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Pattern Based Gender Classification

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Abstract: ***Various methods of Gender classification have been reported in various papers. Gender classification is one of the fundamental face analysis task. Automated gender classification is a most significant research area. Gender classification offers several industrial applications in future like monitoring, surveillance, commercial profiling and human computer interaction. There are different methods have been proposed for gender classification such as gait, iris, hand shape and hair. However, major techniques used for gender classification based on facial information. In this paper, we target a comparative study of gender classification using different existing techniques used for gender classification and focused on major strengths and limitations of these existing gender classification techniques like LDP, LBP, and PCA etc. This pattern study presents several future research areas in the domain of gender classification.***

Keywords: Gender Classification, LDP, LBP, PCA, facial information.

I. INTRODUCTION

Gender classification can be stated as inferring female or male from a collection of facial image. It is useful pre-processing step to find intrinsic information for facial application, such as facial expression, emotion and age estimation. Gender classification plays a significant role during our social interactions such as behavioural perception identification in passive demographic data collection. It plays an important role in field of human-interaction computer as biometric related issues, filtering mechanism to enhance performance of face recognition both in terms of speed and accuracy. Many techniques have been used for classification purpose. Some of them deal with pixel and some of them deal with features. One small image contains thousands of pixels. So that techniques based on pixels are slow. While feature based processing is faster. There are two types of features. These are appearance-based features and geometric based features. Appearance based features selection approaches have evidence of greater evolution because of its flexibility towered unconstrained variants. Methods such as raw pixels, Haar-like features, Local-region matching, fragment-based filter banks, pixel comparisons, LBP features, Boosted LBP features. Geometric based feature seeks to find those features which are based on properties and relationship such as distance, angle, area and other geometric measurements between the facial features such as nose, eyes, lips, chin etc. Gender classification is the main problem for nay machine but it is easy task for human. Gender recognition can be applied in different areas of computer science like security system and biometric authentication etc. Gender classification also plays an important role in face recognition system. Many techniques have been used in past years to classify gender including Gaussian processes.

II. STEPS INVOLVED IN GENDER CLASSIFICATION

Generally, Gender Classification consists following steps. Figure 1 depicts these steps

- **Pre-processing-**every face database needs some pre-processing, like size normalization, histogram equalization, noise removal and face detection etc.
- **Feature Extraction-** after completing pre-processing, we need we need to extract face features. Generally two types of feature extracted. Geometric based features and appearance based features.
- **Classification-** in this step, face is successfully classified as that of a male or female. For classification purpose, different types of classifiers are used. E.g. KNN [25], NN [27], and SVM [26].

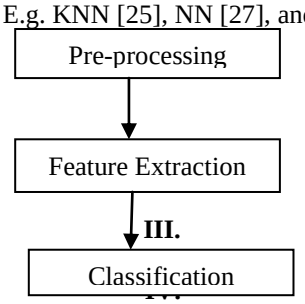

Figure 1. Steps Involved in Gender Classification

V. APPROACHES TO GENDER CLASSIFICATION

Gender Classification approaches are divided into two categories based on features. Geometric based features like nose, mouth and size of the eyes. Appearance based features which extract features from the whole face part.

A. Geometric based Features

These approaches seeks to find those features which are based on properties and relationship such as distance, angle, area and other geometric measurements between the facial features such as nose, eyes, lips, chin. These geometric measurements can be used as descriptors to recognize the faces.

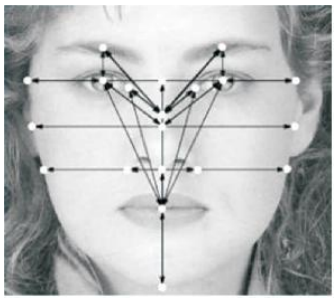

Figure 2. Most promising points of interest for geometrical formulation for feature extraction

Roberto Brunelli and Tomaso Poggio [1] presented geometric based approach. They extract 16 geometric features such as nose, chin, and mouth and eyebrow thickness. Burton et al. [2] reported 94% accuracy by extracting 73 points from full view face.

