Gender Classification Using Fingerprints Based On Support Vector Machines (SVM) With 10-Cross Validation Technique

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Abstract— Fingerprint is one of the biometric used in security system which are practically applicable in different fields for safety measures. In forensic anthropology fingerprints are the most mature biometric technologies used for gender classification. Finger prints evidence is the most reliable and acceptable evidence in order to identify the criminal and to minimize the suspect search list. As per study many authors have carried out research on gender identification and classification techniques which are based on face image with high accuracies; but these techniques consume more time. In the same way some machine vision techniques have been carried out for the identification of gender using fingerprints. In this work we have extracted the statistical features based on discrete wavelet transform for the gender identification classification using fingerprints. The real fingerprints were collected from both rural and urban people of the different age groups. The SVM classifier is used to classify the gender. An 89 % and 91% classification rate is achieved for discrete wavelet transforms (DWT) using SVM (RBF sigma) and SVM (polynomial) classifier respectively. The concept is analyzed and reported results in this work overcome the limitations of earlier methods and algorithms with the competitive and satisfactory results.

Index Terms— Gender classification, discrete wavelet transform (DWT), SVM (Support vector machine) (RBF_sigma), SVM (polynomial).

1 INTRODUCTION

A Gender determination is very important task in today's life in every social interactions which are based on credentials for every identification documents which depends which upon gender recognition. Many prevailing methods are facing difficulties and cannot growing demands because of inflexible security in many applications such as ID cards, government benefits and access control. Psychological and computation perspectives are investigated for gender classification although gender classification has attracted much attention in psychological literature [1-3], relatively few learning based vision methods have been proposed. In order to enhance the accuracy by using biometric technique gender classification is viewed as soft biometric traits which can be used as indexed data base. To identify an individual there are many measurable physiology and behavioural characteristics that can be utilized to verify an individual using biometrics.[4-5].

In biometric techniques fingerprint identification is one of the oldest techniques. From the author of china document of fingerprints are proved as positively identifying technique which spreads the system around and become more common. Finger prints offer an infallible means of personal identification. That is the essential explanation for fingerprints having replaced other method of establishing the identities of criminal's reductant to admit previous assets. The other visible human characteristics tend to change-fingerprints do not. Fingerprint and palm print features have never been shown to move about or change their unit relationship throughout the life of a person. Human have used fingerprint for personal identification for many decades. The matching (i.e., identification) accuracy has been shown very high using fingerprints.

Fingerprints have persistence and uniqueness. It is very difficult to steal and reproduce them which is proved by empirical and statistical observations. From the empirical point of view it is easy to say that not a couple of twins have same fingerprints and which do not change throughout the life of an individual. Estimation of gender from fingerprints is a still challenging issue increasing the accuracy level with little computer complexity [26],[28-29]

In this work the discrete wavelet transform based statistical features are used to extract gender information for classification of male and female using fingerprints. The statistics features were extracted are classified using SVM (RBF_sigma) and SVM quadratic kernel function with 10 fold cross validation techniques for analyzing the gender discriminatory ability of the extracted features.

The rest of the paper is organized as follows: the section-2 gives the outline of the related work. Section-3 gives the proposed methodology and algorithm. Section-4 gives an analysis and discussion of the experimental work followed by

the conclusion and future work in section-5.

2 Related Work

In [6], authors have worked on fingerprint based age estimation using 2D discrete wavelet transforms and principal component analysis. The statistical features are extracted using 2D-discrete wavelet transform (DWT) and principal component analysis (PCA) combined. An internal dataset of 400 fingerprints of different age groups between 12-60 years were collected. The overall success rate of 68% is obtained.

In [7] authors carried out research on Fingerprint gender classification using wavelet transform and singular value decomposition. The classification is achieved by extracting with spatial features obtained from singular value decomposition using k-nearest neighbour (KNN). An internal database of 3570 fingerprints in which 1980 male fingerprints and 1590 female fingerprints was used in the experiments. The result obtained is 91.6% for male finger prints and 84.69% for female fingerprints. Overall classification rate is 88.28%.

