Classification of Gender Face Image Based on Slantlet Transform

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ABSTRACT

Image Face classification has been an effective research area over last two or three decades and it is considered as a challenging research topic. In this paper a new classification algorithm is proposed for gender classification based on face image. The proposed algorithm consists of two phases: training and testing phases. In the training phase five steps are implemented to classify gender images; at first step the face in a digital image is segmented so as to eliminate the undesirable background, the redundancy and suppression of noise is reduced using Slantlet Transform in step two. From transformed face images, Eigen faces feature is extracted using Principle Component Analysis (PCA). In step three to reduce the number of dimensions without losing information (Eigen value is used as a vector of features), in the final step decision whether the face image is male or female is done by applying Support Vector Machine (SVM).

The experimental outcome indicate that the SVM classifier achieves precision of 89% whenthe classification process using Wavelet 'Transform, and 93 % with Slantlet' Transform for the same number of the test-set.

Keywords: Slant Transform, Principle Component Analysis (PCA), Support Vector Machine (SVM).

INTRODUCTION

The face is the essential focus of attention in the society, and normally used as identification. in spite the ability to deduce intelligence or personality from facial manifestation is suspected, the human capability to distinguish faces is remarkable. A human can distinguish thousands of faces learned during the lifetime and recognize commonplace faces at a glimpse even after long time of separation. This skillfulness is quite sturdy, in spite of big changes in the optical stimulus due to viewing conditions', caducity, expression, and distractions such as, changes in hair style or beards [1].

Since 1990's, the research benefit in face classification has grown significantly as a result of the next facts:

The increasing need for monitoring related applications due to terrorist activities, drug trafficking, etc.Growth in importance on civil /commercial research plans. The availability is of real time system [2].

The face is one of the most important bio features of the human beings. Each person has their own innate face and mostly a different face. As a human', to distinguish the different faces with-out any difficulty is more easily, but it becomes difficulty with the system to recognize the

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human faces [3].
On the other hand, face classification is an active research area, and it can be used in wide range of applications. It is about identifying a person from one or more images of his/her face. These images are assumed to be acquired with a normal camera. No assumption is made about the quality of the image [4].
The generation surveillance systems are expected to take human face as input pattern and extract useful information, such as identity,age, ethnicity and genderfrom it [5].
It is often useful to have a machine learning classification method to classify human gender (male or female) images.

Face and Gender Classification

The development and advancement in face classification area leads to wide use in much application scope, since the method of face classification can significantly improve cognitive and interactive computer capabilities. Face classification can be used in theAuthentication, Access control, Surveillance, E-commerce and Internet [6, 7].
The difficult of face-recognition can be specified as follows: Identifying unique or additional individuals in the sceneryby utilization a kept database of faces in a given still image or video of a scene. The difficulty is mostly aproblem classification, so training'the face-recognition method with images of the known individuals'and classifying the test images into one of the classes is the main side of the face-recognition systems [8].
Classification and prediction of data play a major role in extracting knowledge from the existing database [9]. The classifying method which has been proposed during the last decade and under evaluation includes: Genetic algorithm, Artificial neural network, Bayesian, Support Vector Machine (SVM) , Decision tree and the other method [10].
Extracting two sets of data for both male and female and separate them accurately isa challenging task, So a better classifier is needed to improve the classification performance, among all kinds of classification methods [11].

Recognition Machine of Faces Images

Research on machine -recognition of face-images has advanced of studies on human face recognition. During 1970’s, pattern classification methods, which use quantities between features in faces or face profiles, were used [12]. During the 1980’s, effortion face recognition is continued unchanging.
Since the early 1990’s, the study is interested on machine recognition of faces has grown-up extremely. The reasons could be:
The obtain ability of real time hardware. And growth in importance on civil /commercial research plans and the increasing need for surveillance requests.,The studies on neural network classifiers with emphasis on real-time calculation and adaptation
The-basic inquiry pertinent for face classification is that; what procedure the organizational code (for encoding the face) should take to accomplish face recognition

Two main methods are used for machine identification of human faces; based methods geometrical local feature, and holistic pattern matching based systems. Also, hybrid of these both methods could be used. The first method, the geometrical local feature abstracts and estimates discrete local features (such as 'eye, hair, mouth, nose, etc.) for retrieval and identifying faces. Formerly, neural network approaches and/or standard statistical pattern recognition techniques are used for matching faces depend on these measurements [13].
The Elastic Bunch Graph Matching (EBGM) technique is One of the geometrical-local feature' based methods. The other method, the holistic one, theoretically pertinent to pattern matching, attempt to identify faces using 'global depictions' [8].
Holistic methods scan the entire face-image and attempt to extract features from the entire face area. In this method, as the prior method, after extracting the features the pattern classifiers are

applied to classify the image. In a holistic system is applying one of the methods to extract features by using statistical methods such as "Principal Component Analysis" (PCA) to the entire image. In this paper 'PCA is used to reduce the number of dimensions, without much loss of information.