B. Appearance based Features

Appearance based feature involve the role of classifier. Appearance based feature selection approaches have evidence of greater evolution because of its flexibility toward unconstrained variants. Baluja and Rowley [3] compared Adaboost with pixels and achieved 93% accuracy.

VI. LITERATUREE REVIEW

The researcher research on gender classification starts from beginning of 1990s. Golomb et al. [4] used multi layer neural network for gender classification. They aligned the face manually for their experiment. First they squeezed 900 unit images into 40 images and then performed classification. They reported only 8.1 % gender classification error rate.

en-Sheng Chu et al [5] apply new method for gender classification for un-aligned face image, which uses only single face and they crop using various poses and combined them in a set. Then, images set are converted into subspaces; correlation evaluates the similarity between two subspaces. They use Discriminate analysis of Canonical Correlation (DCC) for finding most accurate gender. They Used FERET and MORPH face database for experiment.

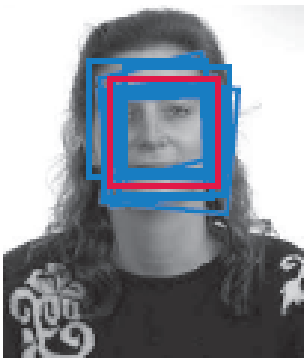

Figure. 3 Cropping gender face by different directions for Image Set Generation.

Ravi and Wilson [6] proposed an algorithm converts the RGB image into the YCbCr color space to detect the skin regions in the facial image. But for getting facial features, they convert RGB images to gray scale image.

They combined face detection with facial features and gender classification to produces more accurate results, according to them face detection works as pre-processor for classification. The area of skin is detected by converting RGB to gray scale image.

Y represents the luminance of skin colour while rest represents the colour. Features of the face like mouth, lip and eyes are detected after converting the colour images into gray scale images. They uses Support Vector machine as a gender classifier.

Shobeirinejad and Gao [7] proposed Interlaced Derivative Pattern (IDP) to extract facial features; and more information can be obtained by Local Derivative Pattern (LDP) as compared to Local Binary pattern (LBP).

IDP produces feature vector by extracting distinct facial features. The IDP image is a four-channel derivative image representing four directions that are0°, 45°, 90°, and 135°. Thus this method contains more important information about gender face recognition.

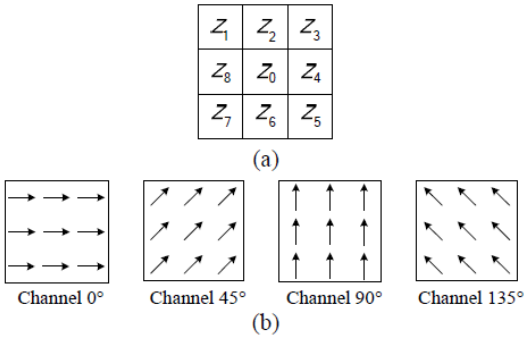

Figure. 4 (a) A 3 x 3 neighbourhood around a pixel (b) Four directional derivatives channel of IDP Image

Jain et al. [8] apply Independent Component Analysis (ICA), by this they make the coefficient independent of other data vectors, used in linear manner. They used FERET database for implementation containing 250 males and females faces. They used database for empirical evaluation. They used SVM as a classifier and achieve 96% accurate result. Xu and Lu [9] combine both geometric features and appearance based features for enhancing the process of gender classification. They perform normalization through histogram equalization for getting normal form of an image. They pick Haar-like feature of images and apply AdaBoost algorithm for finding out strong features; which clearly represent a face image. They used Active Appearance Model (AAM) for getting 3403 of local features but they picked only 10 features out of 3403 of local features by which they clearly identify the difference between genders.