In [8] workded on real time approach to determine the gender using fingerprints and they have focused on extracting the features based on frequency domain analysis, Discrete wavelet transform (DWT) and singular value decomposition(SVD). A dataset of 300 persons of different age and gender is collected. The proposed algorithm produces an accuracy decision of 92% for female and 80.02% for male.

In [9], A novel method is proposed for gender classification using discrete wavelet transform and singular value decomposition techniques" authors have focused on 2D-discrete wavelet transformation (DWT) to find frequency domain vector and singular value decomposition in order to find spatial features using K-nearest neighbour classifier. A dataset of 100 left hand index finger fingerprints were collected belong into same age group. The success rate is more than 80% is obtained in this experiments.

In [10], authors have focused on neural network neural network based gender classification. Discrete wavelet transform (DWT) the directional images of fingerprints are obtained. Then the feed-forward back-propagation neural network is applied for male-female fingerprints recognition. The dataset of 300 fingerprints were collected. Success rate of classification was 91.3%.

In [11], authors have studied different methods for gender identification using fingerprints and have focused on different fingerprints identification methods like DWT and SVD method, spatial and Frequency domain analysis and principal components analysis (PCA) using KNN classifier. The works conclude that gender classification is depending on qualities of fingerprint images and maximum number of images should be collected to obtain good result.

In [12], autors have focused on identification of fingerprint using discrete wavelet transform in conjunction with support vector machine. The proposed computational model is developed using three discrete features extraction method such as discrete wavelet transform, principal component analysis and discrete cosine transform. Two diverse nature of classification hypothesis are utilized namely Support vector machine (SVM) and k-nearest neighbour. And 10-folds error validation is done to evaluate the fingerprint images which were collected. The experimental results using SVM has achieved success rates of 95%and 91.5% is in DWT features respectively.

In [13], an improved method for gender classification using fingerprint has been focused on discrete wavelet transform and singular value decomposition. The support vector machine was used to classify for extracting features. A classification rate achieved is 91.67% for male and 84.89% for female.

In [14], authors have focused on frequency domain approaches for fingerprint based gender classification. The frequency domain techniques like discrete cosine transform (DCT), discrete wavelets transform (DWT), and BBDCT (black based discrete cosine transforms) are used to extract the feature set. The k-nearest neighbour classifier is used to evaluate its performance. The dataset of 900 female and 900 male fingerprints are used for feature extraction the success percent for female using DWT is 65, using DCT is 64 and BBDCT is 65.25 likewise for male success rate using DWT, DCT and BBDCT is 52.25%, 55.75% and 52% respectively.

3 Proposed Methodology

The proposed work is divided into three sections, first is preprocessing of all fingerprints images, second is computation of statistical features of Discrete wavelet transform and third is classification of testing fingerprints as male and female fingerprints using SVM classifiers with RBF_sigma and Quadratic kernel function. The general block diagram for gender classificaiton is shown in Figure-1.

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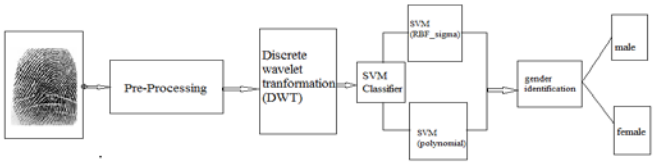

3.1 FINGERPRINT ACQUSATION:

There is no availability of separate standard fingerprints database of both male and female fingerprint as per till studied. Hence we have created own fingerprint database. The data is collected from both rural and urban areas from different age groups. "Fingkey hamster 2nd scanner is used for the fingerprint acquisition made by Nitgen biometric solution [30 with interface USB 2.0]". The gray scale of 200x200 pixels with 512 DPI resolution images ware captured and normalized accoringly [15]

3.2 PREPROCESSING:

After collection the fingerprints samples, initially preprocessing techniques are used which are application dependent. Primarily it is a color image, converted into gray scale the image size of 164x164 pixels dimensional will be reduced and saves the memory. Pre-processing back ground elimination, cropping is done to improve computer efficiency.