Literature Survey

There have been many studies and researches on gender classification, the most important of which are outlined below:

Nazir M. & et al., 2010 [14]: Viola and Jones are used for face detection is reducing image size which eliminates unwanted area from the image. Histogram equalization is performed to normalize the illumination effect. Discrete Cosine Transform (DCT) is can be used for feature extraction and sorting the features with high variance. K-nearest Neighbor Classifier (KNN) is supervised for classification process.

Nawfal M. & Esteklal A. & et al, 2013 [15]: recognize a person's using face image, and the uses of this paper at airports and other offices which use surveillance cameras that take pictures of views at different angles. The wavelet is used in order to get more accurate details of the image, and then features were extracted based on the seven moments. The neural network was used as a tool to identify people.

Yuan L. & Cai-ming W. & et al, 2013 [16]: hybrid method of PCA and local binary pattern (LBP). Firstly, the method of area eight eyes segmentation was introduced to extract the effective area of facial expression image; then extracted the global gray scale feature of the whole facial expression image by PCA andat the same time reduced the data size. Local neighbor was extracted by LBP to texture feature of the mouth of area. Finally, to complete facial expression recognition usedSVM to the fusion feature. The average recognition rate of all (happy, surprise, sadness, anger, fear and disgust) is Experiment results.

The Proposed Gender Classification Algorithm

The main idea of images gender classification algorithm is to classify gender images, male from female face. The proposed images gender classification algorithm consists of two phases it Training phase and Testing phase.

Each phase has specific steps as shown in figure (1), which represents the overall diagram of gender classification algorithm.