Nazir et at. [10] proposed a new method for gender classification more efficiently. They reduced the dimensions by detecting the face using Voila Jones technique. Voila Jones [11] represented image as integral image to make faster process. AdaBoost algorithm worked as a classifier. They discarded the background of image by using AdaBoost [12]. For getting lighting effect to its normal form, they performed histogram equalization. Every face image contains some important features and they obtain these features, they implemented Discrete Cosine Transformation (DCT) technique. They used Stanford University Medical Student (SUMS) frontal facial images database. Their works is based on KNN classifier [25] using Euclidean distance to find closest neighbours. They conclude that the ratio of training and testing image is 50 to 50 for KNN classifier. Then their obtainable accuracy is 99.3%. Their results are more accurate as compared to support vector machine [13]. Neural Networks (NN) [14], [27], Linear Discriminate Analysis (LDA) and Bayes techniques. The accuracy of SVM, NN [14], LDA and Bays is 91.10%, 82.30%, 85%, and 77.62 % respectively.

Du, Ding [15] presents a new method which is based on decision tree classifier to identify the gender. They use FERET and CAS-PEAL database for their experiments. They consider that the feature of gender may be related to the feature of ethnicity. The tree is designed by them which decide ethnicity first and then decide gender with its corresponding ethnicity. This new method is implemented in a system that mainly consists of three parts, face detection, feature extraction and gender classification with a decision tree. They used 1928 face images. Chuan-xu et al. [16] proposed a method for gender classification is 2-D Gabor transform used for extraction the face features and user SVM as a classifier. They used FERET face database for classification. There used 946 male and 544 female which are from different gesture, illumination and different facial expression Gender classification is the most challenging problem in the field of pattern recognition. PCA-based image recognition algorithms can reduce the dimension. It is based only basis of optimal entropy for choosing face feature. Good performance of gender classification test is achieved on a relative large scale and low-resolution face database.

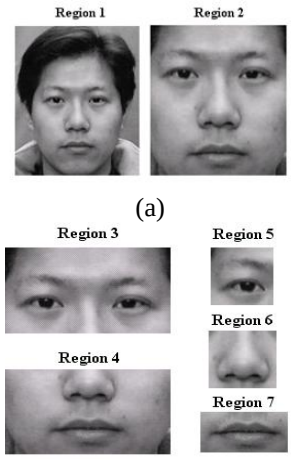

Figure 5. (a) Whole face region and internal face region. (b) Five smaller facial regions are obtained from the whole face image.

LU et al. [17] they describe different facial regions of a person for the task of gender classification. For this task, they used Support Vector Machine (SVM) [26] as a classifier on face images for gender classification. They use CAS-PEAL database images of size 480 × 360 gray scale. Gray scale image is converted to a normalized whole face image and a normalized internal face image. They obtained seven facial regions of an image. They perform experiments using different facial regions of varying resolution. They proposed a method based on significance of different facial regions. This methods based on fusion of multiple facial regions is able to compensate method is able to compensate for facial expressions and lead to better overall performance. Han X. et al. [13] used 3D face GavabDB contains 427 three dimensional facial surface images. They use 61 frontal face images with geometric meshes (45 males, 16 females) are used. They use non-linear support vector machines (SVMs) for gender classification. The SVM is applied to triangular meshes representing human faces. They extracted 3-d facial features from corresponding geometry meshes. The experimental error rate, they obtained is 17.44%.