3.3 FEATURE EXTRACTION AND COMPUTATION:

Feature extraction and classification will take a crucial role in any classification algorithm. In this work we have used Discrete Wavelet Transform (DWT) for feature extraction and Support Vector Machines (SVM) for classification. The brief description of DWT and SVM are discussed in below sections.[16]

3.3.1. DISCRETE WAVELET TRANSFORMATION:

Discrete wavelet transform is one of the most popular mathematical tools that are used for feature extraction, denoising, detection, image compression and recognition purposes. Wavelet algorithms process data at different scales or resolutions. Multi resolution analysis with localization is performed in frequency and time domain. Temporal analysis is performed with a contracted, high-frequency version of the mother wavelet. Frequency analysis is performed with a dilated, low-frequency version of the same wavelet. Therefore original signal is its wavelet expansion (using coefficients in a linear combination of the wavelet functions) and thus data operations are performed using corresponding wavelet coefficients. Wavelet is an excellent tool in the field of digital signal and image processing. In discrete wavelet transform (DWT) wavelets are discretely sampled which captures both frequency and location information (location in time). In DWT the mother wavelet is shifted and scaled by powers of two:

$$\Psi_{j,k}(t) = \frac{1}{\sqrt{2^j}}\Psi\left(\frac{t - k2^j}{2^j}\right)$$

where j → scale parameter , k → shift parameter, both which are integers.[25]. The first level decomposition is shown in figure-2 and Figure-3 shows the three level pyramidal decomposition of image.

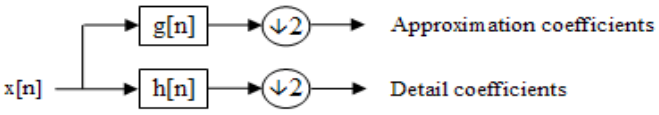

Figure 2: One level decomposition

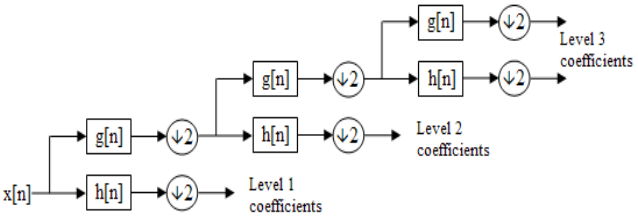

Figure-3: shows the three level decomposition.

The coefficients obtained include an approximation and three detail transform coefficients. The approximation region has more details of image and if the embedding is done in this region there will be degradation of the image. Hence the embedding is done in other detail co-efficient regions (LH, HL or HH). In the second level decomposition the LL band is decomposed producing even more sub-bands. This can be continued by decomposing in a pyramidal fashion as in figure.[17-18]

$$A_L f(x,y) = < f(x,y), \emptyset(x,y) >$$
$$D_L^V f(x,y) = < f(x,y), \Psi_L^V(x,y) >$$
$$D_L^H f(x,y) = < f(x,y), \Psi_L^H(x,y) >$$
$$D_L^D f(x,y) = < f(x,y), \Psi_L^D(x,y) >$$

3.4. FEATURE CLASSIFICATION

For the automatic fingerprint classification several techniques have been developed mainly on the basis of four main categories.[16],[19-20]

- Knowledge-based : The location of singular points like core points and delta point is used to fingerprint classification
- Structure-based: The orientation field is estimated in the finger print image to classify.
- Frequency-based: In this technique frequency spectrum of fingerprint is calculated for classification.

- Syntactic: A formal grammar of the fingerprint is used to classify the fingerprints.

In this research work we are approaching structured based classification techniques like support vector machine (RBF_sigma) and support vector machine quadratic kernel function classifies for gender classification.

