Gender Classification based on Fingerprints using SVM

Romany F. Mansour[1,2], Abdulsamad Al-Marghilnai[3], Meshrif Alruily[4]
[1]Department of Computer Science, Faculty of Science, Northern Border University, Arar, Saudi Arabia
[2]Department of Science and Mathematics, Faculty of Education, N.V., Assiut University, Assiut, Egypt
[3]College of Computer Science & Information, Northen Border University, Arar, Saudi Arabia,
[4]College of Computer Science & Information, Aljuof University, Skaka, Saudi Arabia

Keywords: Fingerprint, Gender Classification, SVM, Biometrics.

Abstract: The fingerprint is commonly used biometric method for person identification. It is the most conventional and widely used technique in forensics and criminalities. Identification of the person's age and gender based on his/her fingerprint is an important step in overall person's identification. The aim of this research paper is to propose a gender classification technique based on fingerprint characteristics of individuals using discrete cosine transform (DCT). Gender classification evaluated using dimensionality reduction techniques such as Principal Component Analysis (PCA), along with Support Vector Machine (SVM). A dataset of 2600 persons of different ages and sex was collected as internal database. Of the samples tested, 1250 samples of 1375 exactly identified male samples and 1085 samples of 1225 exactly identified female samples.

1 INTRODUCTION

The fingerprint is commonly used biometric method for person identification. It is the most conventional and widely used technique in forensics and criminalities. Identification of the person's age and gender based on his/her fingerprint is an important step in overall person's identification; this area still needs more work (IBG 2007; Kralik M. & Novotny V.2003; Hall J. & Kimura D.1994; Karine C.et al 2000 and Acree & Mark A.,1999). (Badawi et al 2006) indicated that gender classification is the most important step in forensic anthropology that can be used to reduce the list of suspects and reduce the search domain.

There is evidence that male and females fingerprint characteristics - such as ridge count, thickness and density - are different. Accra showed that females have a higher ridge density (Acree, Mark A.,1999 and Gungadin S 2007) while Kralik showed that the males have higher ridge breadth (Hall J. & Kimura D.1994). Also, researchers showed that both males and females have higher rightward directional asymmetry in the ridge count (Karine C.et al 2000 and Acree & Mark A.,1999; Badawi et al 2006 and Sanders G.& Kadam A.2001) with the asymmetry being higher in males than females (Austin R.et al 2001) . Figure 1 shows an example of two different fingerprints for a male and female.

(Gnanaswami et al., 2012) proposed a method based on discrete wavelet transform (DWT) and singular value decomposition (SVD). K nearest neighbor (KNN) is used as a classifier and overall correct classification rate of 88% is achieved. (Ritu et.al 2012) used frequency domain analysis for fingerprint based gender identification. The classification is obtained by analyzing fingerprints using Fast Fourier transform (FFT) and other techniques. Tom, et al, (Rijo et al 2013)] has proposed a technique based on frequency domain analysis to estimate gender. They achieved an overall accuracy rate of 70%.

The aim of this research paper is to propose a gender classification technique based on fingerprint characteristics of the individual. In section 2 research approach is discussed, results are presented in section 3 and we conclude in section 4.

2 RESEARCH APPROACH

2.1 The Major Feature

The gender of each person can be learned from the features of their fingerprints. General features

F. Mansour R., Al-Marghilnai A. and Alruily M..
Gender Classification based on Fingerprints using SVM.
DOI: 10.5220/0004721602410244
In *Proceedings of the 6th International Conference on Agents and Artificial Intelligence* (ICAART-2014), pages 241-244
ISBN: 978-989-758-015-4

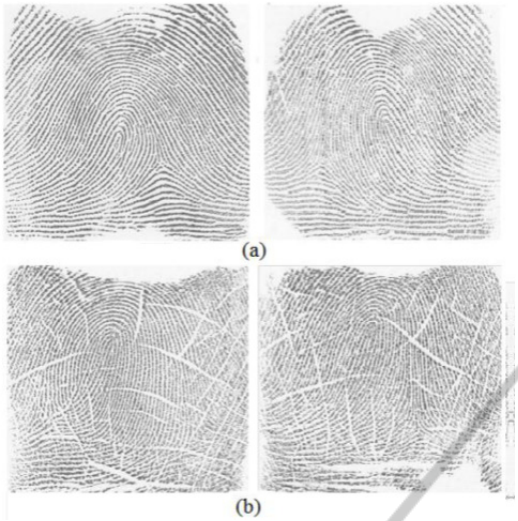

Figure 1: Example of Two different fingerprints for a male and female: (a) Two different fingerprints for a male showing no (or few) white lines and small RTVTR and (b) Two different fingerprints for a female showing large count of white lines and large RTVTR (Badawi et al 2006).

include RTVTR, fingerprint pattern type, line count, and the type of pattern matching between corresponding left and right tracks. The average ratio between the ridge thickness and the valley thickness for each of the fingerprints is computed and an average ratio is computed for every person.