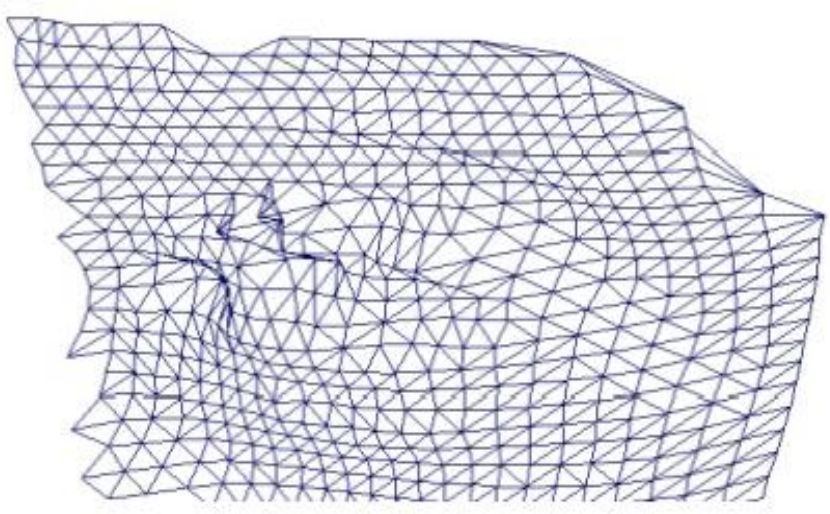

Figure 6. A triangular mesh of eye region

Preeti Rai et al. [18] used Feature extraction using wavelet and random transforms and their focused only enhancing the performance and efficiently extract features. Due to this they get less miss rate and robust to illumination change and expression of gender. M.Nazir, et al. [19] used Feature extraction using discrete cosine transform (DCT) for enhancing the performance by reducing the dimension of the data set. They improved classification accuracy and robust to change in illumination. T.Jabid et al. [20] represent face by using Local Directional Pattern (LDP). They enhance the result by reducing the noise. They get robust to noise, changed illumination and more accurate result.

XU et al. [9], [17] used Hybrid approach by combining appearance and geometric based features and Increasing the accuracy and performance. Their propose method robust to pose and illumination variation

S. Muzaffari et al. [21] used Feature extraction from single face image using global and local features single face image using combination of global and local features. They find more accurate results by minimizing the false positive rate occurs due pose and illumination variation. Their method improves classification accuracy.

A. Jain et al. [8] used feature vector representation by using independent component analysis (ICA) for enhancing the performance by reducing the dimensions. They find more accurate results in terms of accuracy.

A. Shobeirinejad et al. [7] used Feature extraction using Interlaced Derivative Pattern (IDP). They improved performance by increasing system speed and reducing error. Their proposed detect error and increase system speed. Their main focused on reduced computational complexity compared with Local Derivative Pattern (LDP).

Yuchun Fang et al. [22] used Feature extraction using local Binary Pattern (LBP) and Principal Component Analysis (PCA).They Reduce the redundant information of high density LPB features. Their proposed method Traditional LBP features are improved results in a classification accuracy and fast process.

S. Ravi et al. [15] used Feature extraction and classification using Linear Support Vector machine (SVM) [26]. To produce accurate results irrelevant of image size. Accurately classify gender faces with different image size.

Wang Yiding et al. [23] used Feature extraction and classification using Scale Invariant feature Transform (SIFT) and FSVM. Their proposed method Produced accurate and stable result by reducing the Scale Invariant Feature Transform (SIFT) descriptor dimensions. They find more accuracy, robustness to illumination change.

Z. Sun et al. [24] Feature extraction and classification using Principal Component Analysis (PCA) and Neural Networks (NN). To reduce classification error rate, reduce data dimensions. Automatic feature subset selection, error rate reduce significantly.

Hu M. et al. [28] they state the problem of gait based gender classification. They used Gabor feature which is used for gait analysis it is more feasible for classification. They obtained

Gabor-MMI feature for classification. After that, they used gender related Gaussian Mixture Model-Hidden Markov Models (GMM-HMMs) are constructed for classification work. Supervised learning reduces the dimension of parameter space and significantly increases the gap between likelihoods of the gender models.