3.4.1 SUPPORT VECTOR MACHINE:

Support Vector Machine (SVM) is a new classification technique based on the statistical learning theory pro-posed by Vapnik in 1995 [21]. It is a binary classifier it abstracts a decision boundary in multidimensional space using an appropriate sub set of the training set of vectors; the elements of this sub set are the support vectors. Geometrically SVM are those training patterns that are closest to the decision boundary. It is useful to understand linear discriminamnt functions and neural networks.[22-24],[27]

3.4.1.2 KERNEL FUNCTION:

The Radial Basis Function (RBF) is one of the most popular kernel and reasonable first choice because of its property of nonlinearity. Given the linearly reparability sample set (xi, yi) where i = 1,…, n. If taking the simplest case; 2 class classification, then x€Rn, y€ { + 1, − 1} is the classes number. This representation permits us to deal with the patterns and liner decision boundaries in multi-dimensional space in a flexible manner. In a d-dimensional space the decision boundary is a hyper-pane and can be represented by

$f(x) = w^t. x + b$-------- (1)

Where w and x are d-dimensional vectors, when b=0, it is a homogenous representation; otherwise it is a non homogenous representation. This representation can be used to characterise linear separability. We say the two classes 'male' and 'female' are linearly seperable, if the weight of vector w and a scalar b such that

$w^t. x + b>0$-------- (2) for all patterns x belonging to one class(for example say 'male') and

$w^t. x + b<0$-------- (3) for all patterns x belonging to another class(for example say 'female')

An attractive feature of the SVM is that this selection is implicit, with each support vectors contributing one local Gaussian function, centre at that data point.[23]

3.4.1.2 CROSS VALIDATION (CV)

Cross-validation is a statistical method of evaluating and comparing learning algorithms. Presently Cross-validation has been extensively used for estimating the performance of neural networks and other applications such as support vector machine and k-nearest neighbour. The basic idea of cross-validation is splitting the data, which is consists of training data into two sets. The first set is used to train the network, while the other is used to train the network. In typical cross-validation, the training and validation sets must cross-over in successive rounds such that each data point has a chance of being validated against. The basic form of cross-validation is k-fold cross-validation. Other forms of cross-validation are special cases of k-fold cross-validation or involve repeated rounds of k-fold cross-validation. In our experiment the support vector machine (polynomial) classifiers is used to test the accuracy using 10 fold cross validation.[24]

4. EXPERIMENTAL ANALYSIS AND DISCUSSION

In this section the performance of gender classification algorithm is verified by using internal database collected from different age groups of both rural and urban population. A real 1000 fingerprints were collected and conducted experiments on 600 samples, 300 male and 300 female fingerprints are trained and tested. The support vector machines (RBF_sigma) and SVM quadratic kernel classifiers are used with function of 10 fold cross validation.

Algorithm:
Input:- Fingerprint image
Output:- Classification of male and female fingerprint images.

Step1:- The fingerprint undergoes pre-processing i.e. noise removal, cropping etc.
Step2:- The fingerprint is converted into gray scale image.
Step3:- The gray scale image is normalized to 164x164 and defines matrix co-occurrence.
Step4:- The discrete wavelet transform statistical features were extracted.
Step5:- Apply support vector machine (RBF sigma) classifier to test the accuracy using folds cross validation.
Step6:- Apply support vector machine (polynomial) classifiers to test the accuracy using 10 fold cross validation.
End of algorithm

From the above algorithm result obtained is showed in table 1 and table 2. Table 1 gives the confusion matrix of the data set and table 2 gives the classification rate using SVM (RBF_sigma) and SVM quadratic kernel function.

Support Vector Machine (Quadratic)		**Support Vector Machine (RBF_sigma)**	
Male	Female	Male	Female
270	36	291	45
30	264	09	255

Table 1: Confusion matrix

Classifier	**Overall Accuracy**
SVM(RBF_sigma)(sigma=2)	91%
SVM(polynomial)	89%

Table 2: Result using SVM (polynomial &RBF signal)

5. Conclusions and Future work

In this paper we have described an automated gender classification system using computer vision and machine learning techniques. A gender classification using fingerprints based on support vector machine with 10-cross validation technique. The discrete wavelet transforms (DWT) is used to compute the features and SVM classifier is used to classify the male and female. From the experimental work an 89 % and 91% classification rate is achieved for using SVM (RBsigma) and SVM (polynomial) classifier respectively. The significant thing in this work is that SVM (RBF) classifier has given good classification accuracy and more competitive when compared to other results available in the literature.

Further, there is an opportunity for greater pragmatism in biometrics, though this will doubtlessly require more sophisticated features and modelling strategies are required for gender classification in near future.

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