For each fingerprint the white lines count and ridge count are extracted manually; then, the average white lines count as well as the ridge count was calculated for each subject. Pattern type is extracted manually for each fingerprint. The pattern type concordance was calculated for the fingerprints of each right-left corresponding fingerprint pair for the subject (1 if the corresponding fingerprints have the

The ridge count asymmetry between the right-left corresponding fingerprints of a person is calculated. The asymmetry is 1 for a left-right corresponding fingerprint pair if the ridge count of the left fingerprint is greater than the right one, is -1 if it is smaller, and is 0 if both ridge counts are equal.The pre-classification steps include image enhancement, noise reduction, binarization and extraction of features; same approach used by (Girgis et al 2009)followed.

2.2 Classification Methods

The frequency domain approach is adopted where the DCT is used to analyze figure print properties and obtain its vectors of coefficient. Once a database of fingerprint is obtained, PCA is used to reduce data dimensionality and identify sets of unique characteristics are called the principal components. The most significant m vectors are then chosen on the basis of the eigenvalues. The value of m is chosen by considering the cumulative sum of the eigenvalues. The features of an image x are then computed by projecting it into the space spanned by the eigenvectors. These feature vectors are used during training and classification. Support vector machine (SVM) is used to classify the subjects according to their gender. SVM results are compared with Fisher linear discriminant and quadratic discriminant function results (Kirby M. & Sirovich L.,1990; Moghaddam, B.& Yang M.2000 and Belhumeur V.et al 1997).

3 RESULTS

Two databases were used for testing the performance of the gender classification system. The databases were named as ‘synthetic’ and ‘internal dataset’. The first was synthetically generated database (DB4) from the FVC2006 competition (Jayadevan R.et al 2006). The second was the database in which the Fingerprint samples were scanned from 2600 persons of different ages and gender (1375 males, and 1225 females) were obtained from different places that used biometric fingerprint sensor for marking the attendance and were analyzed using frequency domain analysis. The images in the entire two databases had a size of 240x320 pixels and have a resolution of 500dpi. The developed algorithm has been tested using the MAT LAB 7.1.

3.2 Compute RTVTR

Measuring the Ridge thickness to valley thickness ratio (RTVTR), the following results were getting for 20 randomly selected samples. The result shows that the females have a higher RTVTR compared to the males as shown in figures 2 and 3.

3.3 Compute Ridge Count

Ridge count is the number of ridges occurred in a particular region of a particular section of the fingerprint. The result of the Ridge count is shown in the table 1 below, and it shows that the males have a slightly higher ridge count than the females.

From the results above, three observations can rightly be made firstly the females have a higher

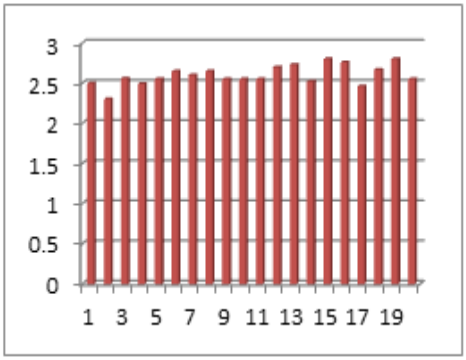

Figure 2: A histogram of the RTVTR obtained for females.

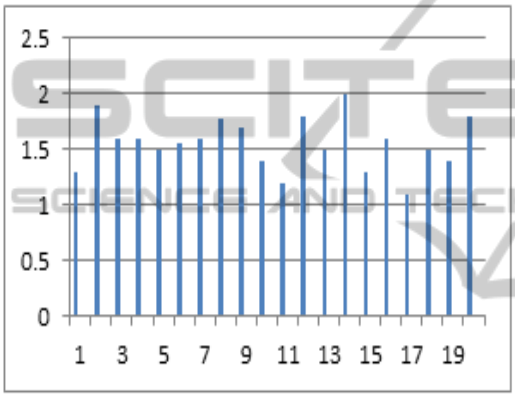

Figure 3: A histogram of the RTVTR obtained for males.

ridge thickness to valley thickness ratio than the males, secondly the Males has a slightly higher ridge count than the females. And there is no particular relationship between the age of subjects and their fingerprint pattern, as it does not change (only as a result of accident or mutation). Table 2 shows the comparison between SVM and other classifiers techniques.

Table 2: Comparison between SVM and other classifiers techniques.

Classifier	Error Rate		
	Overall	Male	Female
SVM	10.2 %	9.1 %	11.4 %
FLD	50.7 %	49.4 %	52.4 %
Quadratic classifier	40. 9 %	36.7 %	44.8 %

Table 1: The result of the ridge count.