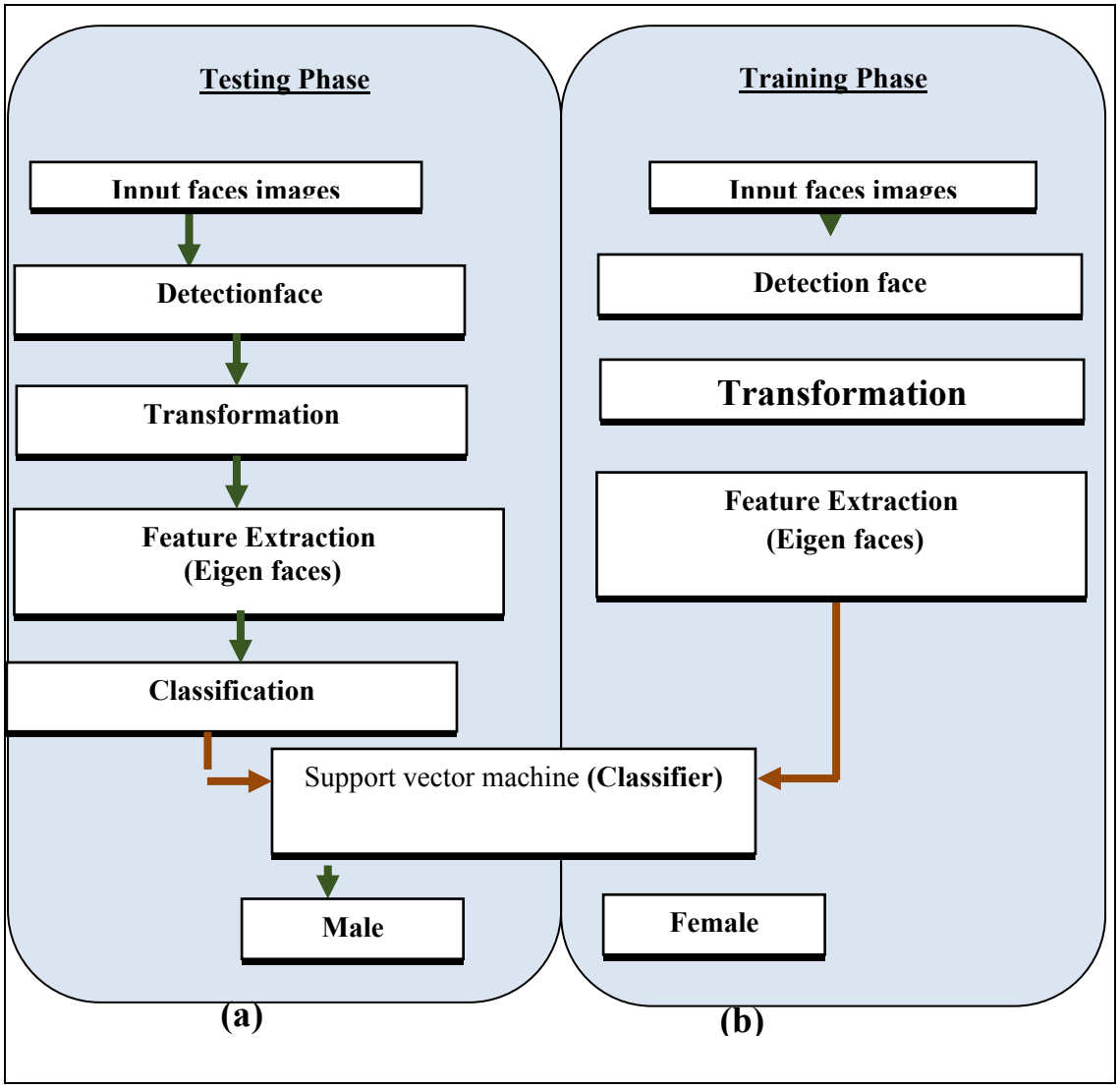

Figure (1):Block Diagram of the Proposed Gender Classification Algorithm. (a) Training Phase. (b) Testing Phase.

Data Set of Face Images

The proposed algorithm is implemented on six different Datasets ((CUFS)[17] ,(FEI)[18],(Helen) [19], (CVSRP)[20], (CMDP)[21], (JAFFE)[22] and (FWS)[23]), and consider in classification process face images with only frontal position, as show in Table (1).

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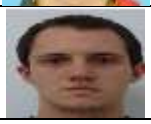
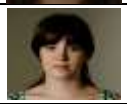
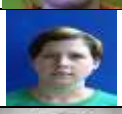
Table (1): Face Data Set Images.

Dataset Images	Sample of Image		No. of Image	No. of Male Images	No. of Female Images
CUFS			187	134	53
FEI			197	100	97
Helen			104	71	33
CVSRP			20	20	19
CMDP			25	22	3
JAFFE			10	-	10
FWS			16	-	16
Sum	-	-	576	346	230

Face Detection and Gender Classification

Face Detection is one of the most important techniques for gender classification. Face Detection task can be solved straightforwardly by humans. However, the difficult task is how to make a computer solve this task effectively. Viola and Jones technique is used for face detection by scan image by set of rectangle regions, all rectangle regions are of the same size have the same form and are vertically or horizontallyneighboring. The rectangle features are selected to highlight the alterations in intensity in a face, but Viola-Jones technique is sensitive to lightcircumstances. All men and women faces share some similar features and a few features common to people faces.

Firstly, the upper-cheeks are brighter than the eye region. Secondly, the eyes region is darker than Nose Bridge as shown in Figure (2).

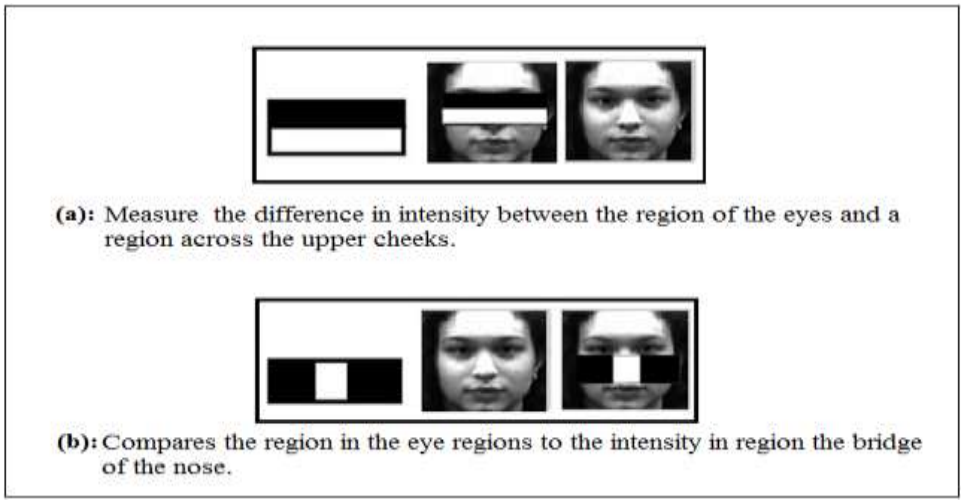


Figure (2): Example of two-rectangle feature used for face detection.