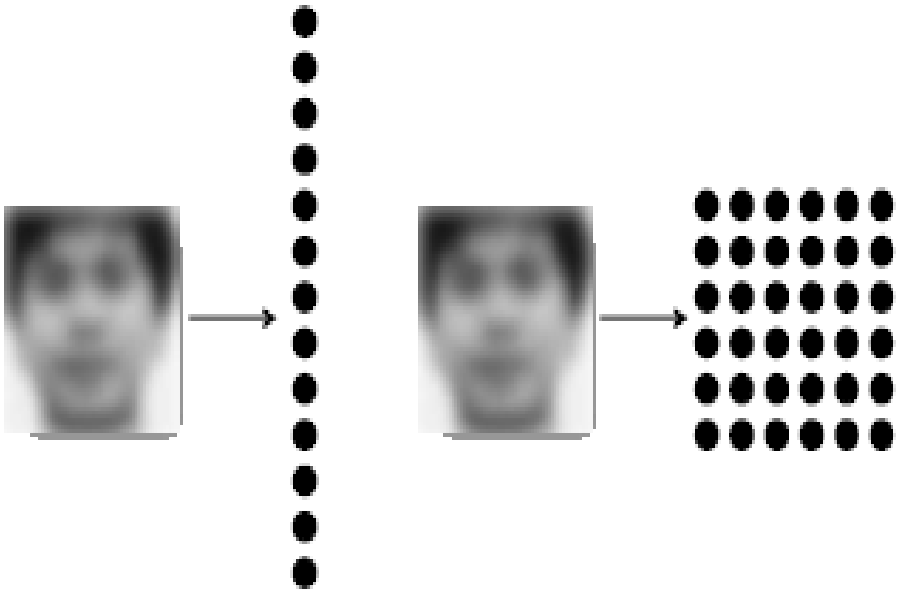

Figure 8. Image representing PCA and 2D-PCA

B Len et al. [29] presented a new method for solving face gender recognition problem. Their method employs 2D Principal Component Analysis (PCA). Prominent methods for extracting feature vectors and uses Support Vector Machine (SVM) as a classifier. They used FERET data set for experiments. Their data set contains 14,126 images stored in 1564 sets for 1199 individuals and 365 duplicate sets and their
results show that the proposed method could improve the classification rates.
Siti Zura A. et al. [30] described analysis of body using human radiation frequency gender classification. The human radiation frequency is experimentally they studied from 33 healthy human. They used 17 males and 16 females and KNN as a classifier is employed for gender classification.
They first analysed raw data set and post processing dataset and then they compare their classification results. They get accuracy 93.8%.
Gholamreza Amayeh et al. [31] state the problem of gender classification from hand shape. Their work has been motivated by studies in anthropometry and psychology they used certain geometric features for classification. Their classification system segments the hand silhouette into six different parts corresponding to the palm and fingers.

(a) (b) (c)

Figure 9. (a) Female hand image, (b) male hand image, and (c) segented female hand image.

For representing the geometry of each part of hand, they used region and boundary features based on Zernike moments and Fourier descriptors.
In their experiments, they compute the distance of a given part from two different eigen spaces, one eigen space corresponding to the male class and the other corresponding to female class. They used a small database containing 20 males and 20 females; their classification results close to 98% using score level fusion and LDA.
G. Filipe et al [32] classify a person in a photo or a video on the basis of personal memories context and used SVM as a classifier. They used Labeled Faces in the Wild database contains 13233 face images of 5749 different individuals. They used 1490 for each gender (male and female) for classification.

Chiraz B. and G. Paul [33] used appearance-based method for gender classification from face images. They focused on pose, expression, or illumination. They used local region analysis of the face to obtain the features for gender classification. Given a new face image and formed a normalized feature vector by matching N local regions of the face against some fixed set of M face images. They implemented a holistic feature extraction method based on the well-known Eigen faces. They used two classifier named Fisher's Linear Discriminant (FLD) and Support Vector Machines (SVM) over 13,000 frontal face images. Find the performance of 94.2% with the local region-based feature extraction and SVM classification methods.

