andlocalization. The template matching researches of these approaches are: researches with predefined templates and other with deformable templates [22].

4) Appearance-based methods:

All templates of matching models are learned firstly about the images stored, and then the learned models are then utilized for detection. It largely used fordetection of face. Many approaches using it such as, NN, SVM, NB, HM, distribution based methods, sparse network of winnows, information theoretical approach and inductive learning [22].

C. Feature Extraction

Extraction the features from the images is main task of gender classification and the next step depending on it. The Performance of system will be patter with goodfeature extraction technique. The structured can be categorized as color, shape, possession, dominate of edges, regions, etc [23].

1) Geometric-Based Feature Extraction (Local Features):

This method it represent the shape and location of the facial components such as, nose, forehead and eyes. Which are extracted in form feature vector that represent the face geometry? Some researchers working in it, for example Burton et al. [24] ,Fellous et al. [25] and Li et al. [26].

2) Appearance-based Feature Extraction (Global Features):

Which applies to the whole base to extract the appearance change of the face.Some researchers working in it, for example Colomb et al. [27] reported 91.9% accuracyand Mousavi et al. [28] reported 87.5% accuracy rate and Rai and Khanna [29]reported 90% accuracy rate.

D. Pattern Recognition (Classification)

Pattern recognition is the scientific discipline of machine learning whose aim is classifying data (patterns) into a number of categories or classes [31]. This research applied this method to classify the gender. In unsupervised learning, there is no such supervisor and have only an input data. The aim is to find the regularities in the input.

The accuracy rate is computed using the equation:

$$Accuracy = (TP+TN)/(TP+TN+FP+FN)*100$$

where:

TP = sum((Class=1) & (test label==1))
TN = sum ((Class=0) & (test label==0))
FP = sum((Class=1) & (test label==0))
FN = sum ((Class=0) & (test label==1))

IV. Evaluation and Results

There are several works in gender identification system as illustrate in bellow table (table 1). There are different datasets and parameters used for evaluation. Evaluation metric are based on the accuracy or classification rate. In table 1 the highest accuracy shown in the study [8] when use PCA with LVQ and facial images is about (100%) but the same study achieved about 98% when use RBF with same database . In the [30] the researchers are used RGP and YCBCR with SVM and NUB dataset study achieved .07 threshold rates.

V. FUTURE WORKS

This field one of the important fields in computer science, since most application now depends on identification the gender of human, so the future work is applying it with deep learning methods and also identifying the gender from the component of the face to be more accurate.

VI. CONCLUSION

In this paper, we have discussed the general system in gender identification method uses preprocessing, face detection, Feature Extraction and then classification. Working on pixels to classify gender is more expensive so for gender classification prefers to extract face features rather than direct work on pixels. Also presents a survey on various gender identification techniques and algorithms that was proposed earlier by researchers for the better development in the field of classification. It also provides an overview of some of

theongoing researches in gender identification. Gender identification in entirely unrestrained settings remains a very challenging task in all it steps.

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Author, year	Techniques	Classification	Dataset	Accuracy
Luis 2010 [31]	LIB	SVM	FERET ,UND	86.78%, 86.34%
Chia Shih 2012 [17]	(AAM) ,(PPH)	POPFT	LFW ,FERET	84.2%,86.5%
P. Rai,P. Khanna 2014 [18]	(2D)PCA	SVM	FERET	98.4%
Amit at.al 2005 [10]	ICA	SVM	FERET	96%
M. Nazir at.al 2010 [12]	DCT	KNN	SUMS	99.3%
Shan Sung at.al 2016 [9]	CNN	NN	SUMS,T& T	98.75% , 99.38%
Tolba 2001 [8]	PCA	LVQ ,RBF	Facial images	100% ,98.04%
J. Wu at. al 2008 [37]	PGSFS	RFNM	ND,FERET	91:67%
J. Zheng at.al 2011 [36]	gray, Gabor, (LBP) , (MLBP),(LGBP)	SVMAC	CAS-PEAL	97.2%
Yasmina at al 2013 [32]	grey ,PCA and LBP	1-NN, PCA + LDA ,SVM	FERET, PAL	97.2% 94.06%, 88.57%
Kalam ,Guttikonda 2014 [33]	LBP ,LDP ,PPBTF ,GWT	ratios threshold	T& T	95.6%
Ravi ,Wilson 2010 [34]	RGB ,YCbCr	SVM	NUB	threshold 0.07
Timo at.al 2008 [35]	LPQ , LBP	NN, Chi square distance	CMU PIE , FRGC 1.0.4	99.2% , 92.7%

TABLEI1: Face gender identification results.