Transformation

Faces images are hard to explain, and it is very important to make the feature extraction stage easier and enhance image. The major objective of this step is to improve gender image and reduce the undesired deformity of gender images. These transforms smooth the image by blocking itemized information. This is done by using Wavelet and Slantlet transforms.

Wavelet Transform (WT)

The calculation of all gender images using a Wavelet Transform with wavelet filter to extract features for each selected gender face image. Algorithm (1) shows the steps for transforming the image using Wavelet Transform.

Algorithm (1): Wavelet Transform

Input: Face Image (X,Y)

Output: Transform Face Image by WT

Step_1 : Determine X , Y image's dimensions
Step_2 : Convert Face Image to gray scale
Step_3: half = (L / 2) // L= X=Y
Step_4: Compute Horizontal direction
For i = 0 To X-1
k = 0
For j = 0 To Y-1 Step 2
R_Gray(k, i) = (Gray(j, i) + Gray(j + 1, i)) / 2
R_Gray(k + half, i) = (Gray(j, i) – Gray(j + 1, i)) / 2
k = k + 1
End for j
End for i
Step_5: Compute Vertical direction
For i = 0 To X-1
k = 0
For j = 0 To Y-1 Step 2
W_Gray(i, k) = (R_Gray(i, j) + R_Gray(i, j + 1)) / 2
W_Gray(i, k + half) = R_Gray(i, j) – R_Gray(i, j + 1)) / 2
k = k + 1
End for j
End for i

SlantletTransform (SLT)

The SLT is another version of WT. For each selected faces image, the computation of all input faces images transformed using SLT transform, then an improved image is gained with high visibility and free of noise. Algorithm (2) describes the steps for SLT transform.

Algorithm (2) :Slant Transform

Input: Face Image

Output: Transform face Image by SLT

Step_1 : Determine N , M image's dimensions

Step_2 : Convert Face Image to gray scale

Step_3: Create transform matrix with size N by M and initialize with zero.

T=Zeros(W , H)

Step_4: Split matrix into four region based on the half = (M / 4).

Step_5: // Implement filter

For block_1 apply filter each implement h filter for first region of matrix (T),

$h_L(n)=\{ \quad (n \quad) \quad \}$

and f filter for second region of matrix (T)

$f_L(n)=\{ \quad (n \quad) \quad \}$

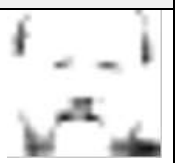
and implement g1 filter for third region of matrix (T) and g1r filter for fourth region of matrix(T).

$g_L(n)=\{ \quad a \quad (n-2^L) \quad \}$

Step_6: Transformed face Image = T* faces images.

In addition to Wavelet Transforms, the proposed algorithm is trained and tested with another transform which is a Slantlet transformin Slantlet transformdifferent filters is appointed for every scale, filters of shorter length are designed orthogonally and zero (0) conditions.These operations are shown in the following different dataset in Tables (2).

Table (2): Sampleof Applying WT and SLT on Dataset.

Image No.	Dataset	Gray scale	Face Detection	WT	SLT
1.					
2.					

3.					
4.					

Features Extraction

Feature extraction is very important step for gender classification, where the transformed results are used as a pre-processing step to extract features. The main idea is to get all the features of the facial image of the face in a mathematical equation rather than physical face feature using mathematical transforms. Inthis proposed algorithm features are extracted using Principle Component Analysis (PCA).

Principle Component Analysis (PCA)

PCA used to decrease the dimensional representation of face image, mainly Eigen face is the eigenvector selected from PCA Eigen faces , so as a small set of characteristic images that are used to describe the variation between face images. In gender classification, each training transformed) image (by WLT or SLT is transformed into a vector. The co-variance matrix is computed by multiply variance image by variance image transform) are constructed Eigen faces (eigenvectors associated with eigenvalues, which represent various features face image that is shown in the Algorithm (3).Sample images of Eigen faces images are shown in Figure (3).

Algorithm (3) : PCA –Eigen Faces Feature
Input: Transform face Images
Output: Eigen faces
Step_1 : Store transform face images in matrix (X) **Step_2:** Calculate mean is vector of (1*M).each element of mean is the average of corresponding column of x matrix. $$\boldsymbol{E(X)} \quad -\sum$$ **Step_3:** Compute variance get a modified ensemble of vectors $$\bar{\mathbf{X}} = \{\bar{\mathbf{X}}_{\mathbf{n}}, \mathbf{n} = \mathbf{1} \ldots \mathbf{N}\} \; \boldsymbol{with} \quad \bar{X} \qquad \boldsymbol{E(X)}$$ **Step_4:** Compute covariance **Step_5:** Extract Eigen faces, selected eigenvector to extract Eigen_faces when: Diagonal of eigenvalue matrix >= 1 Eigen_faces= variance * selected eigenvector.