# image	Males	Females
1	14.642	13.661
2	14.352	13.781
3	14.253	12.978
4	13.948	13.465
5	14.645	13.875
6	16.473	13.667
7	14.731	13.657
8	14.532	13.898
9	14.572	13.675
10	14.493	13.643
11	14.343	13.794
12	14.637	13.103
13	15.362	13.133
14	14.546	12.981
15	14.691	13.408
16	15.356	13.675
17	14.572	13.223
18	14.478	13.454
19	14.398	13.107
20	14.604	14.134

4 CONCLUSIONS

The aim of this research paper was to propose a gender classification technique based on fingerprint characteristics of individuals using discrete cosine transform (DCT). Gender classification evaluated using dimensionality reduction techniques such as Principal Component Analysis (PCA), along with Support Vector Machine (SVM). To classify, we extracted the most significant features based DCT existing database. These features were used to train the SVM classifier. The experimental results showed that the proposed system can be used as a primary candidate in forensic anthropology with an accuracy of 96.39%. For DB4, and from the internal database, 1,375 samples were tested 1,225 men and women samples. The optimal threshold for each transformation is chosen for best results. It is found that SVM produces an accurate decision about 92 % for women and 76 % for men. SVM provides greater accuracy compared to other existing techniques.

REFERENCES

Acree, Mark A.,1999, *"Is there a gender difference in fingerprint ridge density?."* Forensic science international 102.1, 35-44.

Austin R., Christopher L., 2001, *"Implications of the IDENT/IAFIS Image Quality Study for Visa Fingerprint Processing"*, Mitertek Systems (MTS).

Badawi A., Mahfouz M., Tadross R., and Jantz R., 2006, "Fingerprint-Based Gender Classification," In *Proc. of the International Conference on Image Processing, Computer Vision, Pattern Recognition*, Las Vegas, Nevada, USA, Vol. 1.

Belhumeur V., Hespanha J., and Kriegman D., 1997," Eigenfaces vs.fisherfaces: Recognition using class specific linear projection", *Transactions on Pattern Analysis and Machine Intelligence*, PAMI19 (7): 711–720.

Girgis M., Sewisy A., Mansour R., 2009, *"A robust method for partial deformed fingerprints verification using genetic algorithm"*, Expert Systems with Applications 36, PP. 2008–2016.

Gnanasivam .P, and Dr. Muttan S,2012, "Gender Identification Using Fingerprint through Frequency Domain analysis" *IJCSI International Journal of Computer Science Issues*, Vol. 9, Issue 2, No 3.

Gungadin S. 2007, "Sex Determination from Fingerprint Ridge Density". *Internet Journal of Medical*;2(2):4-7.

Hall J. and Kimura D.1994, *Dermatoglyphic asymmetry and Sexual Orientation in Men. Behavioral Neuroscience*, 108, 1203-1206.

IBG, 2007. Biometrics Market and Industry Report. IBG: NY.

Jayadevan R., Jayant Kulkarni V., Suresh N. Mali,Hemant K.,2006,"A New Ridge Orientation based method for feature extraction from fingerprint images, " *Proceedings of World Academy of Science, Engineering and Technology*, Volume 13.

Karine C., Christopher M. and Martin L.2000, *"Birth Order, Birth Interval, and Deviant Sexual Preferences among Sex Offenders."* Sexual Abuse: A Journal of Research and Treatment, Vol. 4, No. 1.

Kirby M., Sirovich L., 1990,"Application of the Karhunen-Loeve procedure for the characterization of human faces" *IEEE Trans. Pattern. Anal Machine Intelligence*, vol. 12, no. 1, pp. 103-108.

Kralik, M., Novotny V. 2003," Epidermal ridge breadth: an indicator of age and sex in paleodermatoglyphics", Variability and Evolution, Vol. 11: 5–30.

Moghaddam, B.; Yang M., 2000, "Gender classification with support vector machines. In: Automatic Face and Gesture Recognition", 2000. *Proceedings. Fourth IEEE International Conference on. IEEE*, p. 306-311.

Rijo J., Arulkumaran T., 2013 "Fingerprint Based Gender Classification Using 2D Discrete Wavelet Transforms and Principal Component Analysis". *International Journal of Engineering Trends and Technology*, Volume 4 Issue 2.

Ritu K. and Susmita G., 2012, "Fingerprint Based Gender Identification using Frequency Domain Analysis". *International Journal of Advances in Engineering & Technology*.

Sanders G., Kadam A. 2001, *"Prepubescent children show the adult relationship between dermatoglyphic asymmetry and performance on sexually dimorphic tasks."*, Cortex., 37(1):91-100.