I. CRITICAL EVOLUTION

Lit. Ref	*Techniques Used*	*Focus Area*	*Advantage*	*Disadvantage*
[5]	Gender classification from un-align facial images	To deal with pose and illumination change	Accurate results	Image containing noise effect in the cropping process, Computation is slow if large dataset is given i.e. subspace of images
[6]	Feature extraction and classification using Linear support vector machine (SVM)	To produce accurate results irrelevant of image size.	Accurately classify gender faces with different image size	Non adaptive (static) threshold value for facial feature detection
[7]	Feature extraction using Interlaced Derivative Pattern (IDP)	Improving performance by reducing error and increase system speed.	Error reduction, faster and reduced computational complexity compared with Local Derivative pattern (LDP).	Noise and pose variation degrade the computation process
[8]	Feature vector representation by using independent component analysis (ICA)	Enhancing the performance by reducing the dimensions	More accurate results in term of accuracy.	Not robust in illumination and pose changed .
[9]	Hybrid approach by combining appearance and geometric based features.	Increasing the performance and accuracy.	Robust to pose and illumination variation	More time consuming in locating face points and feature extracted
[10]				
[11]				
[12]				
[13]	Extract face features and classification using geometric based approach and support vector machine (SVM)	Stabilize the performance under pose and illumination change	Robust to illumination and pose change	Selection of SVM appropriate kernel for particular data set effect results.
[14]	Feature extraction and classification using Principal Component Analysis (PCA) and Neural Networks (NN)	To reduce classification error rate, reduce data dimensions	Automatic feature subset selection, error rate reduced significantly	Training and selecting the best neural networks take more time.
[15]				
[16]				
[17]				
[18]	Feature extraction using wavelet and Random transforms	Enhancing the performance by efficiently extract features.	Less miss rate, efficiently extracts feature robust to expression and illumination change	Knowledge based face detection method is time consuming, increase false positive rate due to more general /strict face detection

				rules.
[19]	Feature extraction using discrete cosine transform (DCT).	Enhancing the performance by reducing the dimensionality of the data set.	Improved classification accuracy and robust to change in illumination.	Face image having pose variation effect the Voila Jones face detection process.
[20]	Representation of the face image using Local directional pattern (LDP)	Enhancing the results by reducing the noise.	More accurate, robust to noise and illumination changed.	Computation process is slower as LDP represent each pixel as eight bit binary code
[21]	Feature extraction from single face image using combination of global and local features.	More accurate result by minimizing the false positive rate occurs due pose and illumination variation.	Classification accuracy improved	Application of Local Binary Pattern (LBP) on larger window increase dimensionality which results more memory consumption and increase the running time of the process.
[22]	Feature extraction using Local Binary Pattern (LBP) and Principal Component Analysis (PCA)	Reduce the redundant information of high density LBP features.	Traditional LBP features are improved results in classification accuracy and fast process	Principal Component analysis (PCA) not guarantees that the direction of maximum variance will contain good features for discrimination.
[23]	Feature Extraction and classification using Scale Invariant Feature Transform (SIFT) and FSVM	Produce accurate and stable results by reducing the Scale Invariant Feature Transform (SIFT) descriptor dimension	More accuracy, robustness to illumination change	Complexity of classification process increased

VII. CONCLUSIONS AND FUTURE WORK

The survey of gender classification techniques, we are using more than one decade. Generally we are dealing with pixels information and features of genders for classification. One thumbnail image contains more than thousands of pixels. For making processing faster, we prefer features of gender. That is why we have take features in this paper for gender classification. There are two types of features; one is local features and global features. Global features much faster than local features. Our upcoming work contributes in the field of gender classification. The survey of gender by different classification techniques accuracy is high but time consuming. Performance of classification is more enhanced by using better classifier. Now we are developed new techniques by this literature review.

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