Figure (3): Sample of Eigen faces images

Basedface-Classifier Model SVM

The Training Set of face images are consist of attribute value represent for a large number of person. In this paper, face-classifier model is done by using SVM based on training faces images. In testing phase, the face-classifier model used to check a new face image which does not exist in the training set.

Face-classifier model give a decision, that's mean its classifiestested image to male orfemale. The SVM classification algorithm has the ability to generate decision based on the attributes, which play an important operation for hyper plane that is used in gender classification, SVM is used in this paper since the Training _Set data has exactly two classes. SVM classifies face images by computing the best hyper plane that separates all data points of one class from be other class. The better hyper plane for SVM is selected based on largest margin between the two classes. Set of images are tested from different dataset to check the accuracy of the gender face image for SVM classifier. Algorithm (4) illustrates SVM gender classifier.

Algorithm (4) SVM classifier
Input: Training _Set and Testing _Set
Output: classifier decision
Step_1 : Making train_ label for all Training Set that defines two groups (male, female). **Step_2 :** Specify the kernel function (Linear kernel) which used to map the Training Set into kernel space by compute hyper-plane **Step_3:** Separate date into two region based on hyper-plane which decided in step2 **Step_4:** Passes Testing _Set on SVM based on the hyper-plane to know the gender .

Performance Measures

The performance of the proposed algorithm is evaluated by using the following criteria:

Result Matrix: The Result matrix of proposed algorithm performance is taken from the applying test phase as shown in Figure (1), results are showen in Table (3) and Table (4). The Result matrix is explained as follows: rows marked the object classify and columns marked the label the classifiers associates at this object.TP, FP, TN, FN being number of true positives, false positives, true negatives and false negatives, respectively, which mean:

TP: the class is male and the predicted is male.

FP: the class is female and the predicted is male.

TN: the class is male and the predicted is female.

FN: the class is female and the predicted is female.

$$\frac{}{(TP \quad FP)}..(1)$$

$$\frac{}{(TP \quad FN)}..(2)$$

Table (3): Result Matrix using Wavelet Transforms

Actual Class	Predicate Class	
	Male	**Female**
Male	26	4
Female	3	37

Table (4): Result matrix using Slantlet transform

Actual Class	Predicate Class	
	Male	**Female**
Male	26	4
Female	0	40

Classification Accuracy: is used to evaluate the performance of any image classification, the accuracy of the algorithm can be calculated as[24]:

$$\frac{(TP+FN)}{FN)}..\ (3).$$

The running-time and accuracy classification of proposed algorithm performance can be shown in a Table (5).

Table (5): Performance Measures of the Proposed Algorithm

	Wavelet transforms		Slantlet transform	
	Running time	**Accuracy**	**Running time**	**Accuracy**
Male	100 Sec	86%	140Sec	86%
Female	120 Sec	92%	170Sec	100%
Average	110 Sec	89%	155Sec	93%

The Comparison between Wavelet and Slantlet transform can be determined by PSNR, MSE values which is calculated for faces image , its clearly shows that Slantlet transform leads to better results as shown in Table (6).

Table (6): Comparison between Wavelet and Slantlet Transform.

Class Type	Wavelet Transforms		Slantlet Transform	
	PSNR	MSE	PSNR	MSE
Male	4.7028	22018.8976	7.2579	12226.2887
Female	1.8456	42512.5732	4.7426	21818.0904

Conclusion and Discussion of the Proposed Algorithm

The experimental results and performance evaluation of the proposed classification algorithm is discussed in the following:

The classification of the faces image as male or female is used in monitoring of people , thus the proposed algorithm is assisted the security methods to improve the diagnosis of the hustlers.

The average time required for the proposed algorithm is reduced and its estimated of about (110 *Sec.*) for Wavelet Transform while Slantlet transform is estimated about (155 *Sec*.) for

The experimental results indicate that the SVM classifier achieves accuracy of 89% in the case of Wavelet Transform and 93 % with Slantlet transform for the same number of the datasets images.

The accuracy of classification has been improved by increasing the size of faces images samples for image training.

Individual Eigen vector feature is superior to others based on the results obtained. Eigen vector features used in this paper are necessary to build the classifier.

All the faces of people sharing some similar characteristics like mean skin color, thick hair, etc. So, when using statistical feature of face images a poor resultsis achieved in classification process.

The Slantlet Transform (SLT) is a multi-resolution technique especially well-suited for piecewise linear data.

The SLT has beenrecently proposedasanimprovementovertheclassicalDWT,whichcanprovidebetter time localization.

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